

04-08-2020

Laboratorio No 4

1) Ejercicio 1

$\begin{matrix} Y \\ C \end{matrix} \backslash AB$	00	01	11	10
0	1	1	0	1
1	0	0	1	1

$$\bar{A}\bar{B}Y = \bar{A}\bar{C} + \bar{B}\bar{C} + AC$$

2)

	00	01	11	10
0	1	0	0	X
1	X	0	0	1

$$Y = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C$$

$$Y = \bar{B}$$

3)

$C \backslash AB$	00	01	11	10
00	1	0	1	0
01	0	1	0	0
11	1	0	1	0
10	0	1	0	1

$$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D$$

4) $Y = A\bar{D} + AC + AB$

	00	01	11	10
00	X	0	1	1
01	X	X	1	0
11	0	X	1	1
10	X	0	X	X

$$A\bar{C}\bar{D} + A\bar{C}D = A\bar{C}\bar{D}$$

$$A\bar{C}\bar{D} + A\bar{C}D = A\bar{C}$$

$$A\bar{C} + A\bar{C} + A\bar{C} = A\bar{C}$$

$$= AB$$

exercício 2

$$1) Y = ABC\bar{D} + A\cdot\overline{BCD} + (\overline{A+B+C+D})$$

$$Y = \overline{BCD} + A\bar{D} + A\bar{C} + A\bar{B}$$

~~ABCD~~

A	B	C	D	Y	00	01	11	10
0	0	0	0	1	00	11	0	1
0	0	0	1	0	01	0	0	1
0	0	1	0	0	11	0	0	1
0	0	1	1	0	10	0	0	1

A	B	C	D	Y
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

$$2) Y = \bar{A}B\bar{C} + \overline{B\bar{C}} + B\bar{C}$$

$$Y = \bar{B} + C$$

A	B	C	Y	00	01	11	10
✓ 0	0	0	1	0	1	0	1
✓ 0	0	1	1	1	1	1	1
0	1	0	0	0	0	0	0
✓ 0	1	1	1	x	0	x	1
✓ 1	0	0	1	x	x	1	1
✓ 1	0	1	1	x	1	0	1
1	1	0	0	x	0	0	0
✓ 1	1	1	1	x	1	1	1

$$4) Y = BC + \bar{A}\bar{B}\bar{C} + B\bar{C}$$

$$Y = \bar{A}\bar{C} + B$$

A	B	C	Y	00	01	11	10
✓ 0	0	0	1	0	1	1	1
0	0	1	0	1	0	1	1
✓ 0	1	0	1	0	1	1	1
✓ 0	1	1	1	0	1	1	1
1	0	0	0	x	1	x	1
1	0	1	0	0	x	0	1
✓ 1	1	0	1	x	1	1	1
✓ 1	1	1	1	x	1	1	1

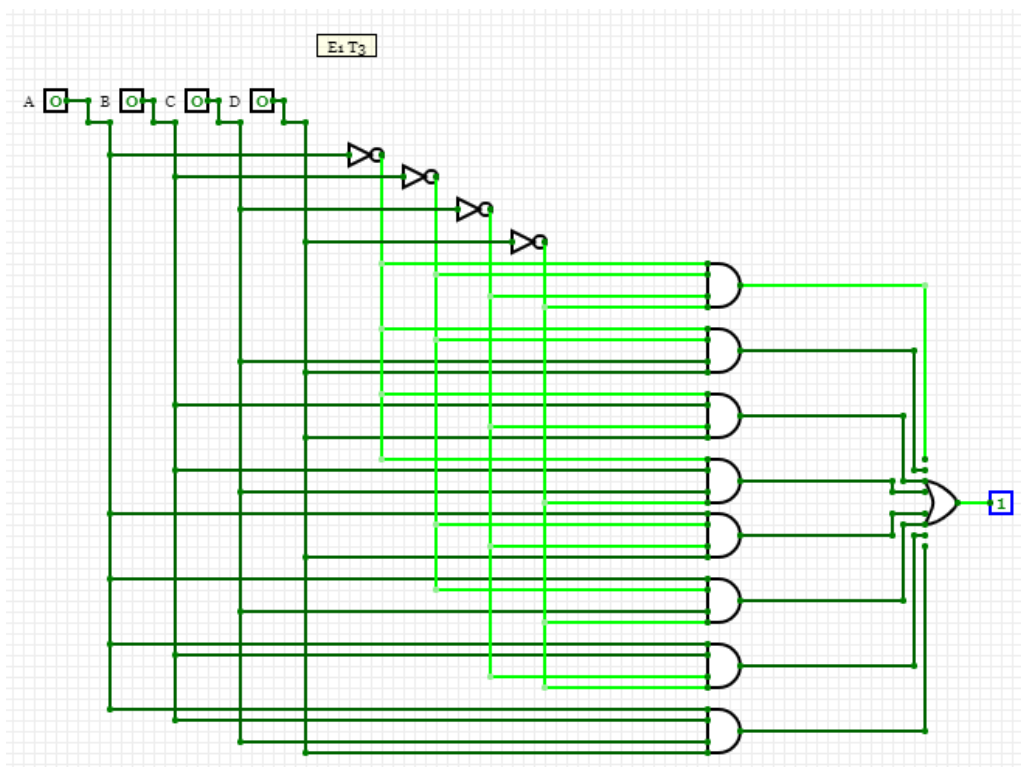
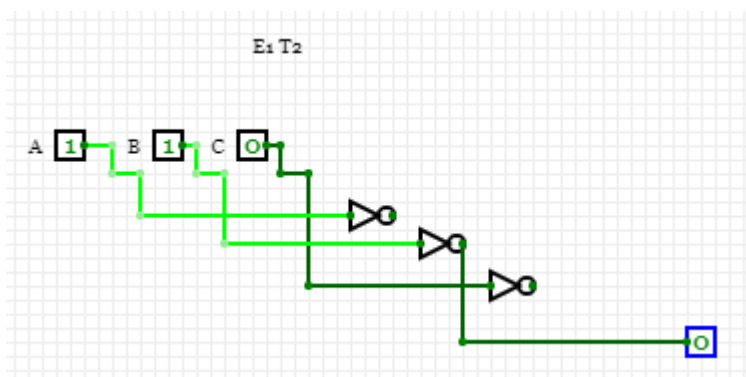
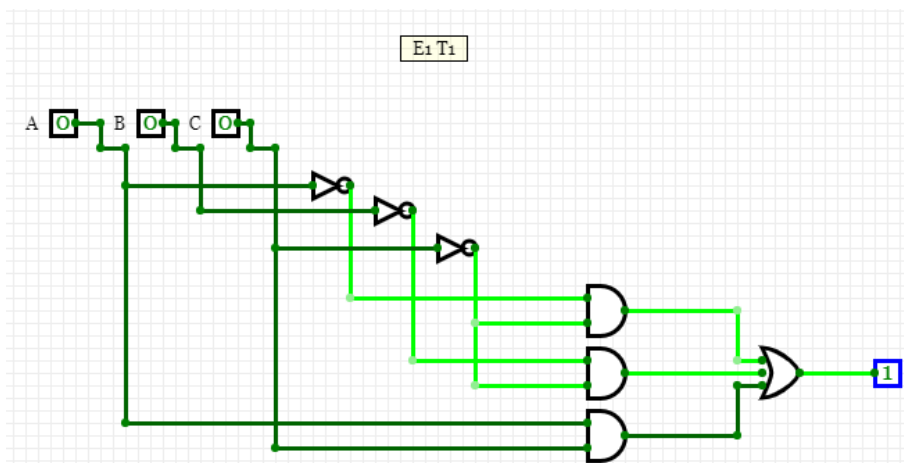
3) $Y = (\overline{A+B+C}) \cdot D + A \cdot D + B$ $(\overline{ABC} \cdot D) + AD + B$

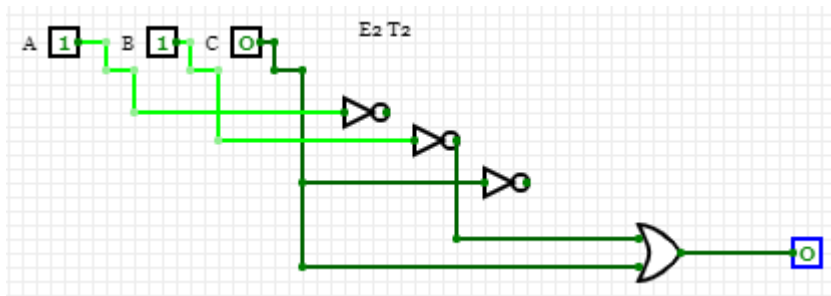
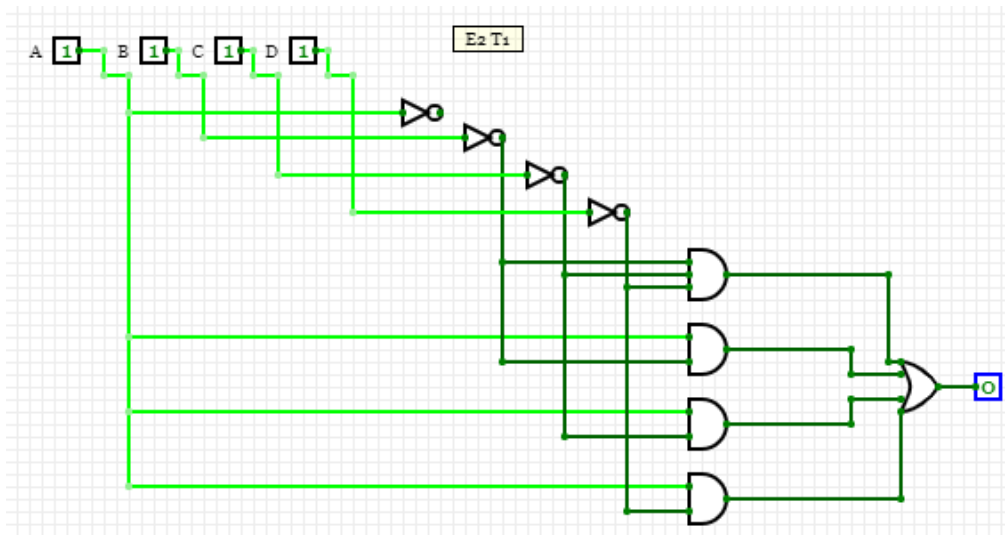
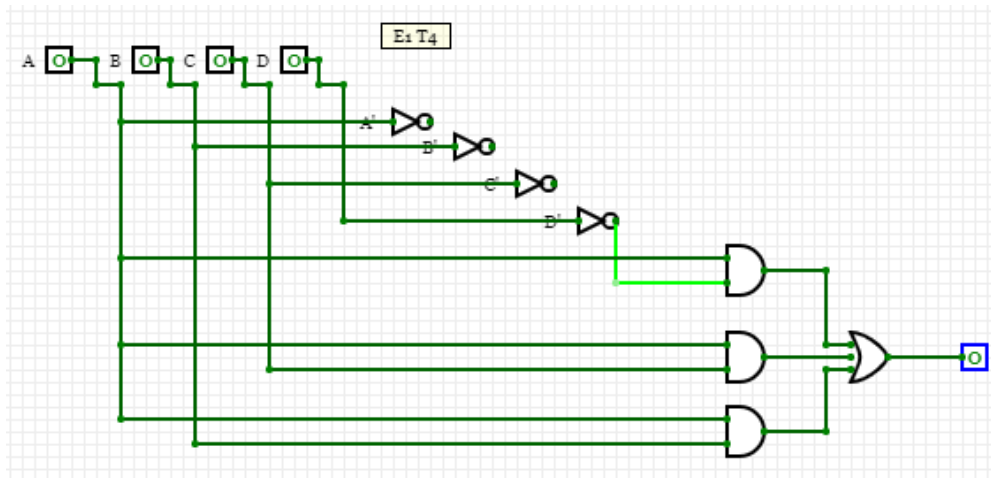
$Y = D + B$

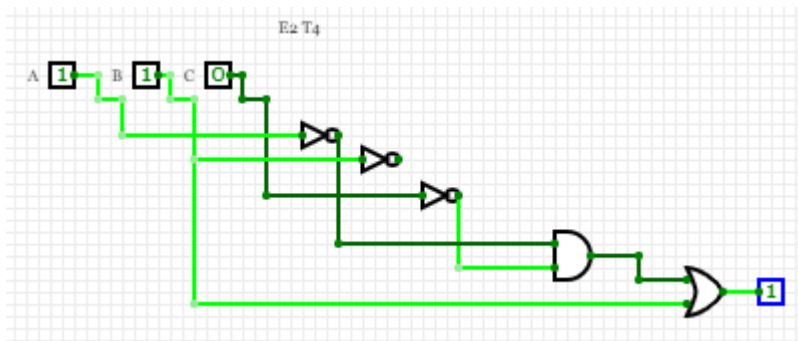
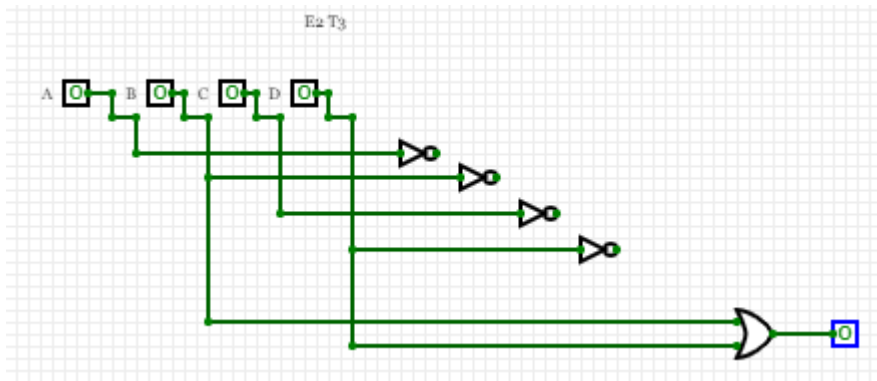
A	B	C	D	Y	00	01	11	10
0	0	0	0	0	0	1	1	0
0	0	0	1	1	1	1	1	1
0	0	1	0	0	1	1	1	1
0	0	1	1	1	0	1	1	0
0	1	0	0	1				
0	1	0	1	1				
0	1	1	0	1				
0	1	1	1	1				
1	0	0	0	0				
1	0	0	1	1				
1	0	1	0	0				
1	0	1	1	1				
1	1	0	0	1				
1	1	0	1	1				
1	1	1	0	1				
1	1	1	1	1				

A	B	C	D	Y
1	x	x	0	1
1	1	x	x	1
x	x	x	1	1

$Y = \overline{BC} + \overline{BA} + \overline{CA} = Y$







```

// -----
module tab1a1_1(input wire A, B, C, output wire Y);

// Elementos
// reg A, B, C;

    wire w1,w2,w3,w4,w5,w6,w7;
// compuertas
not U1 (w1, A);           //A'
not U2 (w2, B);           //B'
not U3 (w3, C);           //C'
not U4 (w4, D);           //D'
and a1 (w5, w1, w3);       //A'C'
and a2 (w6, w2, w3);       //B'C'
and a3 (w7, A, C);         //AC
or o1 (Y, w5,w6,w7);       //Salida

endmodule

// -----
// Ejercicio 1 Tabla 2/Gate Level Modelling
// -----

module tab1a1_2(input wire A, B, C, output wire Y);

// Elementos
// reg A, B, C;
    wire w2;
// compuertas
not U2 (Y, B);             //B'=Salida

endmodule

```



```

// -----
// Ejercicio 1 Tabla 3/Gate Level Modelling
// -----
module tabla1_3(input wire A, B, C, D, output wire Y);

// Elementos
// reg A, B, C, D;
wire w1,w2,w3,w4,w5,w6,w7,w8,w9,w10,w11,w12;
// compuertas
not U1 (w1, A);           //A'
not U2 (w2, B);           //B'
not U3 (w3, C);           //C'
not U4 (w4, D);           //D'
and a1 (w5, w1, w2, w3, w4); //A'B'C'D'
and a2 (w6, w1, w2, C, D); //A'B'CD
and a3 (w7, w1, B, w3, D); //ABCD
and a4 (w8, w1, B, C, w4); //ABCD
and a5 (w9, A, B, w3, w4); //ABCD
and a6 (w10, A, B, C, D); //ABCD
and a7 (w11, A, w2, w3, D); //ABCD
and a8 (w12, A, w2, C, w4); //ABCD
or o1 (Y, w5,w6,w7,w8,w9,w10,w11,w12); //Salida

endmodule

// -----
// Ejercicio 1 Tabla 4/Gate Level Modelling
// -----
module tabla1_4(input wire A, B, C, D, output wire J);

// Elementos
wire j1,j2,j3,j4;
// compuertas
not U1 (j1, D);           //D'
and a1 (j2, A, j1);       //AD'
and a2 (j3, A, C);        //AC
and a3 (j4, A, B);        //AB
or o1 (J, j2, j3, j4);    //AD'+AC+AB

endmodule

```

```

// -----
// Ejercicio 2 Tabla 1/Operadores Logicos
// -----
module tabla2_1(input wire A,B,C,D, output wire Y);

assign Y = (~B&~C&~D) | (A&~B) | (A&~C) | (A&~D);

endmodule

// -----
// Ejercicio 2 Tabla 2/Operadores Logicos
// -----
module tabla2_2(input wire A,B,C, output wire Y);

    assign Y = ~B | C;

endmodule

// -----
// Ejercicio 2 Tabla 3/Operadores Logicos
// -----
module tabla2_3(input wire A,B,C,D, output wire Y);

    assign Y = B | D ;

endmodule

// -----
// Ejercicio 2 Tabla 4/Operadores Logicos
// -----
module tabla2_4(input wire A,B,C, output wire Y);

    assign Y = ~A&~C | B ;

endmodule

module testbench();

    reg A1, B1, C1,          //Entradas Ejercicio 1
        A2, B2, C2,
        A3, B3, C3, D3,
        A4, B4, C4, D4,
        p1, p2, p3, p4,     //Entradas Ejercicio 2
        p5, p6, p7,
        p8, p9, p10, p11,
        p12, p13, p14;
    wire Y1, Y2, Y3, Y4, //Salidas Ejercicio 1
        e1, e2, e3, e4; //Salidas Ejercicio 2

    //-----Modulos Ejercicio 1-----
    tabla1_1 T1_1(A1, B1, C1, Y1);
    tabla1_2 T1_2(A2, B2, C2, Y2);
    tabla1_3 T1_3(A3, B3, C3, D3, Y3);
    tabla1_4 T1_4(A4, B4, C4, D4, Y4);

    //-----Modulos Ejercicio 2-----
    tabla2_1 T2_1(p1,p2,p3,p4,e1);
    tabla2_2 T2_2(p5,p6,p7,e2);
    tabla2_3 T2_3(p8,p9,p10,p11,e3);
    tabla2_4 T2_4(p12,p13,p14,e4);

```

```

//Simulación Ejercicio 1
//-----

//-----tabla 1-----
initial begin
    $display("Ejercicio 1 Tabla 1");
    $display("A B C | Y ");
    $display("-----|-----");
    $monitor("%b %b %b | %b", A1, B1, C1, Y1);
    A1 = 0; B1 = 0; C1 = 0;
    #1 A1 = 0; B1 = 0; C1 = 1;
    #1 A1 = 0; B1 = 1; C1 = 0;
    #1 A1 = 0; B1 = 1; C1 = 1;
    #1 A1 = 1; B1 = 0; C1 = 0;
    #1 A1 = 1; B1 = 0; C1 = 1;
    #1 A1 = 1; B1 = 1; C1 = 0;
    #1 A1 = 1; B1 = 1; C1 = 1;
end

//-----tabla 2-----
initial begin
    #20
    $display("Ejercicio 1 Tabla 2");
    $display("A B C | Y");
    $display("-----|--");
    $monitor("%b %b %b | %b", A2, B2, C2, Y2);
    A2 = 0; B2 = 0; C2 = 0;
    #1 A2 = 0; B2 = 0; C2 = 1;
    #1 A2 = 0; B2 = 1; C2 = 0;
    #1 A2 = 0; B2 = 1; C2 = 1;
    #1 A2 = 1; B2 = 0; C2 = 0;
    #1 A2 = 1; B2 = 0; C2 = 1;
    #1 A2 = 1; B2 = 1; C2 = 0;
    #1 A2 = 1; B2 = 1; C2 = 1;
end

```

```

//-----tabla 3-----
initial begin
    #30
    $display("Ejercicio 1 Tabla 3");
    $display("A B C D | Y ");
    $display("-----|---");
    $monitor("%b %b %b %b | %b", A3, B3, C3, D3, Y3);
    A3 = 0; B3 = 0; C3 = 0; D3 = 0;
    #1 A3 = 0; B3 = 0; C3 = 0; D3 = 1;
    #1 A3 = 0; B3 = 0; C3 = 1; D3 = 0;
    #1 A3 = 0; B3 = 0; C3 = 1; D3 = 1;
    #1 A3 = 0; B3 = 1; C3 = 0; D3 = 0;
    #1 A3 = 0; B3 = 1; C3 = 0; D3 = 1;
    #1 A3 = 0; B3 = 1; C3 = 1; D3 = 0;
    #1 A3 = 0; B3 = 1; C3 = 1; D3 = 1;
    #1 A3 = 1; B3 = 0; C3 = 0; D3 = 0;
    #1 A3 = 1; B3 = 0; C3 = 0; D3 = 1;
    #1 A3 = 1; B3 = 0; C3 = 1; D3 = 0;
    #1 A3 = 1; B3 = 0; C3 = 1; D3 = 1;
    #1 A3 = 1; B3 = 1; C3 = 0; D3 = 0;
    #1 A3 = 1; B3 = 1; C3 = 0; D3 = 1;
    #1 A3 = 1; B3 = 1; C3 = 1; D3 = 0;
    #1 A3 = 1; B3 = 1; C3 = 1; D3 = 1;

end

//-----tabla 4-----
initial begin
    #50
    $display("Ejercicio 1 Tabla 4");
    $display("A B C D | Y");
    $display("-----|---");
    $monitor("%b %b %b %b | %b", A4, B4, C4, D4, Y4);
    A4 = 0; B4 = 0; C4 = 0; D4 = 0;
    #1 A4 = 0; B4 = 0; C4 = 0; D4 = 1;
    #1 A4 = 0; B4 = 0; C4 = 1; D4 = 0;
    #1 A4 = 0; B4 = 0; C4 = 1; D4 = 1;
    #1 A4 = 0; B4 = 1; C4 = 0; D4 = 0;
    #1 A4 = 0; B4 = 1; C4 = 0; D4 = 1;
    #1 A4 = 0; B4 = 1; C4 = 1; D4 = 0;
    #1 A4 = 0; B4 = 1; C4 = 1; D4 = 1;
    #1 A4 = 1; B4 = 0; C4 = 0; D4 = 0;
    #1 A4 = 1; B4 = 0; C4 = 0; D4 = 1;
    #1 A4 = 1; B4 = 0; C4 = 1; D4 = 0;
    #1 A4 = 1; B4 = 0; C4 = 1; D4 = 1;
    #1 A4 = 1; B4 = 1; C4 = 0; D4 = 0;
    #1 A4 = 1; B4 = 1; C4 = 0; D4 = 1;
    #1 A4 = 1; B4 = 1; C4 = 1; D4 = 0;
    #1 A4 = 1; B4 = 1; C4 = 1; D4 = 1;

```



```

//-----
//Simulación Ejercicio 2
//-----
//-----tabla 4l-----
initial begin
    #70
    $display("Ejercicio 2 Tabla 1");
    $display("A B C D | Y");
    $display("-----|---");
    $monitor("%b %b %b %b | %b", p1, p2, p3, p4,
    .....
    p1 = 0; p2 = 0; p3 = 0; p4 = 0;
    #1 p1 = 0; p2 = 0; p3 = 0; p4 = 1;
    #1 p1 = 0; p2 = 0; p3 = 1; p4 = 0;
    #1 p1 = 0; p2 = 0; p3 = 1; p4 = 1;
    #1 p1 = 0; p2 = 1; p3 = 0; p4 = 0;
    #1 p1 = 0; p2 = 1; p3 = 0; p4 = 1;
    #1 p1 = 0; p2 = 1; p3 = 1; p4 = 0;
    #1 p1 = 0; p2 = 1; p3 = 1; p4 = 1;
    #1 p1 = 1; p2 = 0; p3 = 0; p4 = 0;
    #1 p1 = 1; p2 = 0; p3 = 0; p4 = 1;
    #1 p1 = 1; p2 = 0; p3 = 1; p4 = 0;
    #1 p1 = 1; p2 = 0; p3 = 1; p4 = 1;
    #1 p1 = 1; p2 = 1; p3 = 0; p4 = 0;
    #1 p1 = 1; p2 = 1; p3 = 0; p4 = 1;
    #1 p1 = 1; p2 = 1; p3 = 1; p4 = 0;
    #1 p1 = 1; p2 = 1; p3 = 1; p4 = 1;
end

//-----tabla 2-----
initial begin
    #90
    $display("Ejercicio 2 Tabla 2");
    $display("A B C | Y");
    $display("-----|---");
    $monitor("%b %b %b | %b", p5, p6, p7, e2);
    .....
    p5 = 0; p6 = 0; p7 = 0;
    #1 p5 = 0; p6 = 0; p7 = 1;
    #1 p5 = 0; p6 = 1; p7 = 0;
    #1 p5 = 0; p6 = 1; p7 = 1;
    #1 p5 = 1; p6 = 0; p7 = 0;
    #1 p5 = 1; p6 = 0; p7 = 1;
    #1 p5 = 1; p6 = 1; p7 = 0;
    #1 p5 = 1; p6 = 1; p7 = 1;
end

```

```

#100
$display("Ejercicio 2 Tabla 3");
$display("A B C D | Y ");
$display("-----|---");
$monitor("%b %b %b %b | %b", p8, p9, p10, p11, e3);
...
p8 = 0; p9 = 0; p10 = 0; p11 = 0;
#1 p8 = 0; p9 = 0; p10 = 0; p11 = 1;
#1 p8 = 0; p9 = 0; p10 = 1; p11 = 0;
#1 p8 = 0; p9 = 0; p10 = 1; p11 = 1;
#1 p8 = 0; p9 = 1; p10 = 0; p11 = 0;
#1 p8 = 0; p9 = 1; p10 = 0; p11 = 1;
#1 p8 = 0; p9 = 1; p10 = 1; p11 = 0;
#1 p8 = 0; p9 = 1; p10 = 1; p11 = 1;
#1 p8 = 1; p9 = 0; p10 = 0; p11 = 0;
#1 p8 = 1; p9 = 0; p10 = 0; p11 = 1;
#1 p8 = 1; p9 = 0; p10 = 1; p11 = 0;
#1 p8 = 1; p9 = 0; p10 = 1; p11 = 1;
#1 p8 = 1; p9 = 1; p10 = 0; p11 = 0;
#1 p8 = 1; p9 = 1; p10 = 0; p11 = 1;
#1 p8 = 1; p9 = 1; p10 = 1; p11 = 0;
#1 p8 = 1; p9 = 1; p10 = 1; p11 = 1;
end

//-----tabla 4-----
initial begin
#120
$display("Ejercicio 2 Tabla 4");
$display("A B C | Y");
$display("-----|---");
$monitor("%b %b %b | %b", p12, p13, p14, e4);
...
p12 = 0; p13 = 0; p14 = 0;
#1 p12 = 0; p13 = 0; p14 = 1;
#1 p12 = 0; p13 = 1; p14 = 0;
#1 p12 = 0; p13 = 1; p14 = 1;
#1 p12 = 1; p13 = 0; p14 = 0;
#1 p12 = 1; p13 = 0; p14 = 1;
#1 p12 = 1; p13 = 1; p14 = 0;
#1 p12 = 1; p13 = 1; p14 = 1;
end

initial
#130 $finish;

//-----GTKWAVE-----
initial begin
$dumppfile("lap_tb.vcd");
$dumppvars(0, testbench);
end

endmodule

```

Ejercicio 5

Entradas: Sistema Alarma armado (A),
sensores ventana / puerta (B) y sensor
movimiento (C)

Salidas: sonar alarma y encender luces (Y)

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

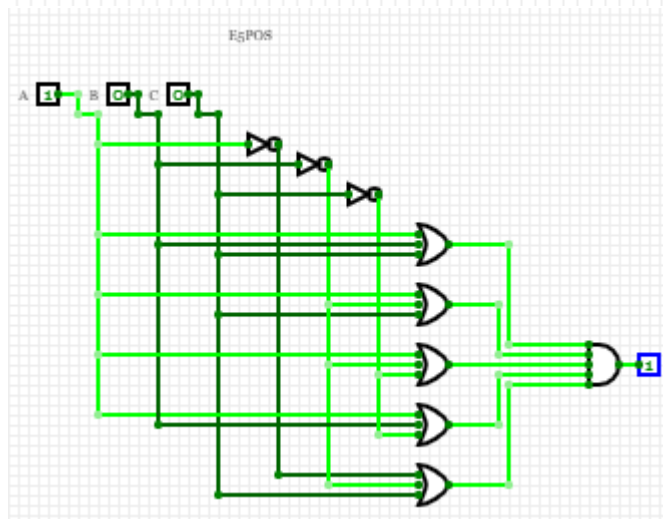
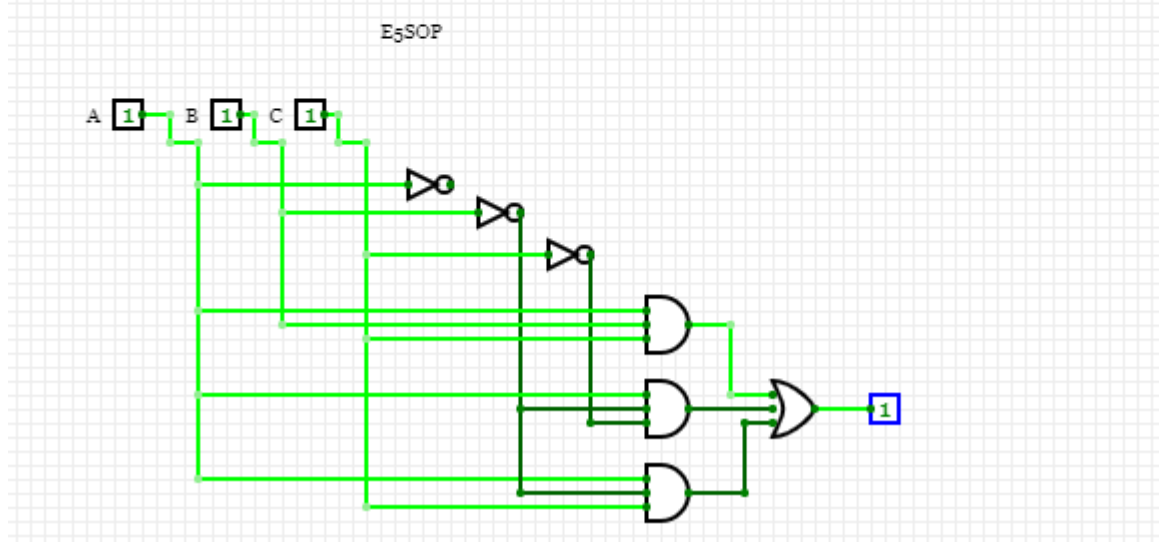
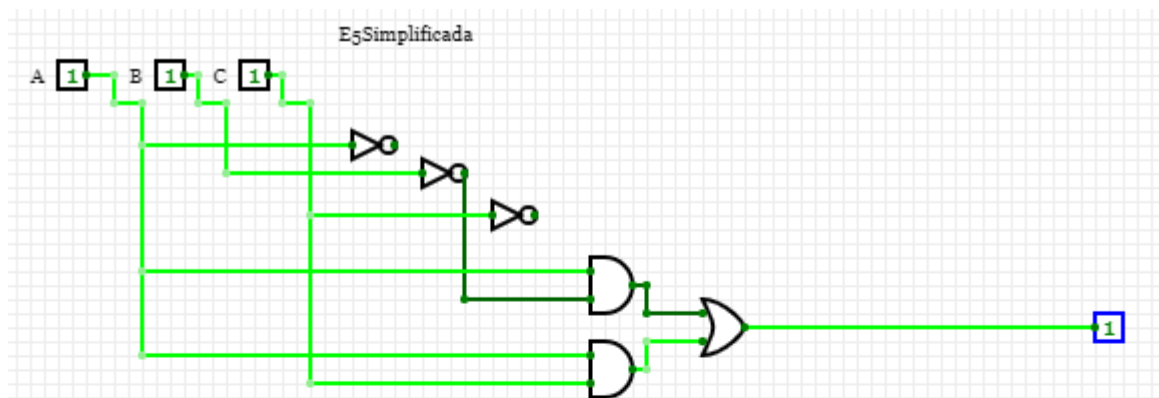
$$Y = A\bar{B} + AC$$

SOP

$$A\bar{B}\bar{C} + A\bar{B}C + ABC$$

POS

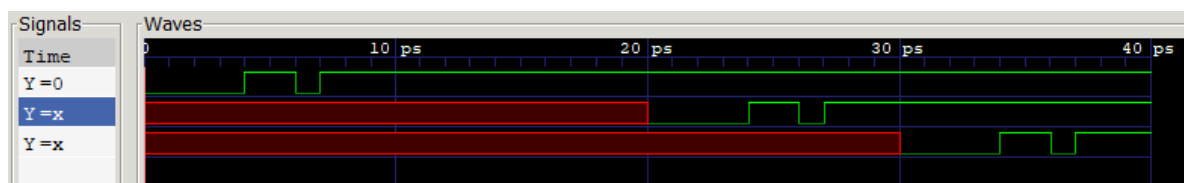
$$(A+B+C) \cdot (A+B+\bar{C}) \cdot (A+\bar{B}+C) \cdot (\bar{A}+\bar{B}+C) \cdot (A+\bar{B}+C')$$




```

Tabla Simplificada
A B C | Y
-----|-----
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 1
1 0 1 | 1
1 1 0 | 0
1 1 1 | 1
VCD info: dumpfile ej5_tb.vcd opened for output.
Tabla SOP
A B C | Y
-----|-----
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 1
1 0 1 | 1
1 1 0 | 0
1 1 1 | 1
Tabla POS
A B C | Y
-----|-----
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 1
1 0 1 | 1
1 1 0 | 0
1 1 1 | 1

```



```

// -----
// José Alejandro Garza Aguirre
// Digital
// lab4
// -----
// Ejercicio 5 Simplificada /Gate Level Modelling
// -----
module t5_S(input wire A, B, C, output wire Y);

    // Elementos

    wire w1,w2,w3;
    // compuertas
    not U1 (w1, B);           //B'
    and a1 (w2, A, w1);       //AB'
    and a3 (w3, A, C);        //AC
    or o1 (Y, w2,w3);         //Salida

endmodule

// -----
// Ejercicio 5 SOP / Operadores Logicos
// -----
module t5_SOP(input wire A,B,C, output wire Y);

    assign Y = (A & ~B & ~C) | (A & ~B & C) | (A & B & C);

endmodule

// -----
// Ejercicio 5 POS / Operadores Logicos
// -----
module t5_POS(input wire A,B,C, output wire Y);

    assign Y = (A | B | C) & (A | B | ~C) & (A | ~B | C) & (~A | ~B | C) & (A | ~B | ~C);

endmodule

// -----
// José Alejandro Garza Aguirre
// Digital
// lab4
// -----
module testbench();

    reg A1, B1, C1,           //Entradas Ejercicio 5
        A2, B2, C2,
        A3, B3, C3;
    wire Y1, Y2, Y3;          //Salidas Ejercicio 5

    //-----Modulos Ejercicio 1-----
    t5_S    tS(A1, B1, C1, Y1);
    t5_SOP  tSOP(A2, B2, C2, Y2);
    t5_POS  tPOS(A3, B3, C3, Y3);

    //-----
    //Simulación Ejercicio 5
    //-----

```

```

//-----Tabla 1-----
initial begin
    $display("Tabla Simplificada");
    $display("A B C | Y ");
    $display("-----|-----");
    $monitor("%b %b %b | %b", A1, B1, C1, Y1);
    ...
    A1 = 0; B1 = 0; C1 = 0;
    #1 A1 = 0; B1 = 0; C1 = 1;
    #1 A1 = 0; B1 = 1; C1 = 0;
    #1 A1 = 0; B1 = 1; C1 = 1;
    #1 A1 = 1; B1 = 0; C1 = 0;
    #1 A1 = 1; B1 = 0; C1 = 1;
    #1 A1 = 1; B1 = 1; C1 = 0;
    #1 A1 = 1; B1 = 1; C1 = 1;
end

//-----Tabla 2-----
initial begin
    #20
    $display("Tabla SOP");
    $display("A B C | Y");
    $display("-----|---");
    $monitor("%b %b %b | %b", A2, B2, C2, Y2);
    ...
    A2 = 0; B2 = 0; C2 = 0;
    #1 A2 = 0; B2 = 0; C2 = 1;
    #1 A2 = 0; B2 = 1; C2 = 0;
    #1 A2 = 0; B2 = 1; C2 = 1;
    #1 A2 = 1; B2 = 0; C2 = 0;
    #1 A2 = 1; B2 = 0; C2 = 1;
    #1 A2 = 1; B2 = 1; C2 = 0;
    #1 A2 = 1; B2 = 1; C2 = 1;
end

//-----POS-----
initial begin
    #30
    $display("Tabla POS");
    $display("A B C | Y ");
    $display("-----|---");
    $monitor("%b %b %b | %b", A3, B3, C3, Y3);
    ...
    A3 = 0; B3 = 0; C3 = 0;
    #1 A3 = 0; B3 = 0; C3 = 1;
    #1 A3 = 0; B3 = 1; C3 = 0;
    #1 A3 = 0; B3 = 1; C3 = 1;
    #1 A3 = 1; B3 = 0; C3 = 0;
    #1 A3 = 1; B3 = 0; C3 = 1;
    #1 A3 = 1; B3 = 1; C3 = 0;
    #1 A3 = 1; B3 = 1; C3 = 1;
end

initial
    #40 $finish;

//-----CTKWAVE-----
initial begin
    $dumpfile("ej5_tb.vcd");
    $dumpvars(0, testbench);
end

endmodule

```