Angel Arnoldo Cuellar Bendfeldt

Ejercicio #1

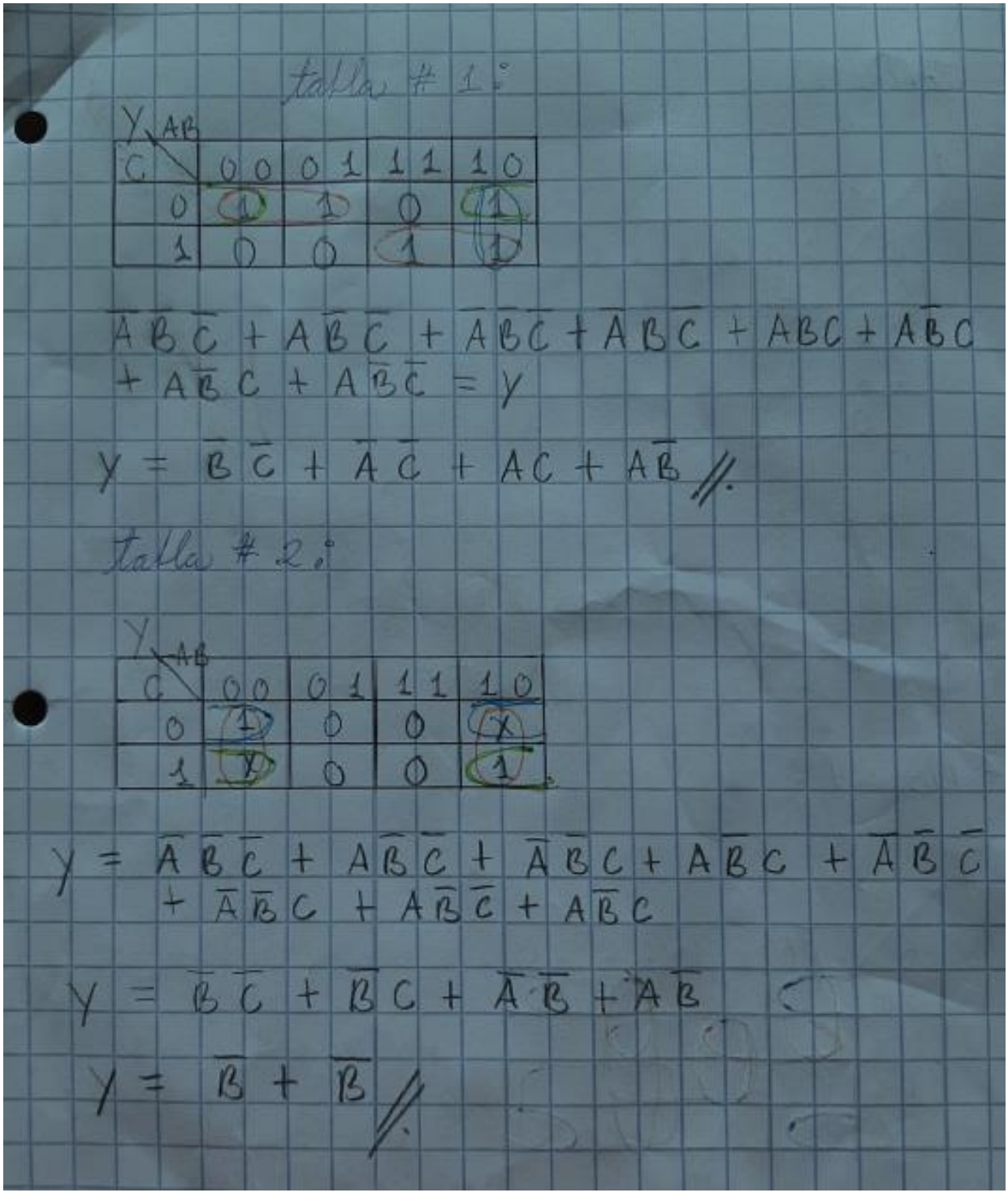


tabla #1:

Y, AB / C	00	01	11	10
0	1	1	0	1
1	0	0	1	1

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

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

tabla #2:

Y, AB / C	00	01	11	10
0	1	0	0	X
1	X	0	0	1

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

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

$Y = \bar{B} + \bar{B}$ //.

falla 3:

Y	AB 00	01	11	10
CD 00	1	0	1	0
01	0	1	0	1
11	1	0	1	0
10	0	1	0	1

No es posible simplificar la falla:

$$Y = \bar{A}B\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + AB\bar{C}\bar{D} + ABCD + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} //.$$

falla 4:

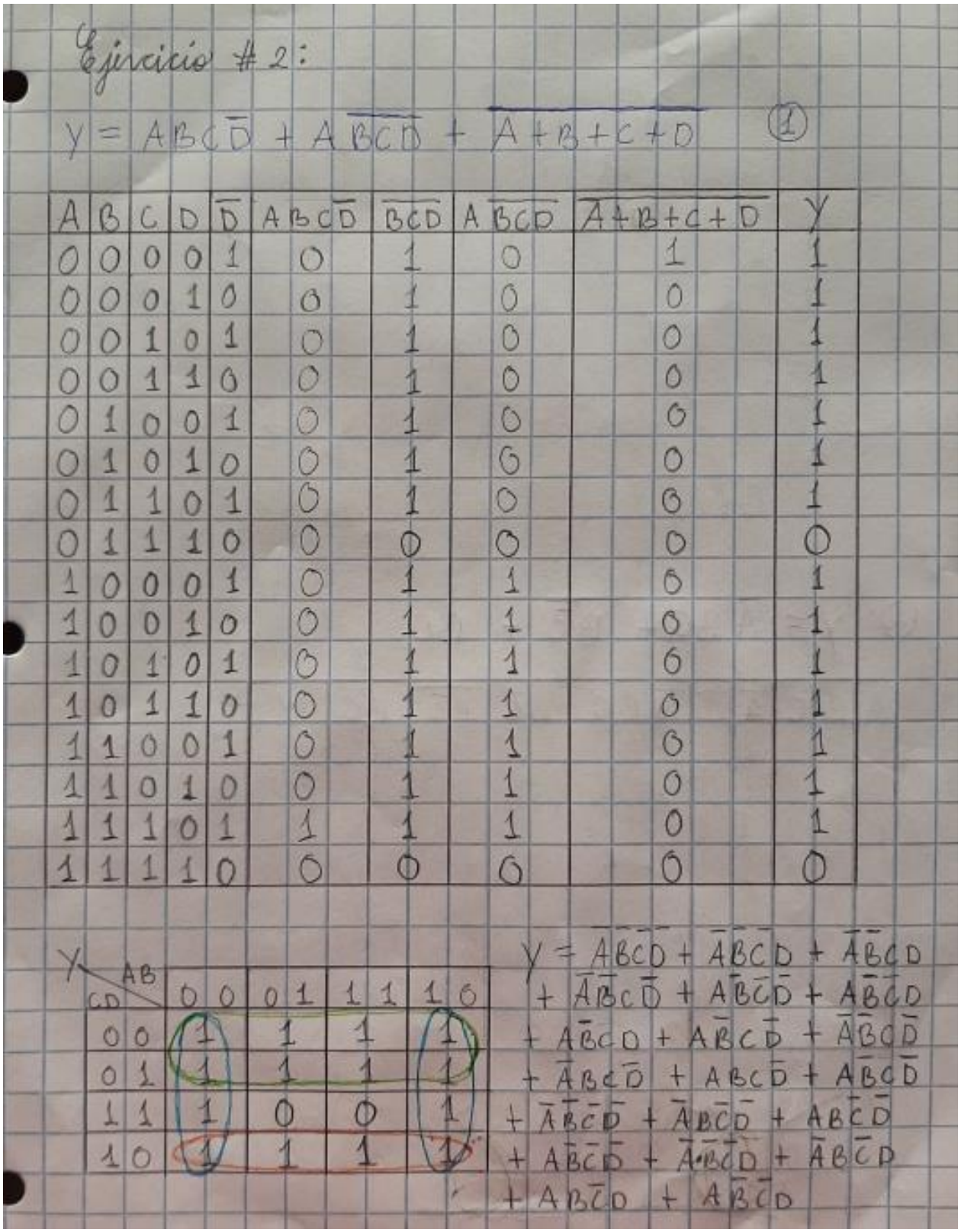
Y	AB 00	01	11	10
CD 00	X	0	1	1
01	X	X	1	0
11	0	X	1	1
10	X	0	X	X

$$Y = \bar{A}BC\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D + ABCD + ABC\bar{D} + \bar{A}B\bar{C}D + \bar{A}BCD + AB\bar{C}D + ABCD + ABCD + ABC\bar{D} + A\bar{B}CD + A\bar{B}C\bar{D}$$

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

$$Y = AC + BD + AB + \bar{B}C\bar{D} //.$$

Ejercicio #2:



Ejercicio #2:

$$Y = A\bar{B}C\bar{D} + A\overline{\bar{B}CD} + \overline{A+B+C+D} \quad (1)$$

A	B	C	D	$\bar{D}$	$A\bar{B}C\bar{D}$	$\overline{\bar{B}CD}$	$A\overline{\bar{B}CD}$	$\overline{A+B+C+D}$	Y
0	0	0	0	1	0	1	0	1	1
0	0	0	1	0	0	1	0	0	1
0	0	1	0	1	0	1	0	0	1
0	0	1	1	0	0	1	0	0	1
0	1	0	0	1	0	1	0	0	1
0	1	0	1	0	0	1	0	0	1
0	1	1	0	1	0	1	0	0	1
0	1	1	1	0	0	0	0	0	0
1	0	0	0	1	0	1	1	0	1
1	0	0	1	0	0	1	1	0	1
1	0	1	0	1	0	1	1	0	1
1	0	1	1	0	0	1	1	0	1
1	1	0	0	1	0	1	1	0	1
1	1	0	1	0	0	1	1	0	1
1	1	1	0	1	1	1	1	0	1
1	1	1	1	0	0	0	0	0	0

Y	AB 00	01	11	10
CD 00	1	1	1	1
01	1	1	1	1
11	1	0	0	1
10	1	1	1	1

$$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + \bar{A}BC\bar{D} + ABC\bar{D} + AB\bar{C}\bar{D} + \bar{A}B\bar{C}\bar{D} + A\bar{B}C\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}BCD + AB\bar{C}D + A\bar{B}\bar{C}D$$

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

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

$$Y = \bar{B}(\bar{A} + A\bar{C} + AC) + \bar{D}(\bar{A}C + AC + \bar{C}) + \bar{C}(\bar{A}D + AD)$$

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

$$Y = \bar{B} + \bar{D} + \bar{C}D \;//.$$ Ecuación minimizada.

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

A	B	C	$\bar{A}$	$\bar{C}$	$\bar{A}BC$	$B\bar{C}$	$\overline{B\bar{C}}$	BC	Y
0	0	0	1	1	0	0	1	0	1
0	0	1	1	0	0	0	1	0	1
0	1	0	1	1	0	1	0	0	0
0	1	1	1	0	1	0	1	1	1
1	0	0	0	1	0	0	1	0	1
1	0	1	0	0	0	0	1	0	1
1	1	0	0	1	0	1	0	1	1
1	1	1	0	0	0	0	1	1	1

Y

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

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

$$y = \bar{A}\bar{B} + AB + A\bar{B} + \bar{A}\bar{B} + A\bar{B} + \bar{A}C + AC$$

$$y = \bar{A}\bar{B} + A + \bar{B} + C \;//\; \text{Ecuación minimizada.}$$

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

A	B	C	D	$\overline{A+B+C}$	$\overline{A+B+C} \cdot D$	AD	X
0	0	0	0	1	0	0	1
0	0	0	1	1	1	0	1
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	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0
1	0	0	1	0	0	1	1
1	0	1	0	0	0	0	0
1	0	1	1	0	0	1	1
1	1	0	0	0	0	0	0
1	1	0	1	0	0	1	1
1	1	1	0	0	0	0	0
1	1	1	1	0	0	1	1

Y

CD \ AB	00	01	11	10
00	1	0	0	0
01	1	0	1	1
11	0	0	1	1
10	0	0	0	0

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

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

$Y = \bar{A}\bar{B}\bar{C} + AD$ //. Ecuación minimizada.

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

A	B	C	$\bar{A}$	$\bar{B}$	$\bar{C}$	BC	$\bar{A}\bar{B}\bar{C}$	$B\bar{C}$	Y
0	0	0	1	1	1	0	1	0	1
0	0	1	1	1	0	0	0	0	0
0	1	0	1	0	1	0	0	0	0
0	1	1	1	0	0	1	0	0	1
1	0	0	0	1	1	0	0	0	0
1	0	1	0	1	0	0	0	0	0
1	1	0	0	0	1	0	0	0	0
1	1	1	0	0	0	1	0	0	1

Y

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

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

$Y = \bar{A}\bar{B}\bar{C} + BC$ //. Ecuación minimizada.

Tablas con Don't cares

① $Y = \bar{B} + \bar{D} + \bar{C}\bar{D}$ minimizada.

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

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

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

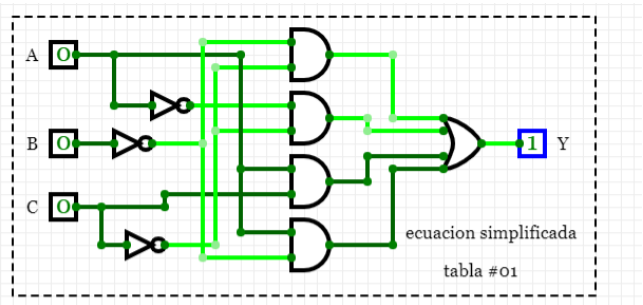
③ $Y = \bar{A}\bar{B}\bar{C} + AD$

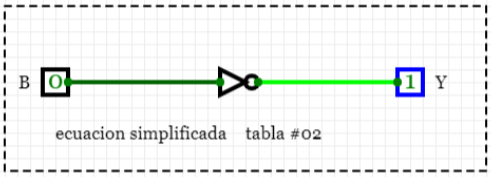
A	B	C	D	Y
0	0	0	X	1
1	X	X	1	1

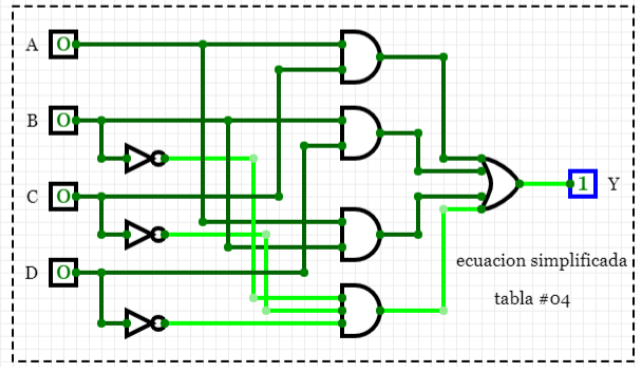
④ $Y = \bar{A}\bar{B}\bar{C} + BC$

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

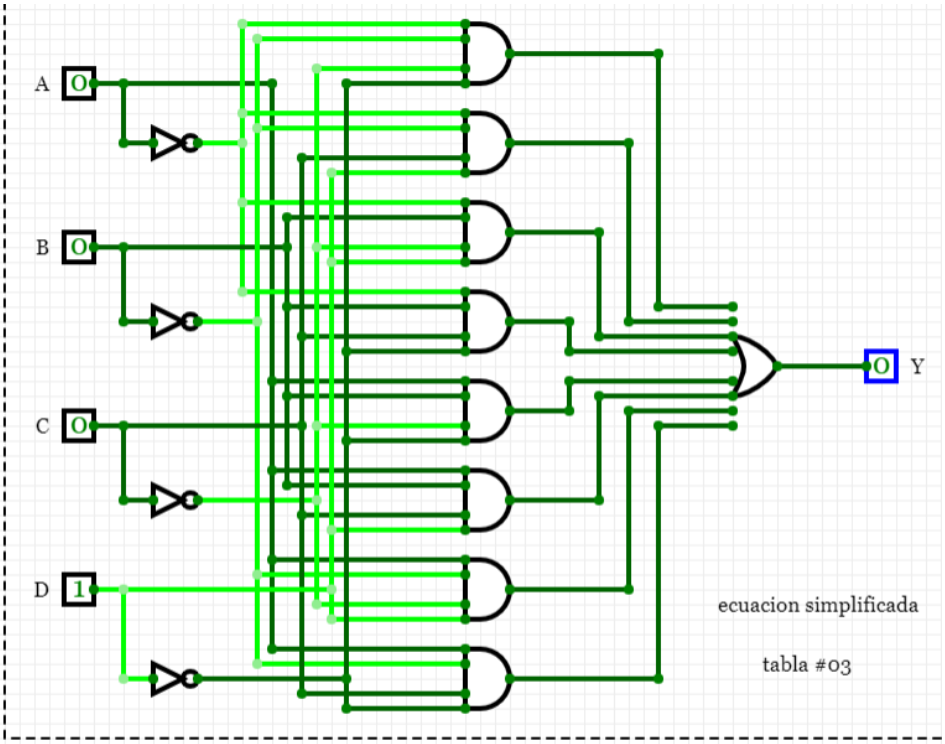
Ejercicio #3:

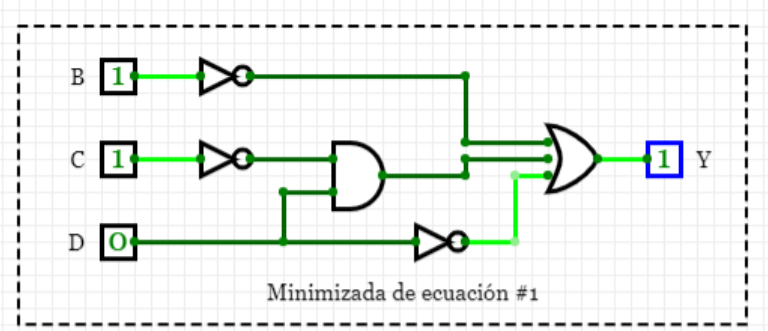


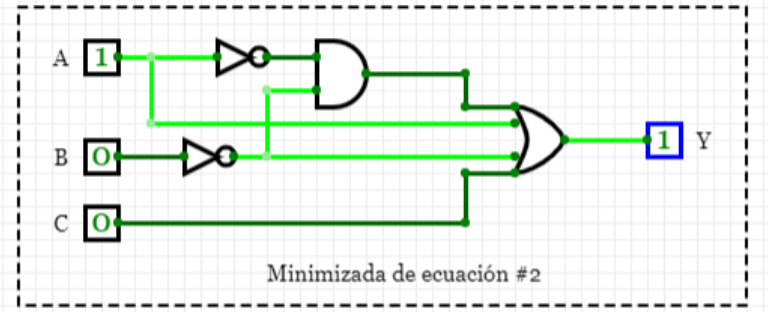


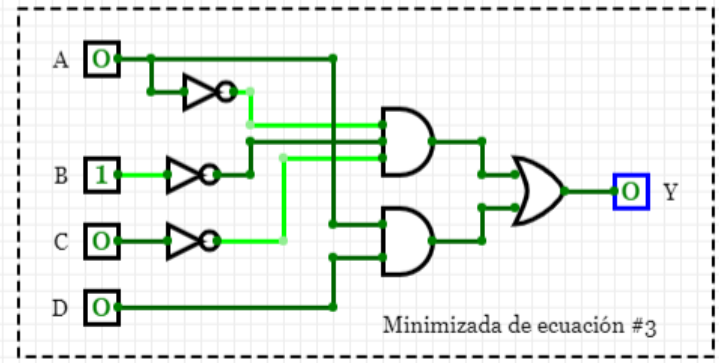


diagramas del ejercicio #1

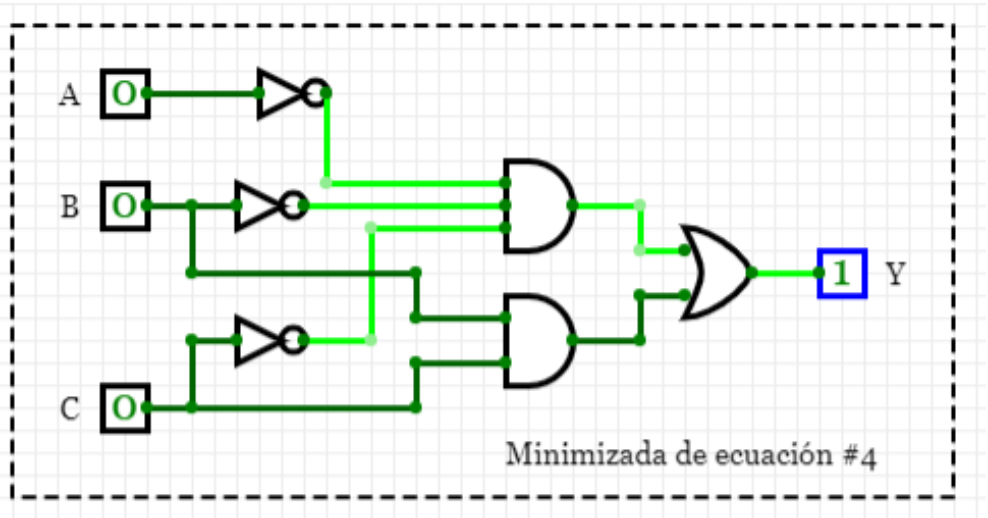








diagramas del ejercicio #2



Ejercicio #4:

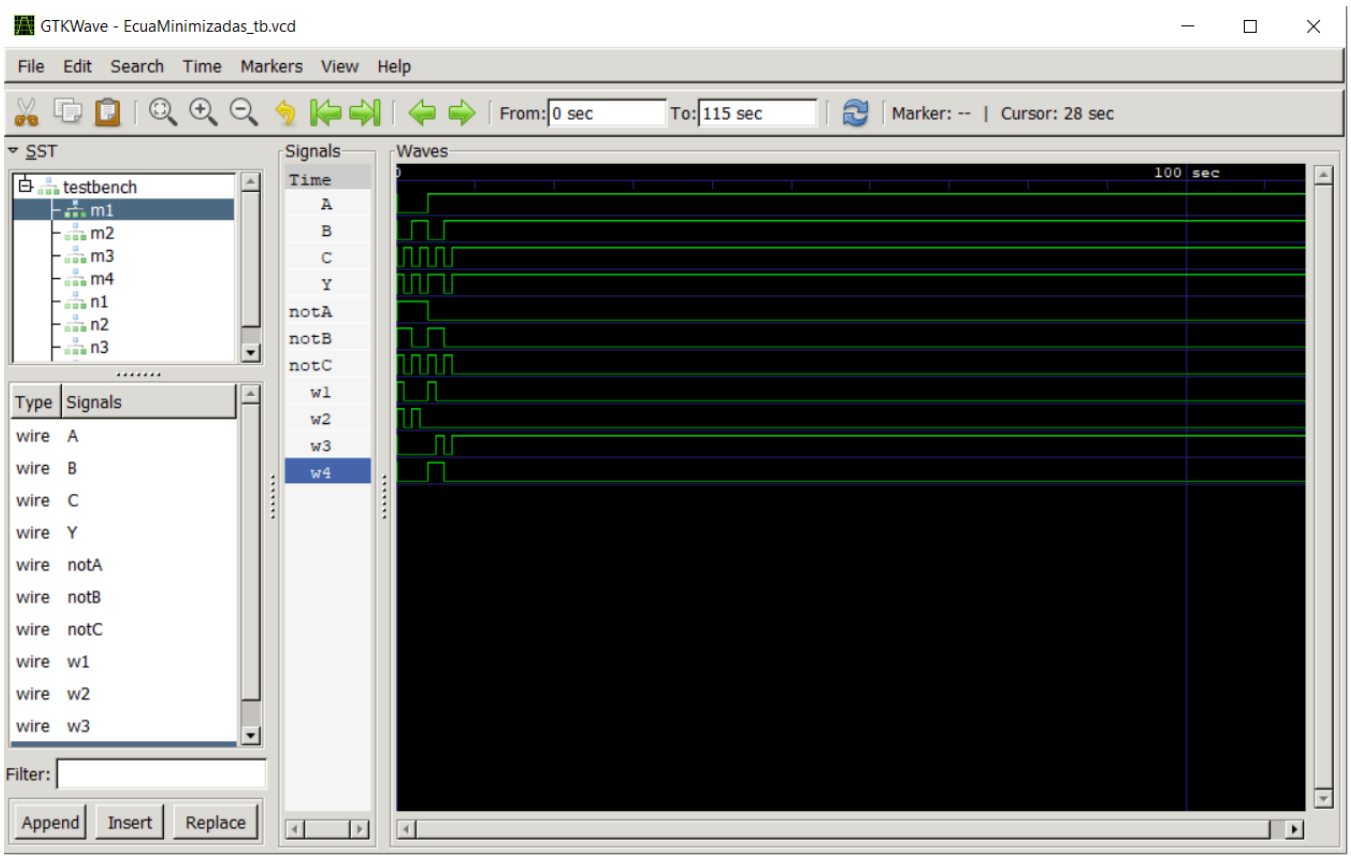
Pequeña vista del código con el .v

```
// ecuaciones de ejercicio 01
// tipo de solucion por gate level

// Ecuacion tabla01

module t01(input wire A, B , C , output wire Y);

    wire notA, notB, notC, w1, w2, w3, w4;
    not (notA, A);
    not (notB, B);
    not (notC, C);
    and(w1, notB, notC);
    and(w2, notA, notC);
    and(w3, A, C);
    and(w4, A, notB);
    or(Y, w1,w2,w3,w4);

endmodule

// Ecuacion tabla02

module t02(input wire A, B , C , output wire Y);

    not(Y, B);

endmodule

// Ecuacion tabla03

module t03(input wire A, B , C ,D, output wire Y);

    wire notA, notB, notC, notD, w1, w2, w3, w4, w5, w6, w7, w8;
    not (notA, A);
    not (notB, B);
    not (notC, C);
    not (notD, D);
    and (w1, notA,notB,notC,notD);
    and (w2, notA,notB,C,D);
    and (w3, notA,B,notC,D);
    and (w4, notA,B,C,notD);
    and (w5, A,B,notC,notD);
    and (w6, A,B,C,D);
    and (w7, A,notB,notC,D);
    and (w8, A,notB,C,notD);
```

pequeña vista del código en el _tb.v

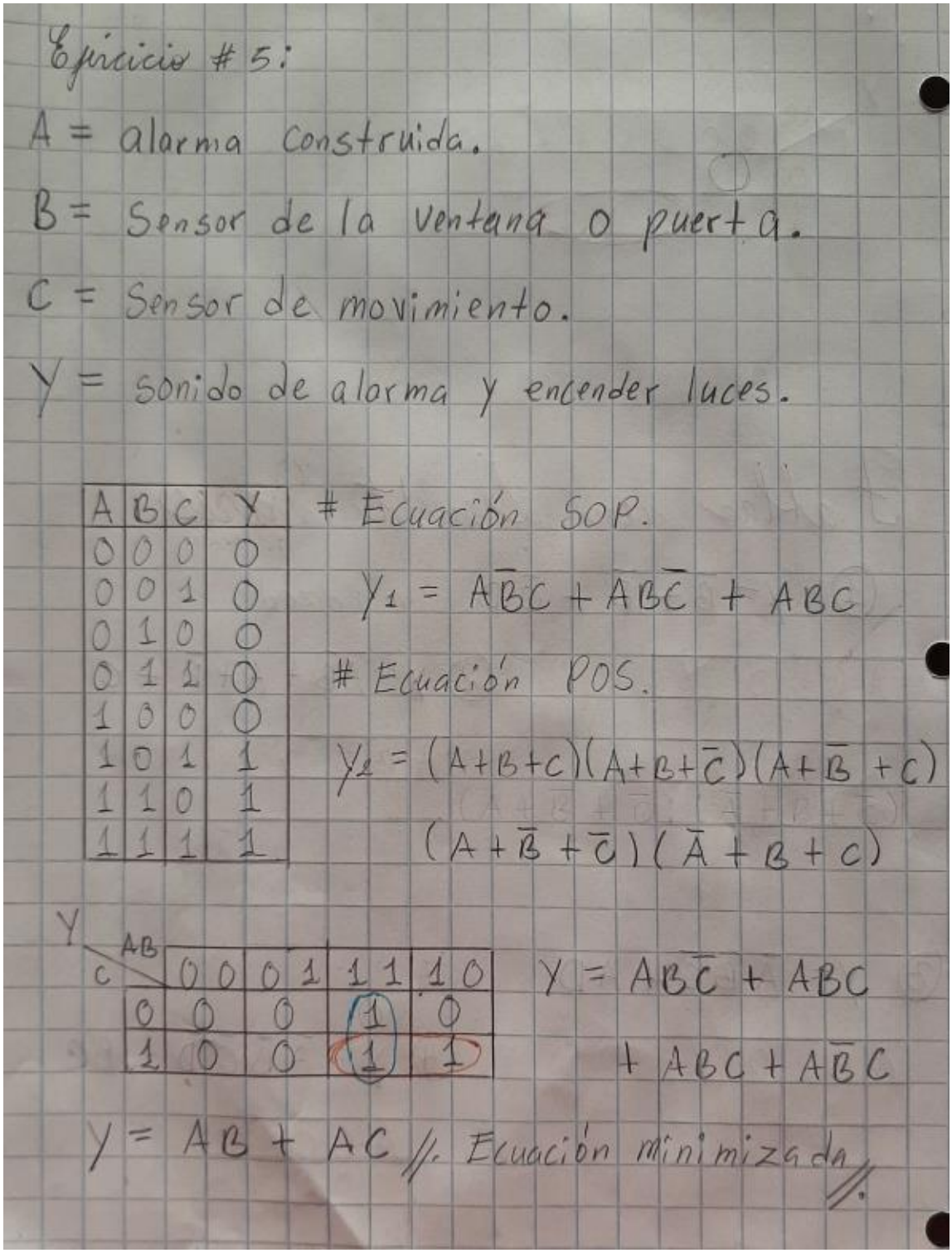
```
`include "EcuaMinimizadas.v"

module testbench();

    reg a1, a2, a3;
    reg b1, b2, b3;
    reg c1, c2, c3, c4;
    reg d1, d2, d3, d4;
    reg e1, e2, e3, e4;
    reg f1, f2, f3;
    reg g1, g2, g3, g4;
    reg h1, h2, h3 ;
    wire s1, s2, s3, s4, s5, s6, s7, s8;

    t01 m1(a1,a2,a3,s1);
    t02 m2(b1,b2,b3,s2);
    t03 m3(c1,c2,c3,c4,s3);
    t04 m4(d1,d2,d3,d4,s4);
    f01 n1(e1,e2,e3,e4,s5);
    f02 n2(f1,f2,f3,s6);
    f03 n3(g1,g2,g3,g4,s7);
    f04 n4(h1,h2,h3,s8);

    initial begin
        $display("ecuacion tabla 01");
        $display("A B C | Y ");
        $display("------|------");
        $monitor("%b %b %b | %b", a1, a2, a3, s1);
        a1 = 0; a2 = 0; a3 = 0;
        #1 a1 = 0; a2 = 0; a3 = 1;
        #1 a1 = 0; a2 = 1; a3 = 0;
        #1 a1 = 0; a2 = 1; a3 = 1;
        #1 a1 = 1; a2 = 0; a3 = 0;
        #1 a1 = 1; a2 = 0; a3 = 1;
        #1 a1 = 1; a2 = 1; a3 = 0;
        #1 a1 = 1; a2 = 1; a3 = 1;
    end

    initial begin
        #10
        $display("\n");
        $display("ecuacion tabla 02");
        $display("A B C | Y");
        $display("------|--");
```

diagrama de timing de las distintas ecuaciones seccionadas en módulos.



Ejercicio #5:

Solución paso a paso del problema.



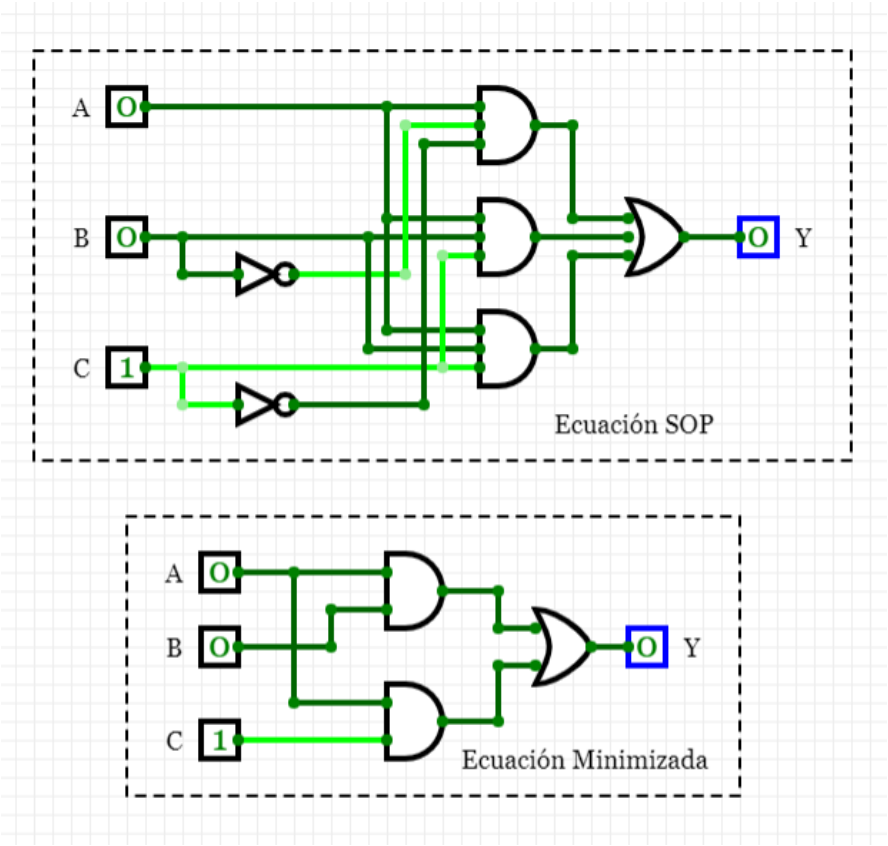
Pequeña parte del código en el archivo .v

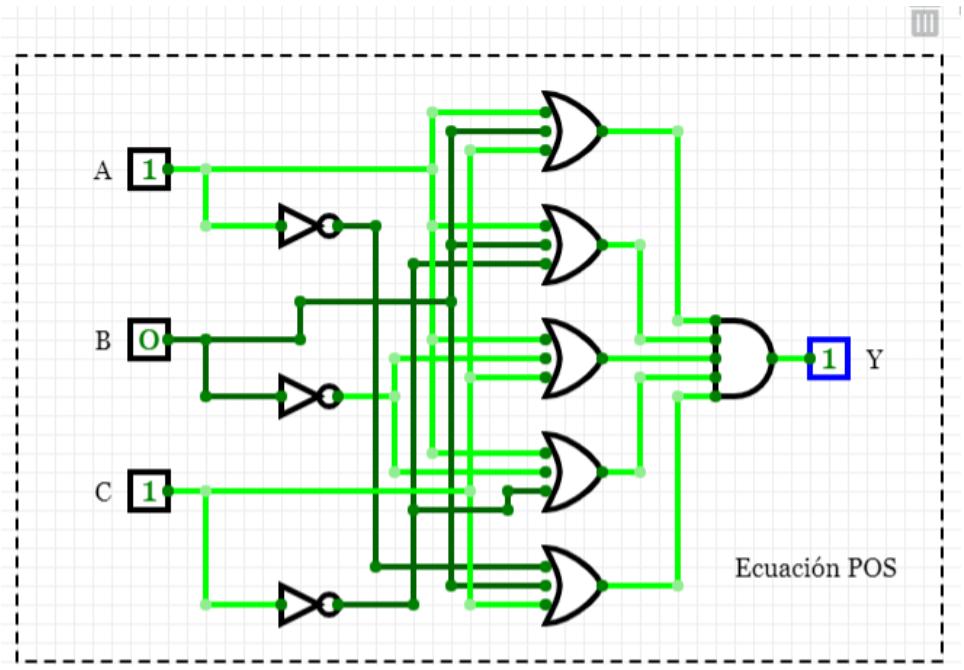
```
// ecuaciones de ejercicio 05
// tipo de solucion por gate level

// Ecuacion SOP

module t01(input wire A, B , C , output wire Y);

    wire notB, notC, w1, w2, w3;
    not (notB, B);
    not (notC, C);
    and(w1, A, notB, C);
    and(w2, A, B, notC);
    and(w3, A, B, C);
    or(Y, w1,w2,w3);

endmodule

// Ecuacion POS

module t02(input wire A, B , C , output wire Y);

    wire notA, notB, notC, w1, w2, w3, w4, w5;
    not (notA, A);
    not (notB, B);
    not (notC, C);
    or (w1, A, B, C);
    or (w2, A, B, notC);
    or (w3, A, notB, C);
    or (w4, A, notB, notC);
    or (w5, notA, B, C);
    and (Y, w1,w2,w3,w4,w5);

endmodule

// Ecuacion minimizada

module t03(input wire A, B , C , output wire Y);

    wire w1, w2;
    and (w1, A, B);
    and (w2, A, C);
    or (Y, w1,w2);

endmodule
```

Pequeña parte del código en el archivo _tb.v

```
`include "ProblemaAlarma.v"

module testbench();

    reg a1, a2, a3;
    reg b1, b2, b3;
    reg c1, c2, c3;
    reg d1, d2, d3;
    reg e1, e2, e3;
    reg f1, f2, f3;
    wire s1, s2, s3, s4, s5, s6;

    t01 m1(a1,a2,a3,s1);
    t02 m2(b1,b2,b3,s2);
    t03 m3(c1,c2,c3,s3);
    f01 n1(d1,d2,d3,s4);
    f02 n2(e1,e2,e3,s5);
    f03 n3(f1,f2,f3,s6);

    initial begin
        $display("ecuaciones con gate level ");
        $display("\n");
        $display("ecuacion SOP");
        $display("A B C | Y ");
        $display("------|------");
        $monitor("%b %b %b | %b", a1, a2, a3, s1);
        a1 = 0; a2 = 0; a3 = 0;
        #1 a1 = 0; a2 = 0; a3 = 1;
        #1 a1 = 0; a2 = 1; a3 = 0;
        #1 a1 = 0; a2 = 1; a3 = 1;
        #1 a1 = 1; a2 = 0; a3 = 0;
        #1 a1 = 1; a2 = 0; a3 = 1;
        #1 a1 = 1; a2 = 1; a3 = 0;
        #1 a1 = 1; a2 = 1; a3 = 1;
    end

    initial begin
        #10
        $display("\n");
        $display("ecuacion POS");
        $display("A B C | Y");
        $display("------|--");
        $monitor("%b %b %b | %b", b1, b2, b3, s2);
        b1 = 0; b2 = 0; b3 = 0;
```

Diagramas de solución de distintas ecuaciones:



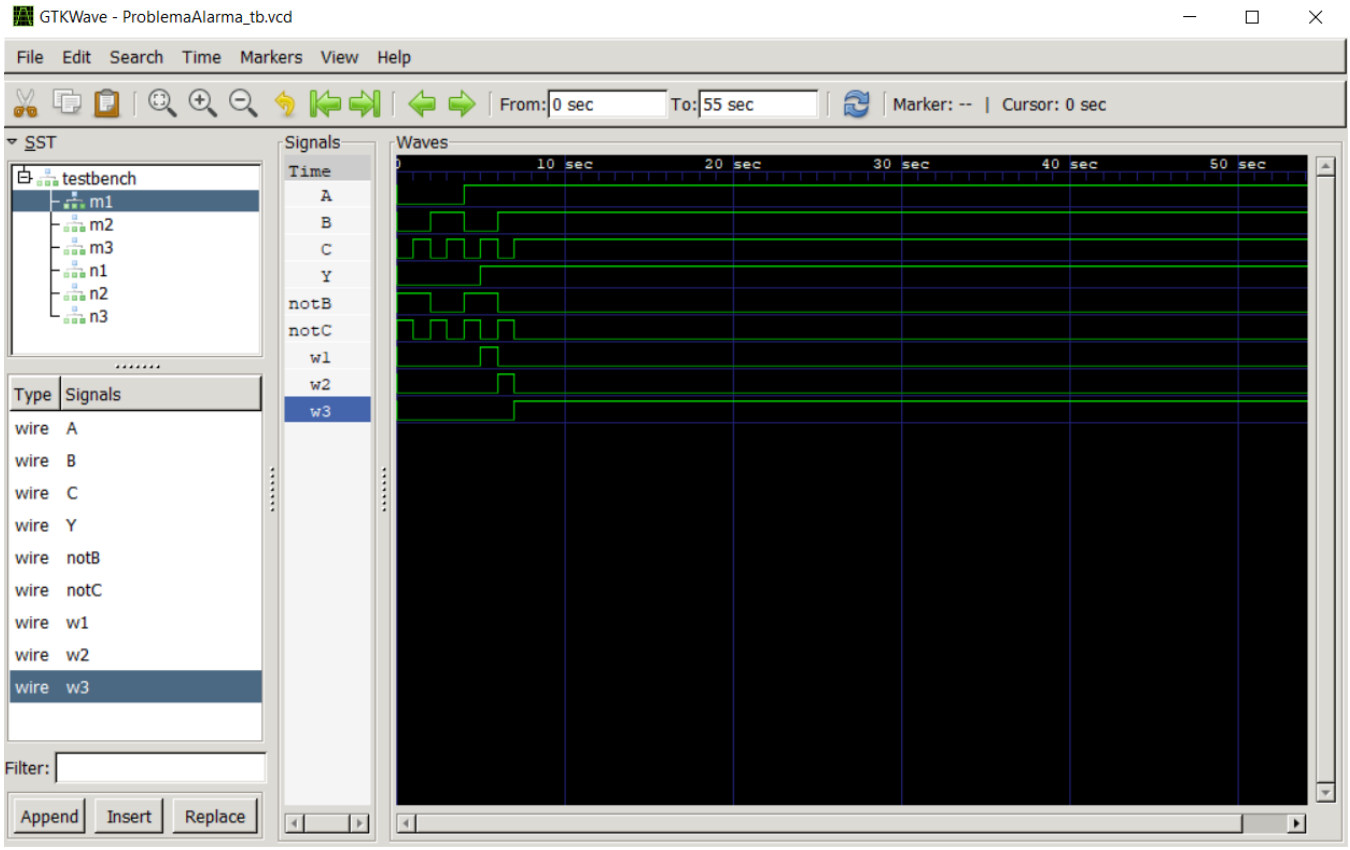


Resultados al ejecutar el código:

```
Microsoft Windows [Versión 10.0.18363.959]
(c) 2019 Microsoft Corporation. Todos los derechos reservados.

E:\laboratorios_digital01\lab04\ejercicio 5>vvp prueba_tb.out
ecuaciones con gate level


ecuacion SOP
A B C | Y
------|------
VCD info: dumpfile ProblemaAlarma_tb.vcd opened for output.
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 0
1 0 1 | 1
1 1 0 | 1
1 1 1 | 1


ecuacion POS
A B C | Y
------|--
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 0
1 0 1 | 1
1 1 0 | 1
1 1 1 | 1


ecuacion minimizada
A B C | Y
--------|--
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 0
1 0 1 | 1
1 1 0 | 1
1 1 1 | 1


ecuaciones con operadores logicos
```

```
ecuaciones con operadores logicos


ecuacion SOP
A B C | Y
--------|--
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 0
1 0 1 | 1
1 1 0 | 1
1 1 1 | 1


ecuacion POS
A B C | Y
--------|--
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 0
1 0 1 | 1
1 1 0 | 1
1 1 1 | 1


ecuacion minimizada
A B C | Y
------|--
0 0 0 | 0
0 0 1 | 0
0 1 0 | 0
0 1 1 | 0
1 0 0 | 0
1 0 1 | 1
1 1 0 | 1
1 1 1 | 1

E:\laboratorios_digital01\lab04\ejercicio 5>
```

Diagrama de timing de solución:



Link de repositorio:

https://github.com/Angel-Cuellar/laboratorios_digital01