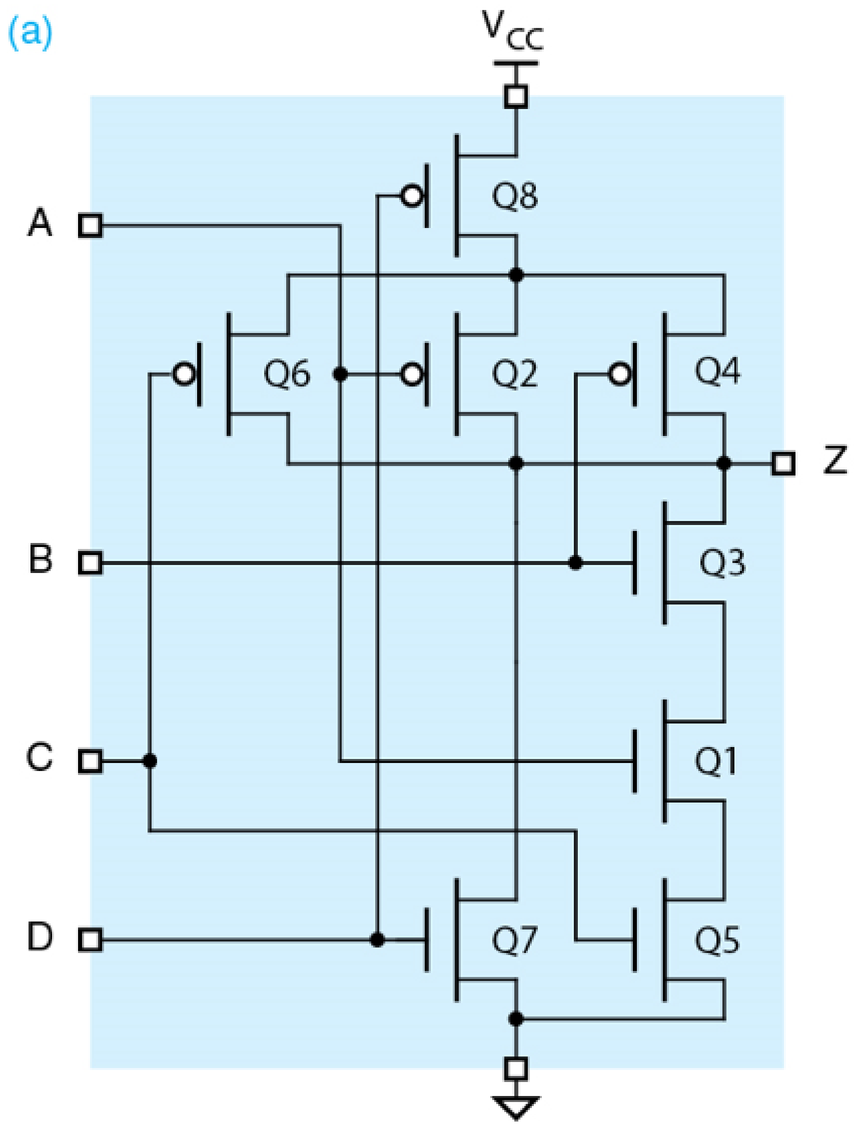
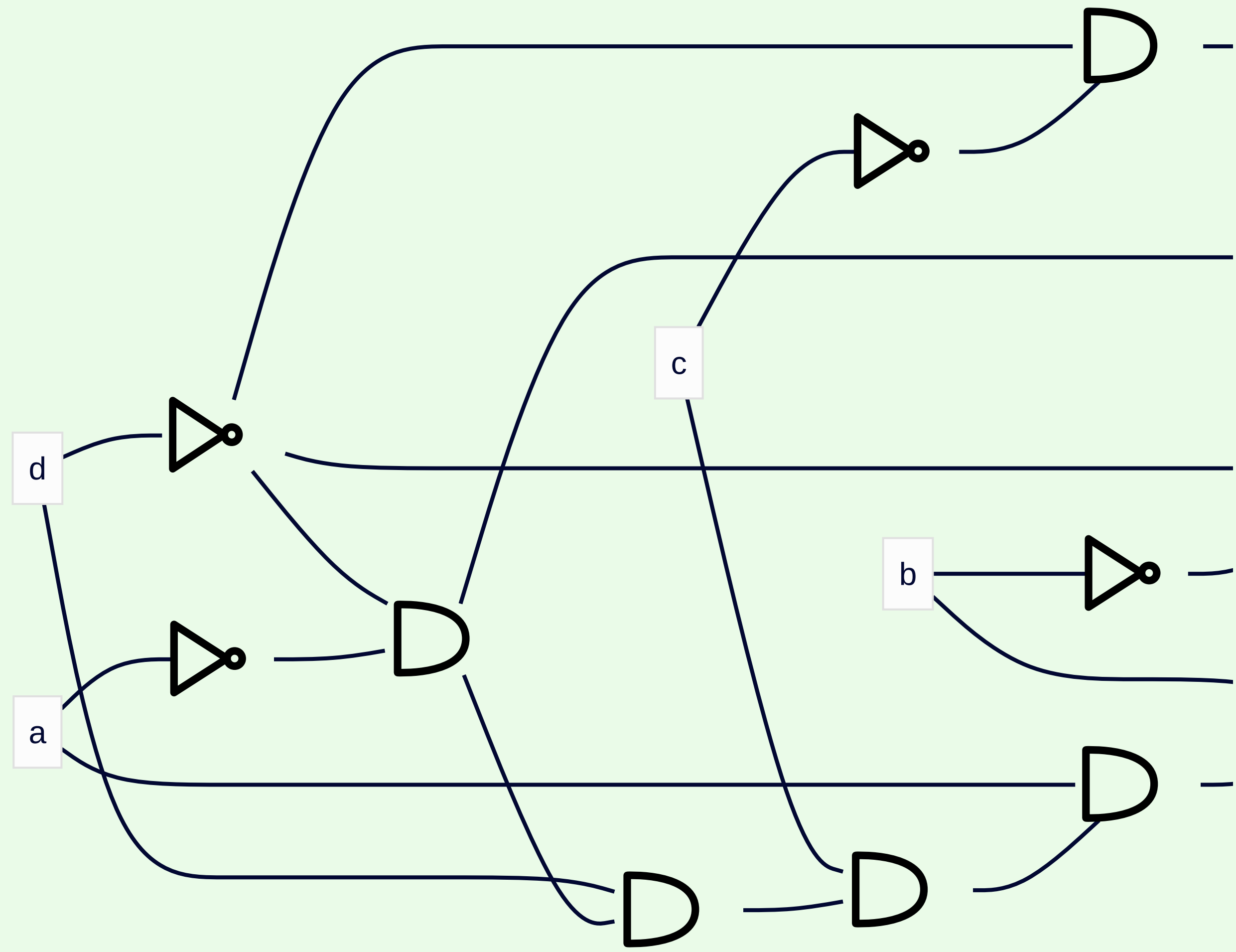
1

For the circuit given below, write a truth table for Z.



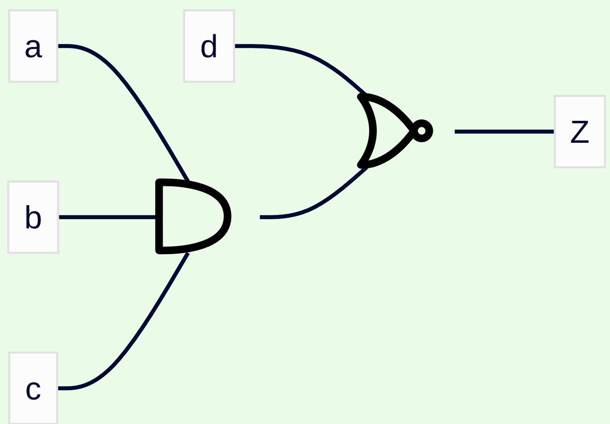
✓ Answer



$Z = c' \cdot d' + d' \cdot a' + b' + d' + d \cdot c \cdot a \cdot b + z' \cdot d'$

$Z = d' \cdot (c' + a' + b')$

$Z = (d + (c \cdot a \cdot b))'$



A	B	C	D	Z
F	F	F	F	T
F	F	F	T	F
F	F	T	F	T
F	F	T	T	F
F	T	F	F	T

A	B	C	D	Z
F	T	F	T	F
F	T	T	F	T
F	T	T	T	F
T	F	F	F	T
T	F	F	T	F
T	F	T	F	T
T	F	T	T	F
T	T	F	F	T
T	T	F	T	F
T	T	T	F	F
T	T	T	T	F

2

Simplify the following expressions using the switching algebra theorems. indicate all the theorems you use at each step.

$(X' \cdot Y' + X) \cdot ((X + Y)' + X' \cdot Y)$ simplifies to $X' \cdot Y'$
$A' \cdot B' \cdot (D' + C' \cdot D) + B' \cdot (A + A' \cdot C \cdot D) + B' \cdot C'$ simplifies to B'

✓ **Answer**

$(X' \cdot Y' + X) \cdot ((X + Y)' + X' \cdot Y)$
$(X' \cdot Y' + X) \cdot ((X' \cdot Y') + X' \cdot Y)$ DeMorgan
$(X' \cdot Y' + X) \cdot X' \cdot (Y' + Y)$ Distributive
$(X' \cdot Y' + X) \cdot X' \cdot \mathbf{t}$ Law of negation
$(X' \cdot Y' + X) \cdot X'$ Identity
$(X' \cdot Y' \cdot X' + X \cdot X')$ Distributive
$(X' \cdot Y' + \mathbf{f})$ Idempotent, Law of negation
$X' \cdot Y'$ Identity

$A' \cdot B' \cdot (D' + C' \cdot D) + B' \cdot (A + A' \cdot C \cdot D) + B' \cdot C'$
$B' \cdot (A' \cdot (D' + C' \cdot D) + (A + A' \cdot C \cdot D) + C')$ Distributive
$B' \cdot (A' \cdot D' + A' \cdot C' \cdot D + A + A' \cdot C \cdot D + C')$ Distributive
$B' \cdot (A' \cdot (D' + C' \cdot D + C \cdot D) + A + C')$ Distributive
$B' \cdot (A' \cdot (D' + D \cdot (C' + C)) + A + C')$ Distributive
$B' \cdot (A' \cdot (D' + D \cdot \mathbf{t}) + A + C')$ Negation
$B' \cdot (A' \cdot (D' + D) + A + C')$ Identity
$B' \cdot (A' \cdot \mathbf{t} + A + C')$ Negation
$B' \cdot (A' + A + C')$ Identity
$B' \cdot (\mathbf{t} + C')$ Negation

$B' \cdot \mathbf{t}$ Universal Bound
B' Identity

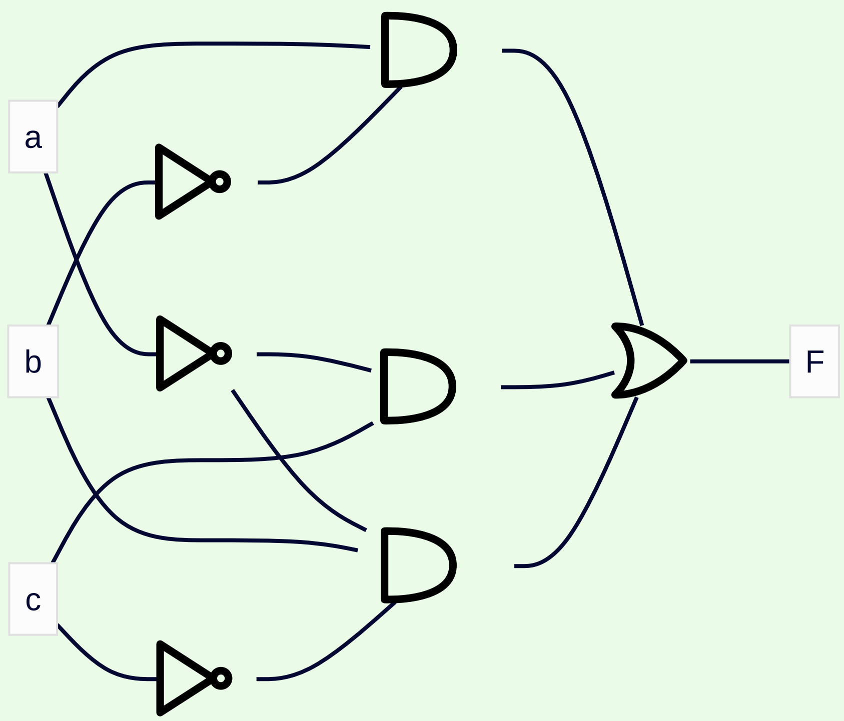
3

Write the truth table for the following function and draw the circuit using AND, OR and NOT gates

$F = a \cdot b' + a' \cdot c + a' \cdot b \cdot c'$

✓ **Answer**

a	b	c	F
F	F	F	F
F	F	T	T
F	T	F	T
F	T	T	T
T	F	F	T
T	F	T	T
T	T	F	F
T	T	T	F



4

Write the canonical sum and canonical product for the function F given below

$F = w' \cdot y + w \cdot (y + x')'$

✓ Answer

w	x	y	F
F	F	F	F
F	F	T	T
F	T	F	F
F	T	T	T
T	F	F	F
T	F	T	F
T	T	F	T
T	T	T	F

Canonical sum:
$F = w' \cdot x \cdot y + w' \cdot x' \cdot y + w \cdot x \cdot y'$

Canonical product:
$F = (w + x + y) \cdot (w + x' + y) \cdot (w' + x + y) \cdot (w' + x + y') + (w' + x' + y')$

5

Find the complement of function F given below and write the canonical product for this complement

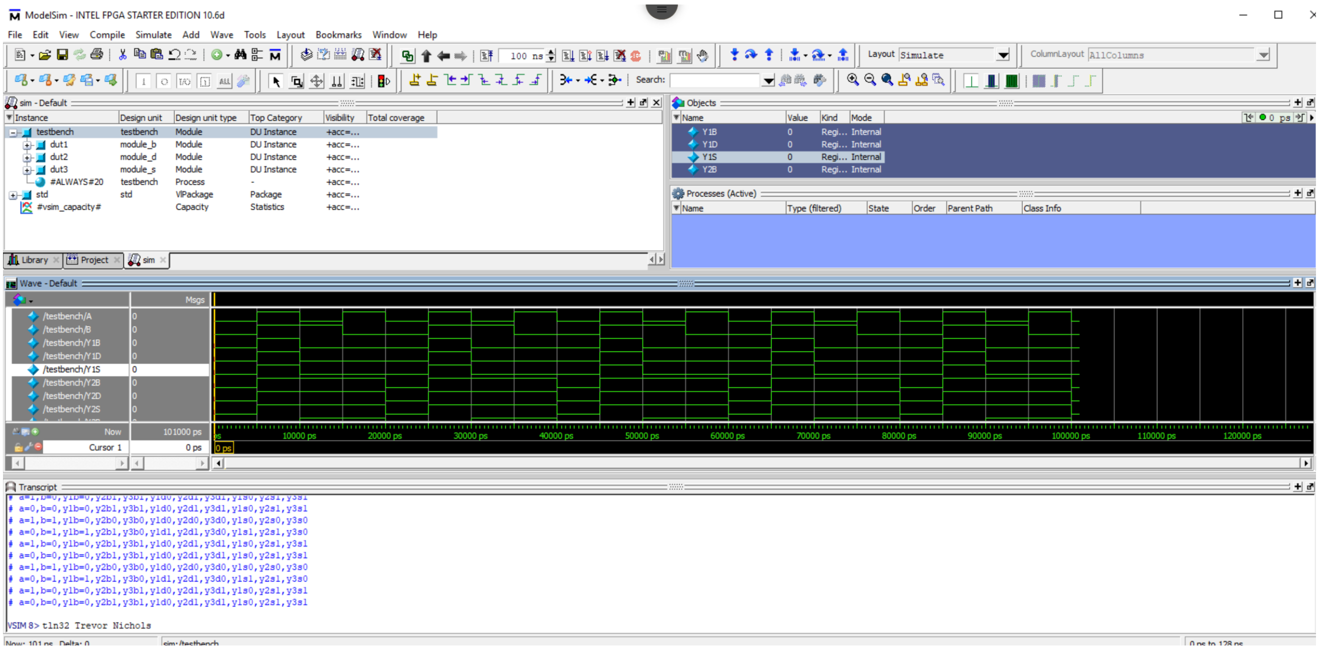
$F = \sum_{a,b,c}(1, 2, 3, 6)$

✓ Answer

Complement:
$F = \sum_{a,b,c}(0, 4, 5, 7)$

Canonical product:
$F = (a + b + c) \cdot (a' + b + c) \cdot (a' + b + c') \cdot (a' + b' + c')$

Deliverable




```
module module_b (
        input logic A, B,
        output logic Y1, Y2, Y3
);
        always_comb begin
                Y1 = A & B;
                Y2 = A | B;
                Y3 = A ^ B;
        end
endmodule
```

```
module module_d (
        input logic A, B,
        output logic Y1, Y2, Y3
);
        assign Y1 = A & B;
        assign Y2 = A | B;
        assign Y3 = A ^ B;
endmodule
```

```
module module_s (
        input logic A, B,
        output logic Y1, Y2, Y3
);
        and U1 (Y1, A, B);
        or U2 (Y2, A, B);
        xor U3 (Y3, A, B);
endmodule
```

```
`timescale 1ns/10ps

module testbench ();
```

```
        logic A=0;
        logic B=0;
        logic Y1B;
        logic Y1D;
        logic Y1S;
        logic Y2B;
        logic Y2D;
        logic Y2S;
        logic Y3B;
        logic Y3D;
        logic Y3S;

        module_b dut1 ( A, B, Y1B, Y2B, Y3B );
        module_d dut2 ( A, B, Y1D, Y2D, Y3D );
        module_s dut3 ( A, B, Y1S, Y2S, Y3S );

        always begin
                #5 A=~A;
                B=B^A;

$display("a=%b,b=%b,y1b=%b,y2b%b,y3b%b,y1d%b,y2d%b,y3d%b,y1s%b,y2s%b,y3s%b",A,B
,Y1B,Y2B,Y3B,Y1D,Y2D,Y3D,Y1S,Y2S,Y3S);
        end
endmodule
```