

3.2 Simplify the following Boolean function using three variable K-Maps

a) $F(x,y,z) = \sum(0,2,4,5)$

$x \setminus yz$	00	01	11	10
0	1	0	1	0
1	1	1	0	0

$F(x,y,z) = y'z' + xy' + x'yz$

b) $F(x,y,z) = \sum(1,2,3,6,7)$

$x \setminus yz$	00	01	11	10
0	0	1	1	1
1	0	0	1	1

$F(x,y,z) = y + x'z$

c) $F(x,y,z) = \sum(2,3,4,5)$

$x \setminus yz$	00	01	11	10
0	0	0	1	1
1	1	1	0	0

$F(x,y,z) = xy' + x'y$

d) $F(x,y,z) = \sum(1,2,3,5,6,7)$

$x \setminus yz$	00	01	11	10
0	0	1	1	1
1	0	1	1	1

$F(x,y,z) = z + y$

e) $F(x,y,z) = \sum(0,2,4,6)$

$x \setminus yz$	00	01	11	10
0	1	0	0	1
1	1	0	0	1

$F(x,y,z) = z'$

f) $F(x,y,z) = \sum(3,4,5,6,7)$

$x \setminus yz$	00	01	11	10
0	0	0	1	0
1	1	1	1	1

$F(x,y,z) = x + yz$

3.3 Simplify the following Boolean functions using K-maps

a) $F(x,y,z) = \sum(2,3,6,7)$

$x \setminus yz$	00	01	11	10
0	0	0	1	1
1	0	0	1	1

$F(x,y,z) = y$

b) $F(A,B,C,D) = \sum(4,6,7,15)$

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

$F(A,B,C,D) = BCD + A'BD'$

c) $F(A,B,C,D) = \sum(3,7,11,13,14,15)$

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

$$F(A,B,C,D) = CD + ABD + ABC$$

d) $F(w,x,y,z) = \sum(2,3,12,13,14,15)$

$w \setminus xyz$	00	01	11	10
00	0	0	1	1
01	0	0	0	0

$F(w,x,y,z) = w'x'y$

$$e) F(w, x, y, z) = \sum(11, 12, 13, 14, 15)$$

w\bar{x}	00	01	11	10
0x	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	0

$$F(w, x, y, z) = w\bar{x} + wyz$$

$$f) F(w, x, y, z) = \sum(8, 10, 12, 13, 14)$$

w\bar{x}	00	01	11	10
0x	0	0	0	0
01	0	0	0	0
11	1	1	1	0
10	1	0	0	1

$$\begin{aligned} & \sum F(w, x, y, z) \\ &= w\bar{x}\bar{z} + w\bar{y}z + w\bar{x}z \end{aligned}$$

$$g) F(w, x, y, z) = \sum(0, 1, 4, 5, 10, 11, 14, 15)$$

w\bar{x}	00	01	11	10
0x	1	1	0	0
01	1	1	0	0
11	0	0	1	1
10	0	0	1	1

$$F(w, x, y, z) = w'y' + wy$$

$$h) F(w, x, y, z) = \sum(2, 3, 6, 7, 8, 9, 12, 13)$$

w\bar{x}	00	01	11	10
0x	0	0	1	1
01	0	0	1	1
11	1	1	0	0
10	1	1	0	0

$$\begin{aligned} & F(w, x, y, z) \\ &= w'y' + w'y \end{aligned}$$

3.5 Simplify the following Boolean functions using four-variable K-maps

$$a) F(w, x, y, z) = \sum(1, 4, 5, 6, 12, 14, 15)$$

w\bar{x}	00	01	11	10
0x	0	1	0	0
01	1	1	0	1
11	1	0	1	1
10	0	0	0	0

$$F(w, x, y, z) = xz' + wxy + w'y'z$$

$$b) F(A, B, C, D) = \sum(2, 3, 6, 7, 12, 13, 14)$$

A\B	CD	00	01	11	10
0C	0	0	1	1	
0D	0	0	1	1	
1C	1	1	0	1	
1D	0	0	0	0	

$$\begin{aligned} & F(A, B, C, D) = \\ & A'C + BCD + ABC' \end{aligned}$$

$$c) F(w, x, y, z) = \sum(1, 3, 4, 5, 6, 7, 9, 11, 13, 15)$$

w\bar{x}	00	01	11	10
0x	0	1	0	1
01	1	1	1	1
11	1	1	0	0
10	0	1	1	0

$$F(w, x, y, z) = w'x + wz + w'y'z + w'yz'$$

$$d) F(A, B, C, D) = \sum(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$$

A\B	CD	00	01	11	10
0C	1	0	0	1	
0D	1	1	1	1	
1C	0	1	1	0	
1D	1	0	0	1	

$$\begin{aligned} & F(A, B, C, D) = \\ & A'D' + BD + AB'D' \end{aligned}$$

3.8 Find the minterms of the following Boolean expressions by first plotting each function in a K-Map

$$a) xy + yz + xy'z$$

$x \backslash yz$	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$$F(x,y,z) = \sum(3,5,6,7)$$

$$b) C'D + ABC' + ABD' + A'B'D$$

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

$$F(A,B,C,D) = \sum(1,3,5,9,12,13,14)$$

$$c) wxyz + w'x' + wxz'$$

$wx \backslash yz$	00	01	11	10
00	1	1	1	1
01	0	0	0	0
11	1	0	1	1
10	0	0	1	0

$$F(w,x,y,z) = (0,1,2,3,11,12,14,15)$$

$$d) A'B + A'CD + B'CD + BC'D'$$

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

$$F(A,B,C,D) = (3,4,5,6,7,11,12)$$

3.10 Simplify the following Boolean by first finding the essential prime implicants

$$a) F(w,x,y,z) = \sum(0,2,4,5,6,7,8,10,13,15)$$

$wx \backslash yz$	00	01	11	10
00	1	0	0	1
01	1	1	1	1
11	0	1	1	0
10	1	0	0	1

$$F(w,x,y,z) = w'z' + xz + wz'$$

$$b) F(A,B,C,D) = \sum(0,2,3,5,7,8,10,11,14,15)$$

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

$$F(A,B,C,D) = B'D' + CD + A'BD + AB'D' + AC$$

$$c) F(A, B, C, D) = \sum(1, 3, 4, 5, 10, 11, 12, 13, 14, 15)$$

		CD		00	01	11	10
		A	B	00	01	11	10
00	00	0	1	1	0		
00	01	1	1	0	0		
01	00	1	1	1	1		
01	01	1	1	1	1		
11	00	0	0	1	1		
10	00	0	0	1	1		
10	01	0	0	1	1		

$$F(A, B, C, D) = ABD + BC' + AC$$

$$d) F(w, x, y, z) = \sum(0, 1, 4, 5, 6, 7, 9, 11, 14, 15)$$

		yz		00	01	11	10
		w	x	00	01	11	10
00	00	1	1	0	0		
00	01	1	1	1	1		
01	00	0	0	1	1		
01	01	1	1	1	1		
11	00	0	0	1	1		
10	00	0	1	1	1		
10	01	1	1	0	0		

$$F(w, x, y, z) = w'y' + xy + wz'z$$

$$e) F(A, B, C, D) = \sum(0, 1, 7, 8, 9, 10, 13, 15)$$

		CD		00	01	11	10
		A	B	00	01	11	10
00	00	1	1	1	0		
00	01	0	0	1	0		
01	00	0	1	1	0		
01	01	1	1	1	0		
11	00	0	1	1	0		
10	00	1	1	0	1		
10	01	1	1	0	1		

$$F(A, B, C, D) = A'B'C'D + A'CD + ABD + AC'D + AB'D'$$

$$f) F(w, x, y, z) = \sum(0, 1, 2, 4, 5, 6, 7, 10, 15)$$

		yz		00	01	11	10
		w	x	00	01	11	10
00	00	1	1	0	0	1	1
00	01	1	1	1	1	1	1
01	00	1	1	1	1	0	0
01	01	0	0	1	1	0	0
11	00	0	0	1	1	0	0
10	00	0	0	0	0	1	1
10	01	0	0	0	0	1	1

$$F(w, x, y, z) = w'y' + w'x + xy' + x'z'y'$$

3.15 Simplify the following Boolean functions F , together with don't-care conditions d , and then express the simplified function in sum-of-minterms form:

$$a) F(x, y, z) = \sum(0, 1, 4, 5, 6)$$

$$d(x, y, z) = \sum(2, 3, 7)$$

		yz		00	01	11	10
		x		00	01	11	10
00	00	1	1	X	X		
00	01	1	1	X	1		

$$F(x, y, z) = (0, 1, 2, 3, 4, 5, 6, 7)$$

$$b) F(A, B, C, D) = \sum(0, 6, 8, 13, 14)$$

$$d(A, B, C, D) = \sum(2, 4, 10)$$

		yz		00	01	11	10
		w	x	00	01	11	10
00	00	1		0	0		
00	01	X	0	0	0		
01	00	0	0	0	0	1	1
01	01	0	1	1	0	1	1
11	00	0	0	0	0	1	1
10	00	1	0	0	0	X	
10	01	0	0	0	0	X	

$$F(A, B, C, D) = B'D' + CD' + ABC'D$$

$$F(A, B, C, D) = (0, 2, 6, 8, 10, 13, 14)$$

$$c) F(A, B, C, D) = \sum(5, 6, 7, 12, 14, 15)$$

$$d(A, B, C, D) = \sum(3, 9, 11)$$

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

$$F(A, B, C, D) = AB'D' + A'B'C'D + CD + BC$$

$$F(A, B, C, D) = \sum(3, 5, 6, 7, 11, 12, 14, 15)$$

$$d) F(A, B, C, D) = \sum(4, 12, 7, 2, 10)$$

$$d(A, B, C, D) = \sum(0, 6, 8)$$

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

$$F(A, B, C, D) = C'D' + B'C'D' + A'BC$$

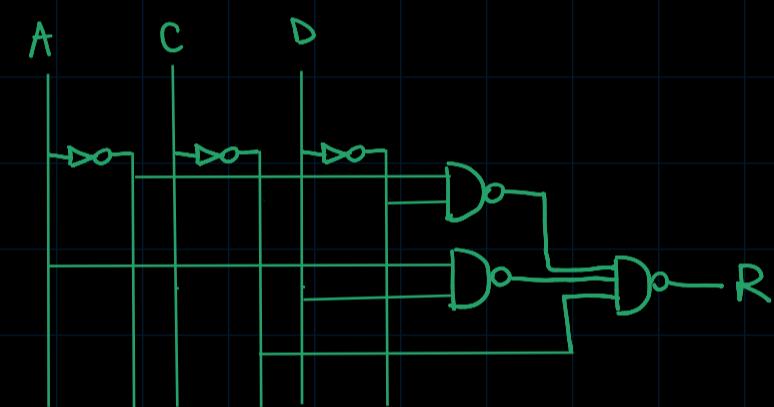
3.16 Simplify the following functions and implement them with two-level NAND circuit gates.

$$a) F(A, B, C, D) = AC'D' + A'C + ABC + AB'C + A'C'D'$$

	AB		CD	00	01	11	10
	00	01		1	1	1	1
00	1			1	1	1	1
01	1			1	1	1	1
11	1			1	1	1	1
10				1	1	1	1

$$F(A, B, C, D) = A'D' + C + AD$$

$$\begin{aligned} & [A'D' + C + AD]' \\ &= (A'D')' (C') (AD)' \end{aligned}$$

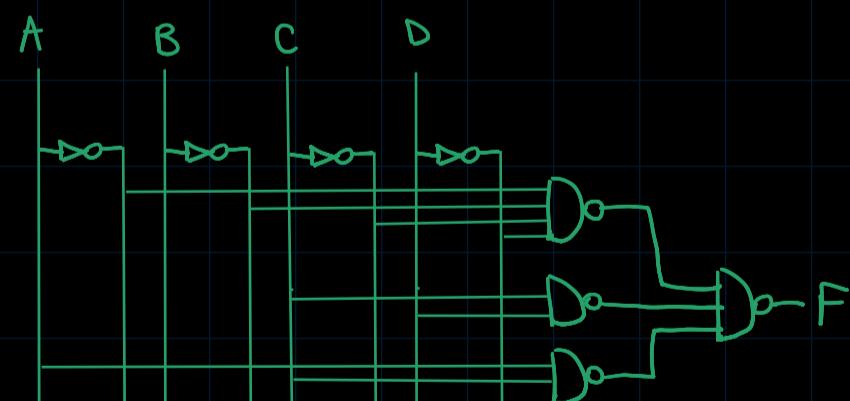


$$b) F(A, B, C, D) = A'B'C'D' + CD + AC'D$$

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

$$F(A, B, C, D) = A'B'C'D' + CD + AC'D$$

$$\begin{aligned} & [A'B'C'D' + CD + ACD]' \\ &= (A'B'C'D')' (CD)' (ACD)' \end{aligned}$$

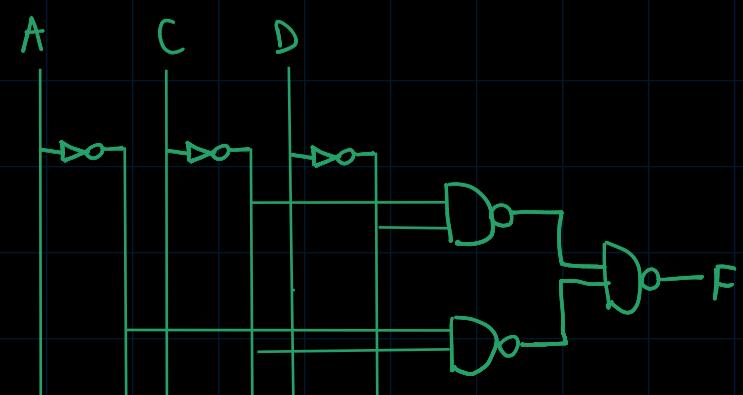


$$c) F(A, B, C, D) = (A' + C' + D')(A' + C)(C' + D')$$

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

$$F(A, B, C, D) = C'D' + A'C'$$

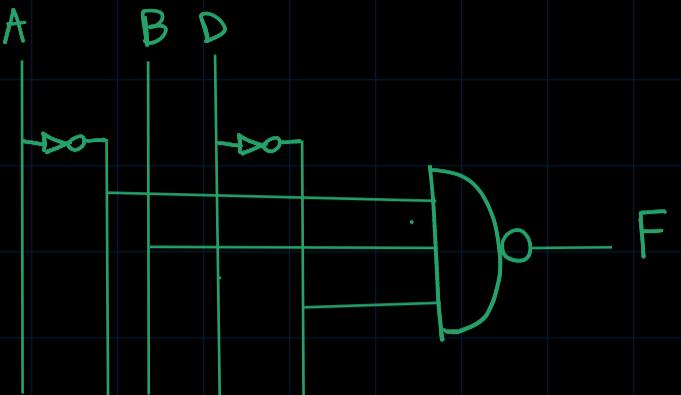
$$\begin{aligned} & [C'D' + A'C']' \\ &= (C'D')' (A'C')' \end{aligned}$$



$$d) F(A, B, C, D) = A' + B + D' + B'C$$

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

$$F(A, B, C, D) = D' + A' + B \\ [D' + A' + B]' \\ (D')' (A')' B'$$



3.18 Draw (a) a logic diagram using only two-input NOR gates to implement the following function:

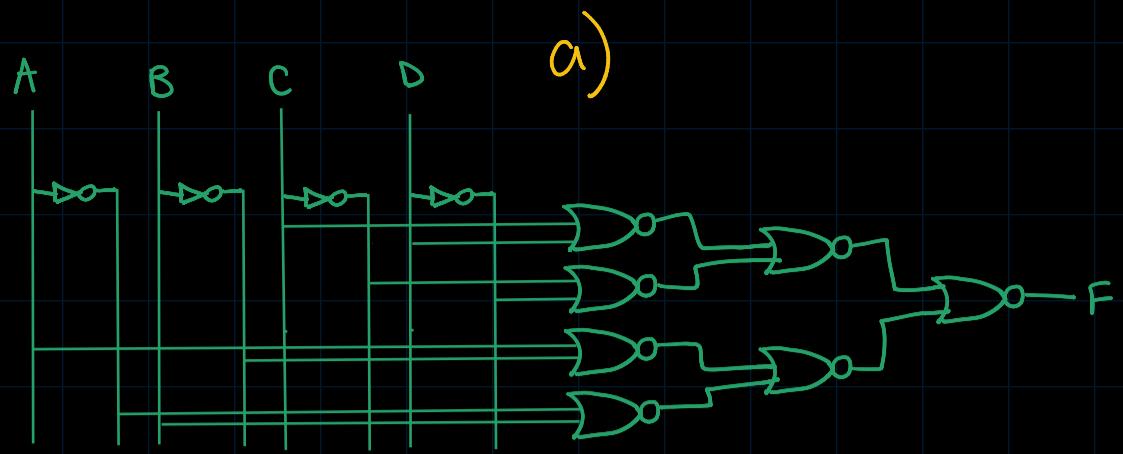
$$F(A, B, C, D) = (A \oplus B)'(C \oplus D)$$

and (b) repeat (a) for a NAND logic diagram

$$\begin{aligned} F(A, B, C, D) &= (A \oplus B)'(C \oplus D) \\ &= (AB' + A'B')(C'D + CD') \\ &= (AB')' \cdot (A'B')' (C'D + CD') \\ &= (A' + B)(A + B)(C'D + CD') \\ &= (A'B' + AB)(C'D + CD') \\ &= A'B'C'D + A'B'CD' + ABC'D + ABCD' \end{aligned}$$

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

$$\begin{aligned} F(A, B, C, D) &= C'D' + CD + A'B + AB' \\ &= [C'D' + CD + A'B + AB']' \\ &= (C'D')' (CD)' (A'B)' (AB')' \\ &= [(C + D)(C' + D')(A + B')(A' + B)]' \\ &= (C + D)' + (C' + D')' + (A + B')' + (A' + B)' \\ &= [(C + D)' + (C' + D')']' [(A + B')' + (A' + B')']' \\ &= \left[\left[(C + D)' + (C' + D')' \right]' \left[(A + B')' + (A' + B')' \right]' \right]' \end{aligned}$$



$$(C'D')' (CD') (A'B)' (AB')'$$

