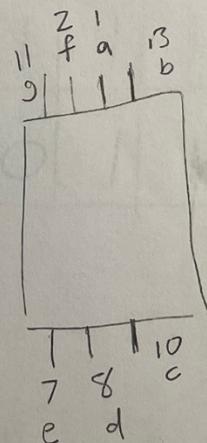


$\textcircled{1}$	$= a, b, c, d, e, f$	$= 1, 13, 10, 8, 7, 2$
$\textcircled{2}$	$= b, c$	$= 13, 10$
$\textcircled{3}$	$= a, b, g, e, d$	$= 1, 13, 11, 7, 8$
$\textcircled{4}$	$= a, b, g, c, d$	$= 1, 13, 11, 10, 8$
$\textcircled{5}$	$= a, f, g, c, d$	$= 1, 2, 11, 10, 8$
$\textcircled{6}$	$= a, f, e, g, d, c$	$= 1, 2, 7, 11, 8, 10$
$\textcircled{7}$	$= a, b, c$	$= 1, 13, 10$
$\textcircled{8}$	$= a, b, c, d, e, f, g$	$= 1, 13, 10, 8, 7, 2, 11$
$\textcircled{9}$	$= a, f, g, b, c, d$	$= 1, 2, 11, 13, 10, 8$

$f \mid \frac{a}{\overline{g}} \mid b$
 $e \mid \frac{g}{\overline{d}} \mid c$



Input

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

Output

	1(a)	2(f)	7(e)	8(d)	10(c)	11(g)	13(b)
0	1	1	1	1	1	0	1
1	0	0	0	0	1	0	1
2	1	0	1	1	0	1	1
3	1	0	0	1	1	1	1
4	0	1	0	0	1	1	1
5	1	1	0	1	1	1	0
6	1	1	1	1	1	1	0
7	1	0	0	0	1	0	1
8	1	1	1	1	1	1	1
9	1	1	0	1	1	1	1

$$F_{1(a)} = A'B'C'D' + A'B'CD' + A'BC'D + A'BC'D' \\ + A'BCD' + A'BCD + AB'C'D' + AB'C'D$$

$$F_{2(f)} = A'B'C'D' + A'BC'D' + A'BC'D + A'BCD' \\ + AB'C'D' + AB'C'D$$

$$F_{7(e)} = A'B'C'D' + A'BC'D' + A'BCD' + AB'C'D'$$

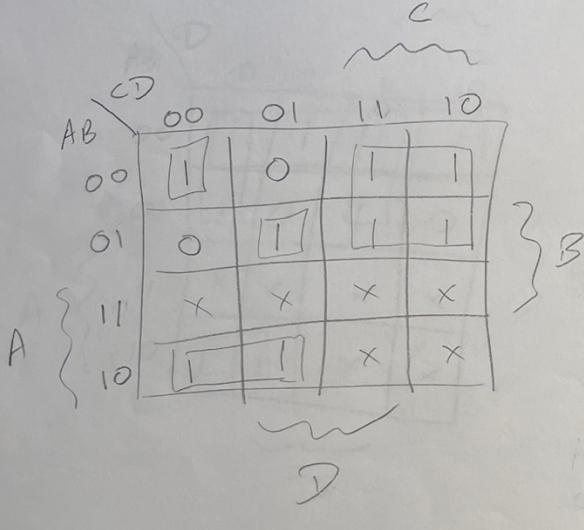
$$F_{8(d)} = A'B'C'D' + A'BC'D' + A'BCD + A'BC'D \\ + A'BCD' + AB'C'D' + AB'C'D$$

$$F_{10(c)} = A'B'C'D' + A'B'C'D + A'B'CD + A'BC'D' + A'BC'D \\ + A'BCD' + A'BCD + AB'C'D' + AB'C'D$$

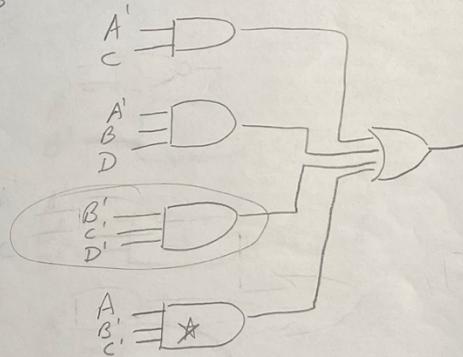
$$F_{11(g)} = A'B'CD' + A'B'CD + A'BC'D' + A'BC'D \\ + A'BCD' + AB'C'D' + AB'C'D$$

$$F_{13(b)} = A'B'C'D' + A'B'C'D + A'B'CD' + A'B'CD + A'BCD' \\ + A'BCD + AB'C'D' + AB'C'D$$

4 Variable
Map for
1(a)



$$F = A'C + A'B'D + B'C'D' \\ 1(a) \quad + A'B'C'$$



$F_{13(b)}$

		CD		C'D'		CD'		C'D	
		00	01	11	10	00	01	11	10
		AB	00	01	11	10	00	01	11
A	00	00	1	1	1	1	0	0	0
	01	01	0	0	0	0	1	1	1
	11	11	x	x	x	x	1	1	1
	10	10	1	1	x	x	1	1	1

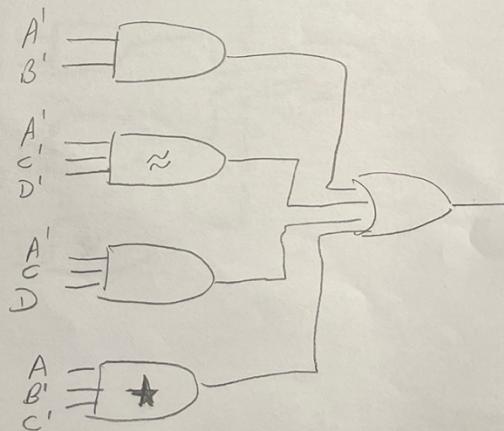
\bar{C}

\bar{D}

\bar{B}

$$F_{13(b)} = A'B' + A'C'D'$$

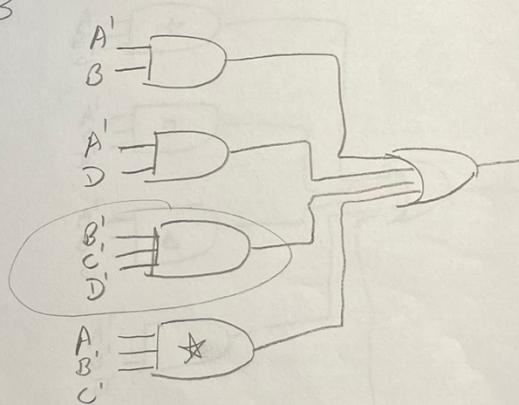
$$+ A'CD + ABC'D'$$



$F_{10(c)}$

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

$$\begin{aligned} F_{10(c)} &= \cancel{ABC'D'} + \cancel{AC'D} + \cancel{A'BCD} + \cancel{A'B'C'D'} \\ &= A'B + A'D + B'C'D' + AB'C \end{aligned}$$



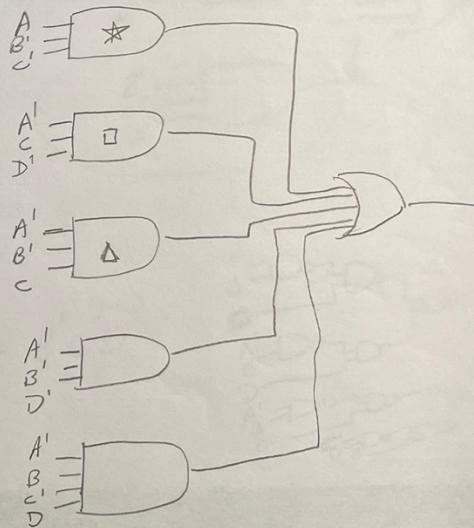
$F_{8(d)}$

F

$F_{8(d)}$

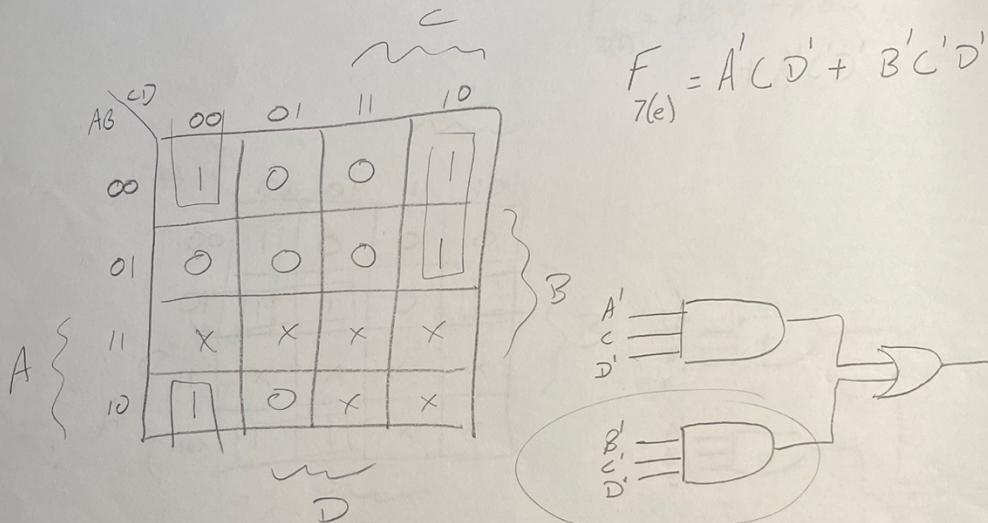
		C	
		00	01
A	00	1	0
	01	0	1
B	11	1	0
	10	X	X
D	11	X	X
	10	1	1

$$\begin{aligned}
 F_{8(d)} = & A'BC' + A'CD' + A'B'C \\
 & + A'B'D' \\
 & + A'BC'D
 \end{aligned}$$

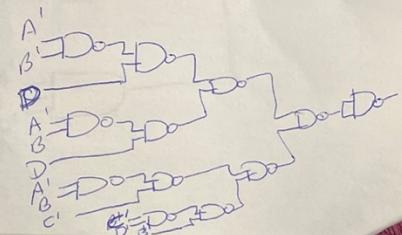


$$F_{11(e)}$$

$$F_{7(e)}$$



$$\overline{F}_{7e} = A'B'D + A'BD + A'BC' + B'C'D$$



$$F_{11(g)}$$

C

$$F_{2(f)}$$

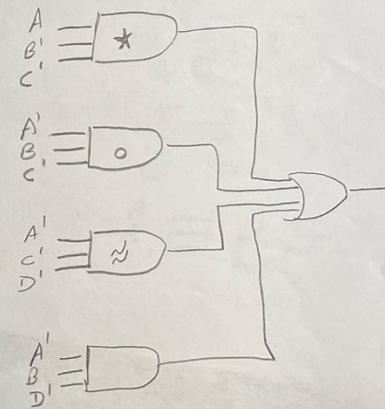
$$\begin{aligned} F_{2(f)} = & AB'c' + A'b'c' \\ & + A'c'd' + A'b'd' \end{aligned}$$

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

A

D

C

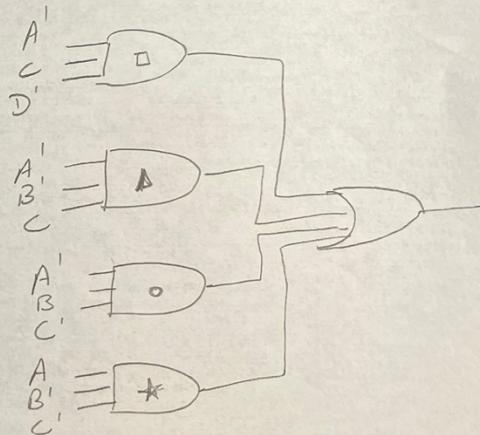


$F_{11(g)}$

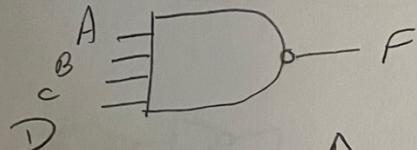
AB		CD		C	
		00	01	11	10
A	00	0 0	1	1	
	01	1 1	0	1	
	11	X X	X X		
	10	1 1	X X		

$$F_{11(g)} = A'C'D' + A'B'C$$

$$+ A'B'C' + AB'C'$$

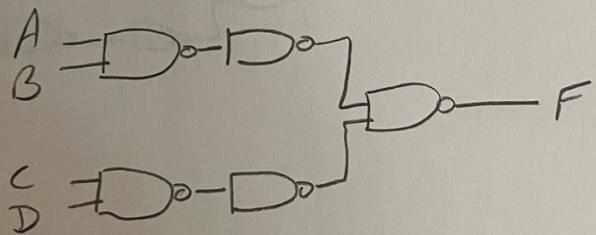


4-Input NAND to 2-Input NAND

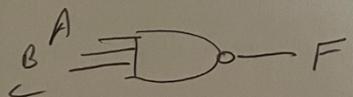


↑

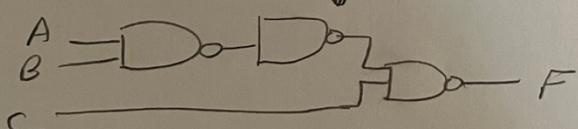
Same
↓



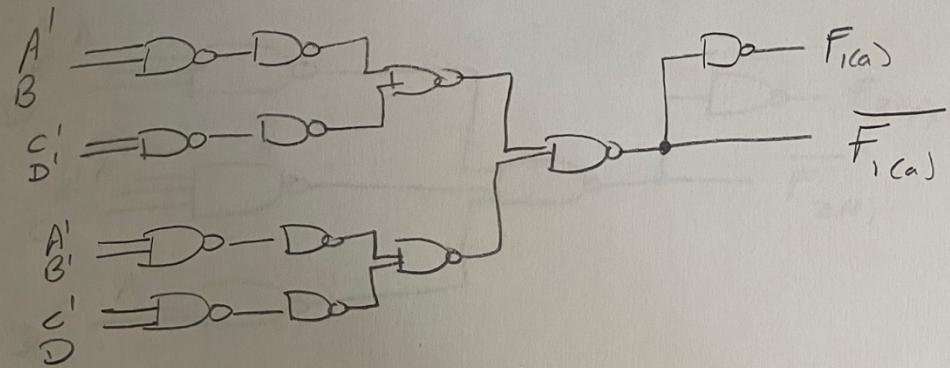
3-Input NAND to 2-Input NAND



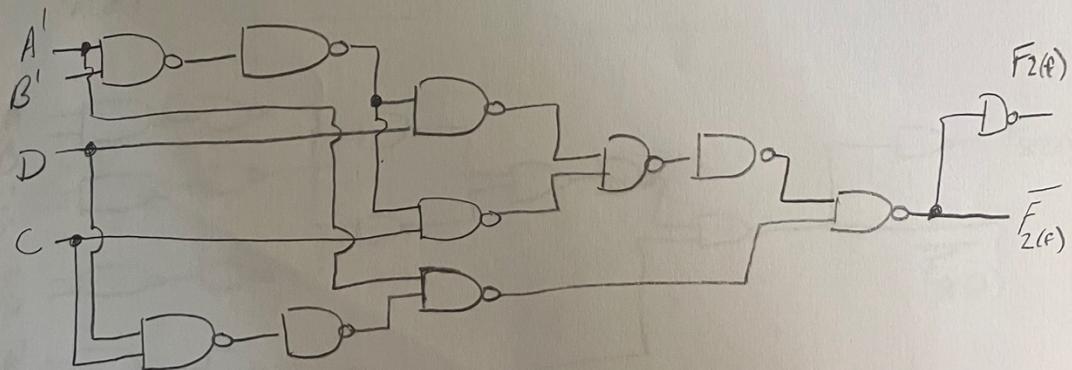
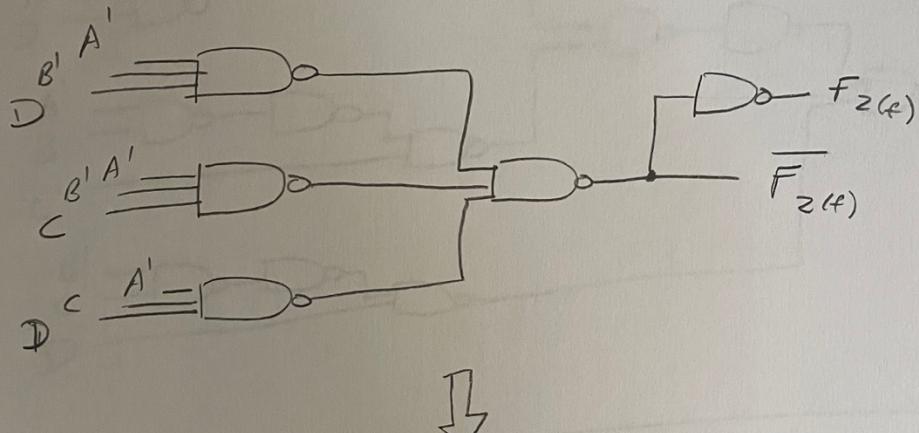
↑
Same
↓



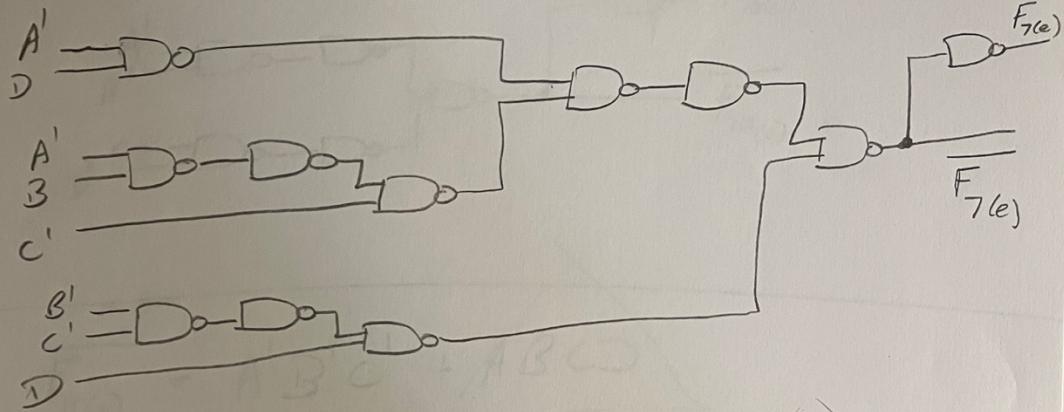
$$\overline{F_{1(a)}} = \boxed{A'B'C'D'} + \boxed{A'B'C'D}$$



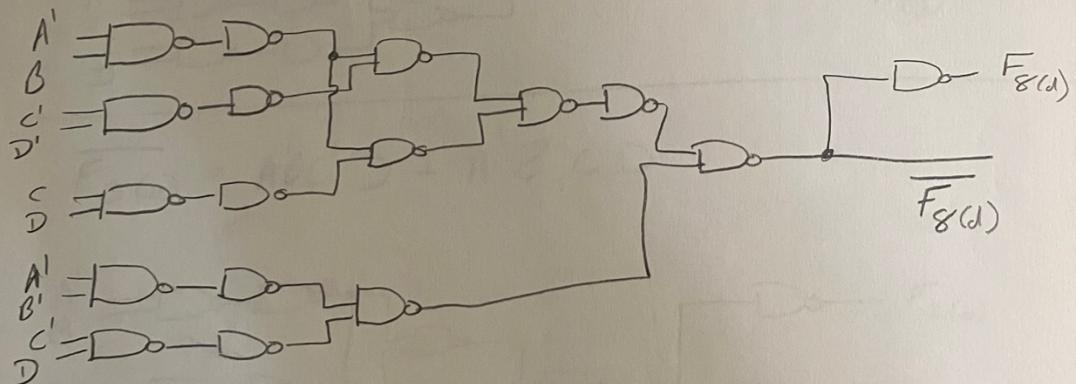
$$\overline{F}_{2(f)} = A'B'D + A'B'C + A'CD$$



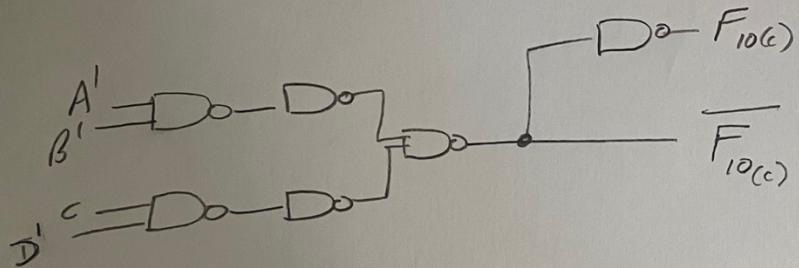
$$\overline{F}_{7(e)} = A'D + A'B'C' + B'C'D$$



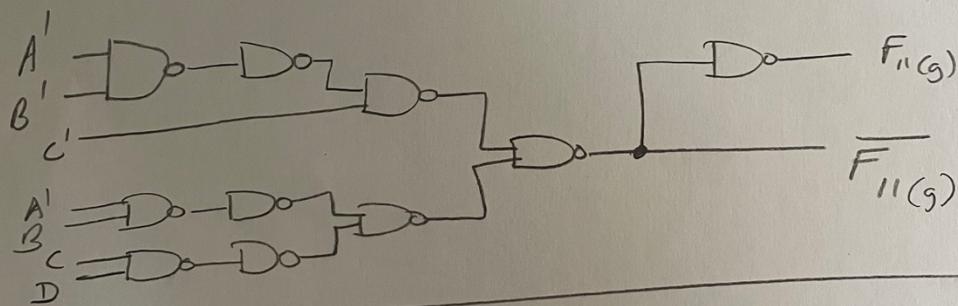
$$\overline{F}_{8(d)} = \boxed{A'B'C'D'} + \boxed{A'B'C'D} + \boxed{A'B'C'D}$$



$$\overline{F}_{10(c)} = A'B'C'D'$$



$$\overline{F}_{11(g)} = A'B'C' + A'B'CD$$



$$\overline{F}_{12(b)} = ABC'D + A'B'CD'$$

