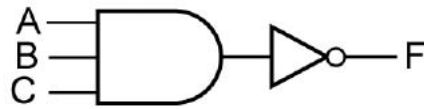
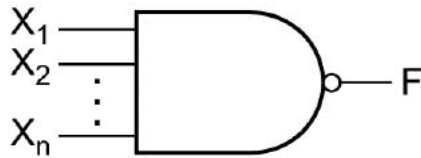




(a) 3-input NAND gate

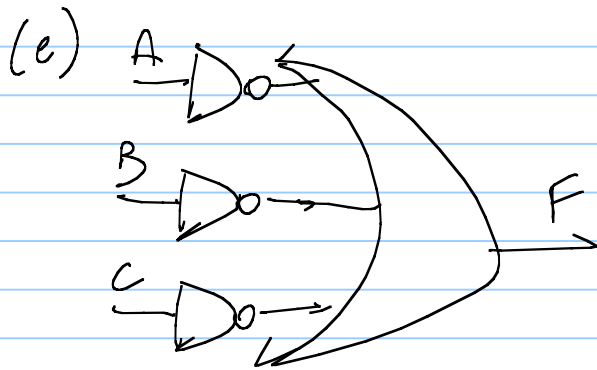


(b) NAND gate equivalent

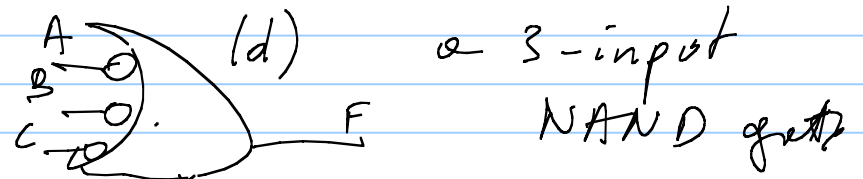


(c) n-input NAND gate

Figure 7-8: NAND Gates



Ch. 7 text
AND-NOT



$$F = (\text{from (d)}) = (A \cdot B \cdot C)' =$$

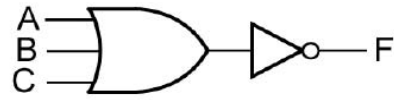
$$= (\text{De Morgan's Law}) =$$

$$A' + B' + C' = (\text{from (e)}) = F$$

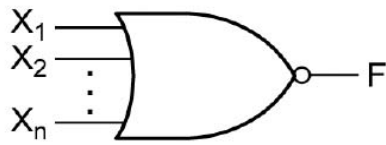
(d) is a shorthand for (e).



(a) 3-input NOR gate



(b) NOR gate equivalent



(c) n-input NOR gate

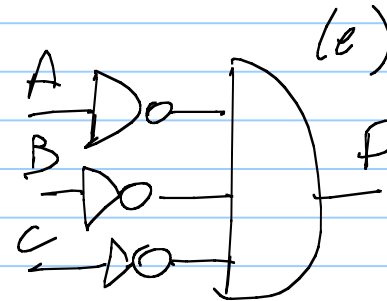
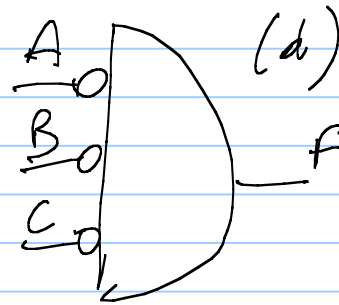


Figure 7-9: NOR Gates

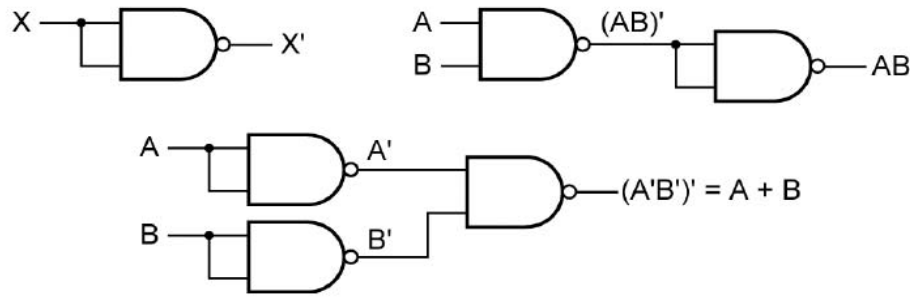
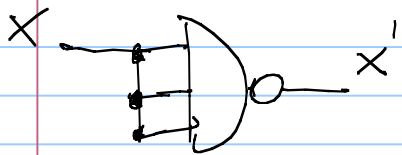


Figure 7-10: NAND Gate Realization of NOT, AND, and OR

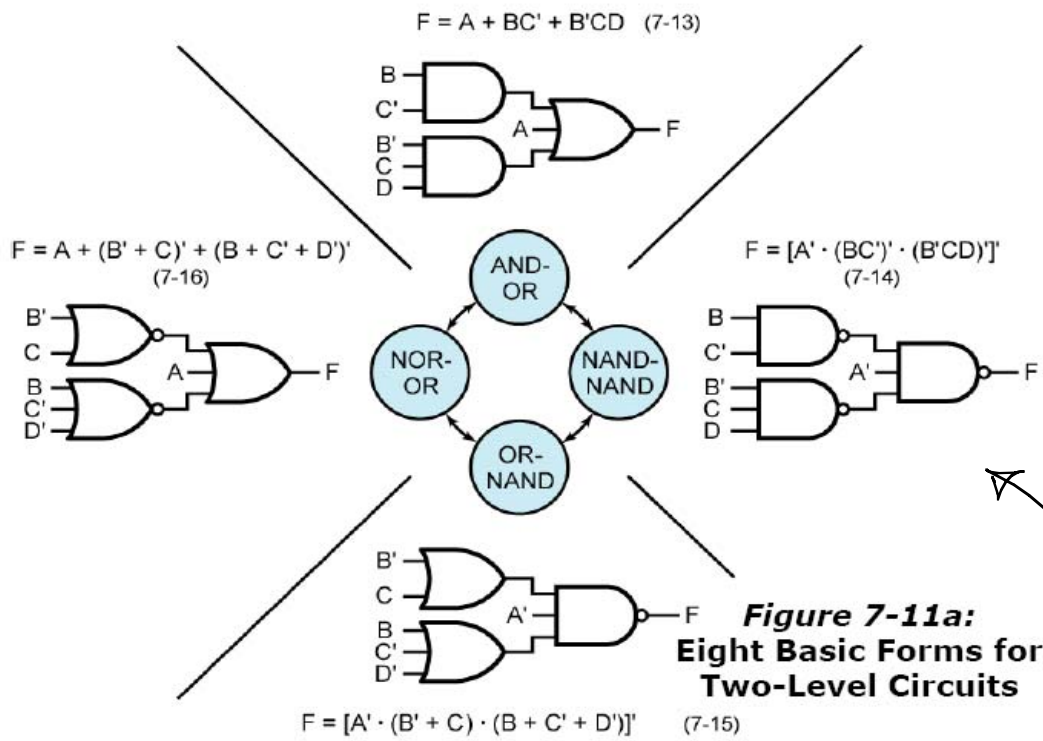
$\{ \text{NAND} \}$ is a complete set of Boolean gates, i.e. this set is sufficient to realize any Boolean circuit.

We know that $\{ \text{AND}, \text{OR}, \text{NOT} \}$ is sufficient.

NAND, as shown in the figure above, can realize NOT, AND, and OR. So, $\{ \text{NAND} \}$ is also a complete set of Boolean gates.



An inverter built from a 3-input NAND.
 $(X \cdot X \cdot X)' = X'$



SOP realization on top
Start from SOP

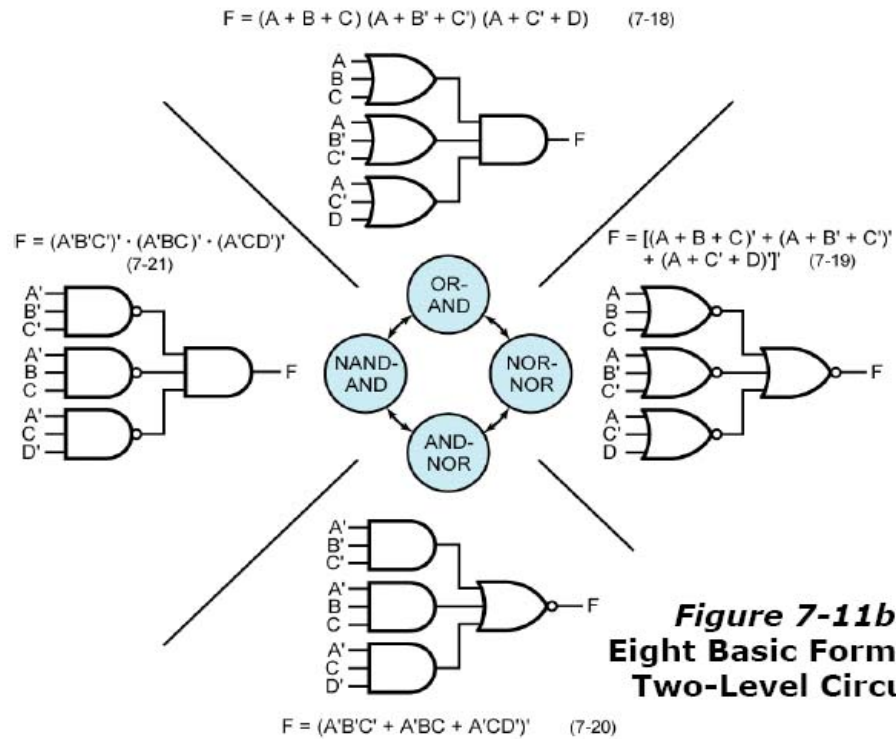
$$F = A + BC' + B'CD =$$

$$[(A + BC' + B'CD)']' =$$

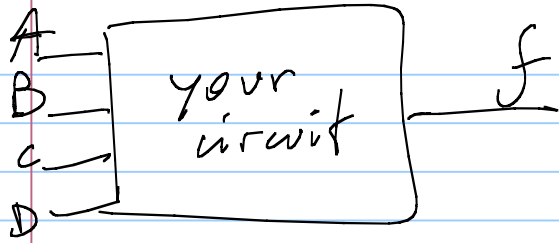
$$[A' \cdot \boxed{(BC')'} \cdot (B'CD)']' =$$

NAND(B, C')

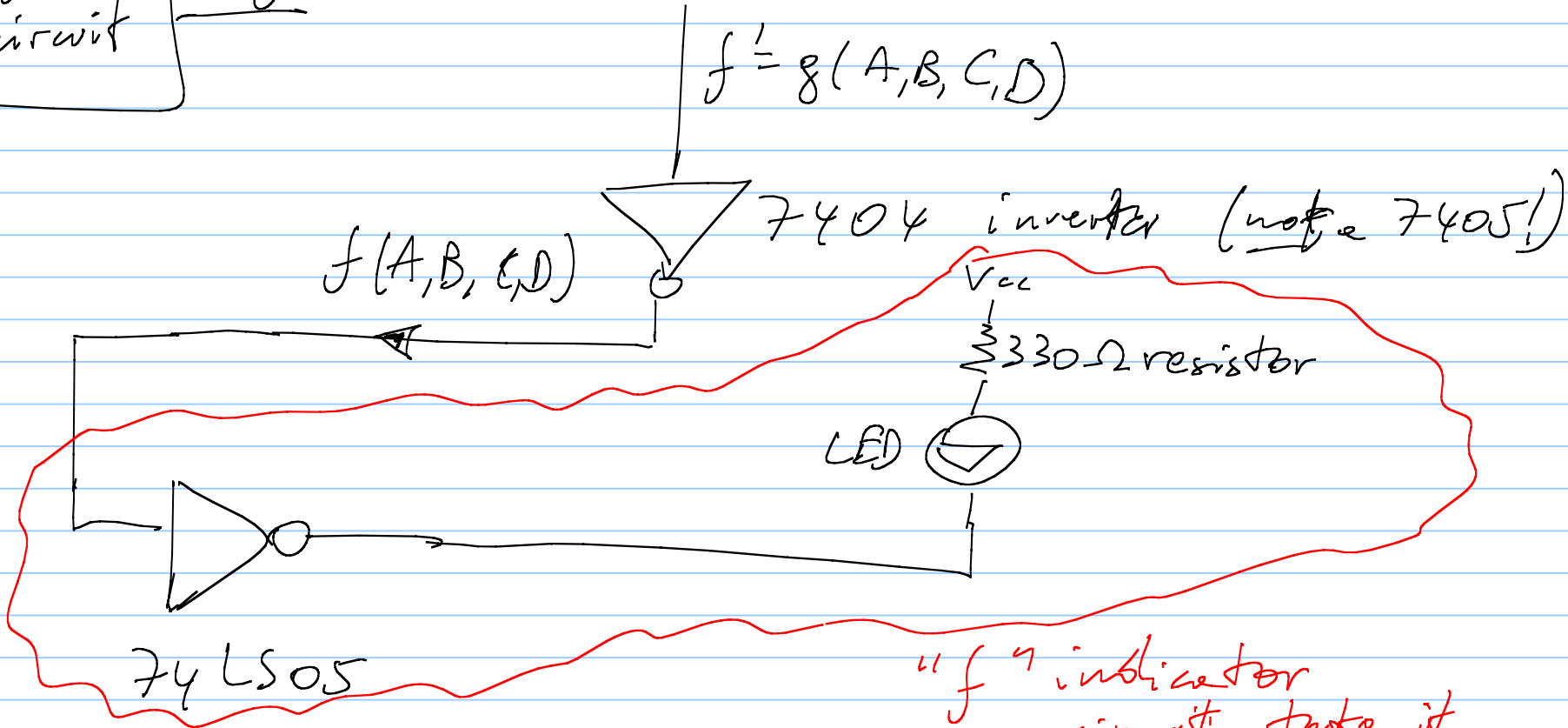
Start with POS
(instead of SOP)



Circuit 2 Discussion



$$f' = g(A, B, C, D)$$



74LS05

"f" indicator circuit - take it as a black box!

- (1) Design a ^{minimal} SOP (AND-OR) expression for g using a K-map
 - (2) Design the corresponding NAND-NAND circuit
 - (3) Negate the output with a 7404 inverter
 - (4) The output of the 7404 inverter will be displayed using the LED indicator circuit.
- (3) and (4) are on the previous page

$$f(A, B, C, D) = \sum m(0, 1, 2, 3, 4, 5, 6) + \sum d(10, 11, 12, 13, 14, 15)$$

		A			
		00	01	11	10
00	0	1	1	X	0
	1	1	1	X	0
01	3	1	0	X	X
	2	1	1	X	X

B

D

	00	01	11	10
	0	4	12	8
00	0	0	X	1
01	1	5	X	9
11	3	7	X	11
10	2	6	X	10

B

$$g(A, B, C, D) = f'(A, B, C, D) =$$

$$\sum m(7, 8, 9) + \sum \phi(10, 11, 12, 13, 14, 15)$$

	00	01	11	10
00	0	4	X	1
01	1	5	X	1
11	3	7	X	X
10	2	6	X	1

The K-map for g

$$g = A + BCD$$

