FROM SMITH & DORF,
CIRCUITS, DEVICES,
& SYSTEMS

ENGINEERING 11
ELECTRICAL CIRCUIT ANALYSIS
ASSIGNMENT 12

LAM

P13-36. Analyze the memory element in Fig. P13.36. Draw up a truth table assuming the input is a series of pulses and **Q** is initially **1**. What function is performed by the **AND** gates?

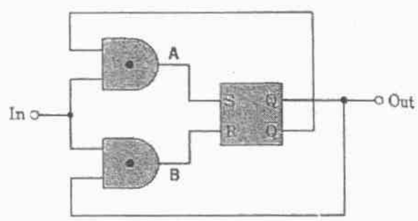


Figure P13.36 Memory element.

P14-12. Use Boolean theorems to prove the following identities:

(a) $A + \overline{A}B = A + B$
(b) $ABC + AB\overline{C} = AB$
(c) $(A + \overline{B})B = AB$
(d) $(A + B)(\overline{A} + C) = AC + \overline{A}B$

P14-13. When writing equations for "programmed array logic" circuits, complicated expressions must be broken down into simple "sums-of-products" (like Eq. 14-6).

(a) Write the following expression as a sum-of-products. Show the Boolean theorems used during each step of simplification.

$$[(A \cdot B \cdot \overline{C}) \cdot (\overline{A \cdot \overline{B} \cdot C}) + \overline{A}\,\overline{B}] \cdot \overline{D}$$

(b) Invert the result from part (a), and factor it into a sum-of-products, showing theorems used.

P14-14. The function $f = A + B$ is to be realized using only **NAND** gates. Use DeMorgan's theorems to express **f** in terms of $\overline{C \cdot D}$ where **C** and **D** can be expressed in terms of **A** and **B**. Draw the necessary logic circuit and check by constructing the truth table.

P14-15. Analyze the logic circuit of Fig. P14.15 and determine **f** in terms of **A** and **B**. Simplify using Boolean algebra and check your result with a truth table.

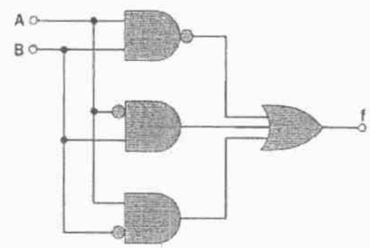


Figure P14.15

P14-20. Given the logic function

$$f = \overline{AB + \overline{A}\,\overline{B}} + \overline{A}B$$

(a) Assuming the complements are available, simplify the function using DeMorgan's theorem and synthesize it using the basic gates.
(b) Assuming the complements are not available, simplify the function and synthesize it from five **NAND** gates.

Answer: (a) $f = A\overline{B} + B\overline{A}$.

P14-24. Map the following functions and find the minimal sum-of-products form:

(a) $ABC\overline{D} + A\overline{B}C + \overline{B}\,\overline{C}$
(b) $AB + \overline{A}\,\overline{B}CD + A\overline{B}C$

From Smith & Dorf
P13-36, P14-12, P14-13,
P14-14, P14-15, P14-20, P14-24

Engineering 11
Electrical Circuit Analysis
Assignment 12 Solutions

2004
LAM.

1. P13-36 R & S are alternatively turned on $\Rightarrow$ output switches on & off w/each pulse.

Pulse #	Q_{n-1}	A	B	Q_n
1	1	0	1	0
2	0	1	0	1
3	1	0	1	0

2. P14-12

a. $A+\bar A B = A(B+\bar B)+\bar A B = AB + A\bar B + \bar A B \ (+AB) = A(B+\bar B) + (A+\bar A)B = A+B$ ✓

b. $ABC + AB\bar C = AB(C+\bar C) = AB$ ✓

c. $(A+\bar B)B = AB + \cancel{B\bar B} = AB$ ✓

d. $(A+B)(\bar A + C) = \cancel{A\bar A} + B\bar A + AC + BC = \bar A B(C+\bar C) + AC(B+\bar B) + (A+\bar A)BC$

$= \bar A BC + \bar A B\bar C + ABC + A\bar B C + ABC + \bar A BC = \bar A BC + \bar A B\bar C + ABC + A\bar B C = \bar A B(C+\bar C) + A(B+\bar B)C$

$\bar A B + AC$ ✓

3. P14-13

a. $[(AB\bar C)\cdot(\overline{A\bar B C}) + \bar A\bar B]\cdot\bar D$

$[(AB\bar C)\cdot(\bar A + B + \bar C) + \bar A\bar B]\cdot\bar D$ DeMorgan

$[\cancel{A\bar A B\bar C} + ABB\bar C + AB\bar C\bar C + \bar A\bar B]\cdot\bar D$ Distribution

$[AB\bar C + \bar A\bar B]\cdot\bar D$ Boole

$AB\bar C\bar D + \bar A\bar B\bar D$ Distribution

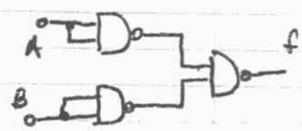
b. $\overline{(AB\bar C\bar D + \bar A\bar B\bar D)} = \overline{AB\bar C\bar D}\cdot\overline{\bar A\bar B\bar D}$ DeMorgan

$(\bar A + \bar B + C + D)\cdot(A+B+D)$ DeMorgan

$\bar A B + A\bar B + AC + BC + D$ Distribution

4. P14-14 $f = A+B = \overline{\bar A\cdot\bar B} = \overline{(\overline{A\cdot A})\cdot(\overline{B\cdot B})}$

A	B	$\bar A\cdot\bar B$	$\overline{\bar A\cdot\bar B} = A+B$ ✓
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1



5. P14-15

$f = \overline{AB} + \bar A B + A\bar B$

A	B	$\overline{AB}$	$\bar A B$	$A\bar B$	$f=\overline{AB}$
0	0	1	0	0	1
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	0	0	0

$f = \overline{AB} + \bar A B + A\bar B$

$= \bar A + \bar B + \bar A B + A\bar B$

$= \bar A(1+B) + (1+A)\bar B$

$= \bar A + \bar B = \overline{AB}$

6. P14-20 $f = \overline{AB + \bar A\bar B} + \bar A B$

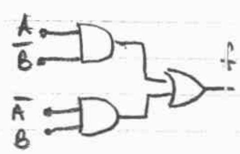
$f = \overline{AB}\cdot\overline{\bar A\bar B} + \bar A B$

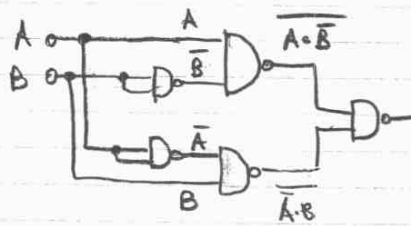
$= (\bar A + \bar B)(A+B) + \bar A B$

$= \cancel{\bar A A} + \bar A B + A\bar B + \cancel{B\bar B} + \bar A B$

$= \bar A B + A\bar B$

$= \overline{\overline{A\bar B}\cdot\overline{\bar A B}}$ (w/NANDS)





$f = \overline{\overline{A\bar B}\cdot\overline{\bar A B}}$

7. P14-24

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

$A\bar B$, $\bar B\bar C$, $AC\bar D$

a) $f = ABC\bar D + A\bar B C + \bar B\bar C$

$= A\bar B + \bar B\bar C + AC\bar D$

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

$\bar B CD$, AB, AC

b. $f = AB + \bar A\bar B CD + A\bar B C$

$= AB + AC + \bar B CD$