CS 231: Intro to Digital Circuits Practice Problems

1. Draw the following logic gates and their truth tables respectively.

    a. AND

    b. OR

    c. NOT

    d. XOR

    e. NOR

f. NAND

2. Complete using Boolean algebra:

   a. A + 0 = ________________

   b. A + A' = ________________

   c. A + A = ________________

   d. A + 1 = ________________

   e. (A')' = ________________

   f. A • 1 = ________________

   g. A • A' = ________________

   h. A • A = ________________

   i. A • 0 = ________________

3. Complete the following terms using each property of Boolean algebra:

   a. Commutative:

A + B =____________________

AB = ____________________

   b. Associative:

A + (B + C) =____________________

A (BC) =____________________

c. Distributive:

A (B+C) =____________________

A + BC =____________________

d. DeMorgan:

(A + B)' =____________________

(AB)' = ____________________

e. Absorption:

A + AB =____________________

A (A + B) =____________________

4. Find the compliment of the following functions by applying DeMorgan's theorem as necessary.

   a. f = a'bc' + a'b'c

   b. f = a(b'c' + bc)

   c. f = AB + C'D' + B'D

   d. f = (ab' + c)d' + e

e. $F = x(y' + z)$

f. $F = X(Y'Z + YZ)$

g. $f = (a + b' + c)(a' + c')(a + b)$

h. $f = ABCD + A'B'CD + ACD + A'B$

i. $F = x'(yz) + w$

5. Given the following functions, find their representation in sum of minterms and product of maxterms format.

   a. $F = XY + X'Z$

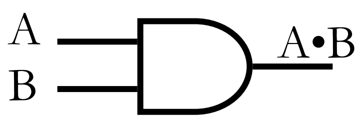
b. $f = (wx + y)(x + y'z)$

c. $F = A'BC + A'B'C' + B'C$

d. $F = a'b'c + a'b + ac + a'b'c'$

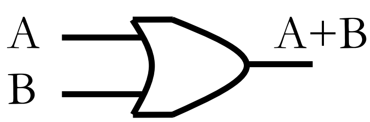
Solutions

1. Draw the following logic gates and their truth tables respectively.
   a. AND



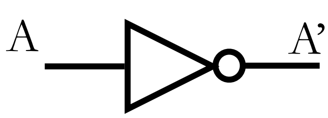
A	B	A•B
0	0	0
0	1	0
1	0	0
1	1	1

   b. OR



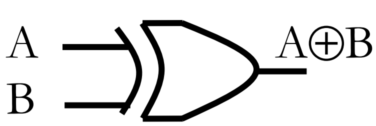
A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

   c. NOT



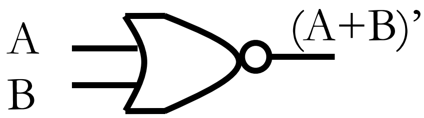
A	A’
0	1
1	0

   d. XOR



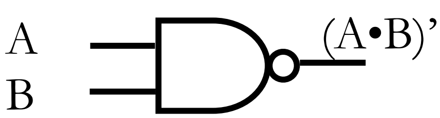
A	B	A⊕B
0	0	0
0	1	1
1	0	1
1	1	0

e. NOR



A	B	(A+B)’
0	0	1
0	1	0
1	0	0
1	1	0

f. NAND



A	B	(A•B)’
0	0	1
0	1	1
1	0	1
1	1	0

2. Complete using Boolean algebra:

   a. A + 0 = A

   b. A + A’ = 1

   c. A + A = A

   d. A + 1 = 1

   e. (A’)’ = A

   f. A • 1 = A

   g. A • A’ = 0

   h. A • A = A

   i. A • 0 = 0

3. Complete the following terms using each property of Boolean algebra:

    a. Commutative:

A + B = B + A

AB = BA

    b. Associative:

A + (B + C) = (A + B) + C

A (BC) = (AB) C

    c. Distributive:

A (B+C) = AB + AC

A + BC = (A + B) (A + C)

    d. DeMorgan:

(A + B)’ = A’B’

(AB)’ = A’ + B’

    e. Absorption:

A + AB = A

A (A + B) = A

4. Find the compliment of the following functions by applying DeMorgan’s theorem as necessary.

    a. f = a’bc’ + a’b’c

    f’ = (a’bc’ + a’b’c)’
    = (a’bc’)’ (a’b’c)’
    = **(a + b’ + c)(a + b + c’)**

    b. f = a(b’c’ + bc)

$f' = [a(b'c' + bc)]'$
$= a' + (b'c' + bc)'$
$= a' + (b'c')' (bc)'$
$= \mathbf{a' + (b + c)(b' + c')}$

c. $f = AB + C'D' + B'D$

$f' = (AB + C'D' + B'D)'$
$= (AB)' (C'D')' (B'D)'$
$= \mathbf{(A' + B')(C + D)(B + D')}$

d. $f = (ab' + c)d' + e$

$f' = [(ab' + c)d' + e]'$
$= ((ab' + c)d')' e'$
$= ((ab' + c)' + d) e'$
$= \mathbf{(((a' + b)c) + d) e'}$

e. $F = x(y' + z)$

$F' = [x(y' + z)]'$
$= x' + (y' + z)'$
$= \mathbf{x' + yz'}$

f. $F = X(Y'Z + YZ)$

$F' = [X(Y'Z + YZ)]'$
$= X' + (Y'Z + YZ)'$
$= \mathbf{X' + (Y + Z')(Y' + Z')}$

g. $f = (a + b' + c)(a' + c')(a + b)$

$f =[(a + b' + c)(a' + c')(a + b)]'$
$= (a + b' + c)' + (a' + c')' + (a + b)'$
$= \mathbf{a'bc' + ac + a'b'}$

h. $f = ABCD + A'B'CD + ACD + A'B$

$f'= [ABCD + A'B'CD + ACD + A'B]'$
$= (ABCD)' (A'B'CD)' (ACD)' (A'B)$
$= \mathbf{(A' + B' + C' + D') (A + B + C' + D') (A' + C' + D') (A + B')}$

i. F =x'(yz) + w

F' =[x'(yz) + w]'
= (x'(yz))' w'
= (x + (yz)') w'
= **(x + (y' + z')) w'**

5. Given the following functions, find their representation in sum of minterms and product of maxterms format.

a. F = XY + X'Z

X	Y	Z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Sum of minterms:
F = X'Y'Z + X'YZ + XYZ' + XYZ

Product of maxterms:
F' = X'Y'Z' + X'YZ' + XY'Z' + XY'Z
(F') = (X + Y + Z)(X + Y' + Z)(X' + Y + Z)(X' + Y + Z')

b. f = (wx + y)(x + y'z) = wx + wxy'z + yx

W	X	Y	Z	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Sum of minterms:
f = w'xyz' + w'xyz + wxy'z' + wxy'z + wxyz' + wxyz

Product of maxterms:
f' = w'x'y'z' + w'x'y'z + w'x'yz' + w'x'yz + w'xy'z' + w'xy'z + wx'y'z' + wx'y'z + wx'yz' + wx'yz
(f')' = (w + x + y + z)(w + x + y + z')(w + x + y' + z)(w + x+ y' + z')(w + x' + y + z)(w + x' + y + z')(w' + x + y + z)(w' + x + y + z')(w' + x + y' + z)(w' + x + y' + z')

c. F = A' BC+A'B'C'+B'C

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

Sum of minterms:
F = A'B'C' + A'B'C + A'BC + AB'C

Product of maxterms:
F' = A'BC' + AB'C' + ABC' + ABC
(F')' = (A + B' + C)(A' + B + C)(A' + B' + C)(A' + B' + C')

d. F = a'b'c + a'b + ac + a'b'c'

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

Sum of minterms:
F = a'b'c' + a'b'c + a'bc' + a'bc + ab'c + abc

Product of maxterms:
F' = ab'c' + abc'
(F')' = (a' + b + c)(a' + b' + c)