

# CPE 64 PAL Worksheet ECS, CSUS

## BOOLEAN ALGEBRA WORKSHEET

- 1) In Boolean algebra, what is the identity law in OR and AND operations?
  
- 2) In regular mathematical operations addition does not distribute over multiplication. For example,  $x + (y \cdot z)$  is NOT  $(x+y) \cdot (x+z)$ , where '+' represents numerical addition and ' $\cdot$ ' represents numerical multiplication. How is this different in Boolean algebra, where '+' represents OR and ' $\cdot$ ' represents AND operations?
  
- 3) Simplify each expression by algebraic manipulation.
  - a)  $a + 0 = ?$
  - b)  $\bar{a} \cdot 0 = ?$
  - c)  $a + \bar{a} = ?$
  - d)  $a + a = ?$
  - e)  $a + ab = ?$
  - f)  $a + \bar{a}b = ?$
  - g)  $a(\bar{a} + b) = ?$

Example 1) Demonstrate the validity of De Morgan's for three variables:  $(x + y + z)' = x' y' z'$  using Truth Table

$x$	$y$	$z$	$x + y + z$	$(x + y + z)'$	$x'$	$y'$	$z'$	$x' y' z'$
0	0	0	0	1	1	1	1	1
0	0	1	1	0	1	1	0	0
0	1	0	1	0	1	0	1	0
0	1	1	1	0	1	0	0	0
1	0	0	1	0	0	1	1	0
1	0	1	1	0	0	1	0	0
1	1	0	1	0	0	0	1	0
1	1	1	1	0	0	0	0	0

- 1) Demonstrate the validity of  $xy + x\bar{y} = x(y + \bar{y})$  using Truth Table.
  
- 2) Demonstrate the validity of De Morgan's for three variables:  $x'yz + xz = z(x + y)$  using Truth Table.

Example 2) Use De Morgan's Theorem to simplify  $\overline{a \cdot b \cdot c} = \bar{a} + \bar{b} + c$

$$\overline{a \cdot b \cdot c} = \bar{a} + \bar{b} + c$$

- 3) Use De Morgan's Theorems to simplify the expression  $\overline{((\bar{a} + c) \cdot (b + c)) + ((a + \bar{d}) \cdot (c + \bar{b}))}$

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- 4) Use De Morgan's Theorems to simplify the following expression  $\overline{b + \bar{c}} \cdot \overline{\bar{a} + c} \cdot (\overline{\bar{d} + \bar{e}})$

Example 3) Reduce the Boolean Expression  $A'C' + ABC + AC'$  to three Literals

$$A'C' + ABC + AC' = C'(A'+A) + ABC$$

$$C' + ABC$$

$$C' + AB$$

- 5) Reduce the Boolean Expression  $(B'C' + D)' + D + BC + AD + A + A'B$  to minimum number of Literals.
- 6) Reduce the Boolean Expression  $A'B(D' + C'D) + B(A + A'CD)$  to one Literals.
- 7) Reduce the Boolean Expression  $(A' + C)(A' + C')(A + B + C'D)(B' + D)$  to Minimum number of Literals.

Example 4) Find the complement of the expression  $xy' + x'y$

$$(xy' + x'y)' = (x' + y) \cdot (x + y')$$

$$= (x'x + x'y' + yx + yy')$$

$$= xy + x'y'$$

- 8) Find the complement of  $F = wx + yz$ ; then show that  $FF' = 0$  and  $F + F' = 1$ .
- 9) Find the complement of the expression  $(a + c)(a + b')(a' + b + c')$

Example 5) Using De Morgan's Theorem, express the function  $F = A\bar{B}C + \bar{A}\bar{C} + AB$  with only OR and complement operations

$$F = A\bar{B}C + \bar{A}\bar{C} + AB$$

$$= \overline{(\bar{A} + B + \bar{C})} + \overline{(A + C)} + \overline{(\bar{A} + \bar{B})}$$

- 10) Using De Morgan's Theorem, express the function  $F = A\bar{B}C + \bar{A}\bar{C} + AB + CDE + B\bar{D}E$  with only AND and complement operations