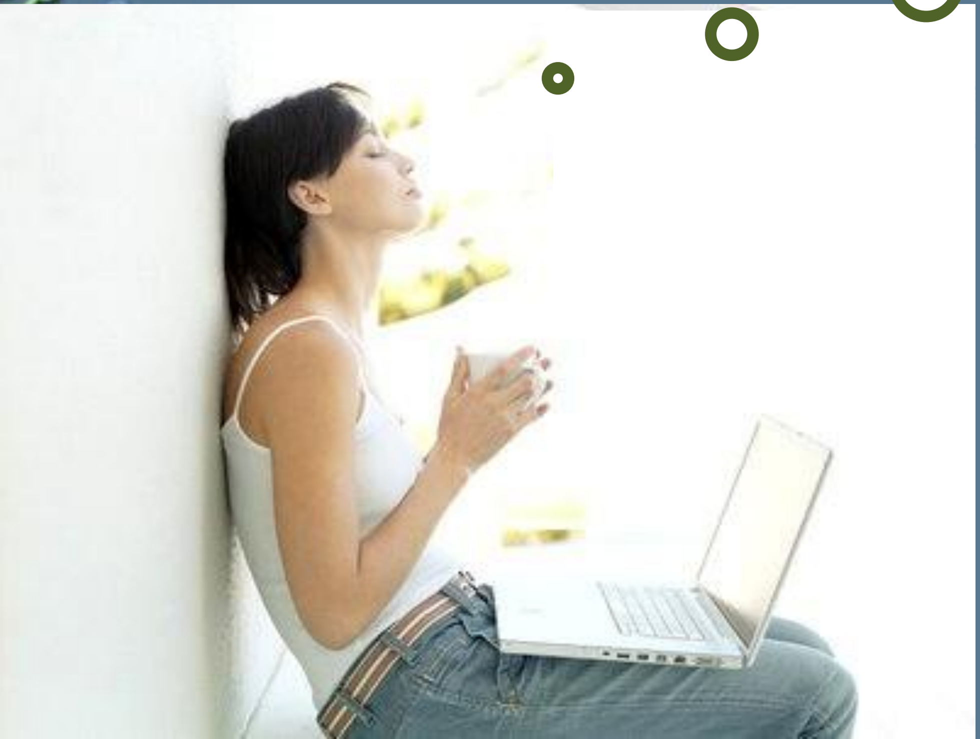
Quiz

```
   91FB8C6D
+  68D3239F
   FACEBOOC
```



Example: BCD Addition

99 + 66 = 165

99	=	1001	1001
66	=	0110	0110
165	=	1111	1111

Example: BCD Addition

99 + 66 = 165

$$
\begin{array}{rcrr}
99 & = & 1001 & 1001 \\
\underline{66} & \underline{=} & \underline{0110} & \underline{0110} \\
165 & = & 1111 & 1111 \\
 & + & & \underline{0110} \\
 & & 1\ 0000 & 0101
\end{array}
$$

Example: BCD Addition

99 + 66 = 165

$$
\begin{array}{rrrr}
 & 99 = & 1001 & 1001 \\
 & \underline{66 =} & \underline{0110} & \underline{0110} \\
 & 165 = & 1111 & 1111 \\
 & + & & \underline{0110} \\
1 & & 0000 & 0101 \\
 & + & \underline{0110} & \\
1 & & 0110 & 0101
\end{array}
$$

BCD Addition

0000	0100	1000	1100
0001	0101	1001	1101
0010	0110	1010	1110
0011	0111	1011	1111

BCD Addition

0000	0100	1000	1100
0001	0101	1001	1101
0010	0110	1010	1110
0011	0111	1011	1111

BCD Addition

0000	0100	1000	1100
0001	0101	1001	1101
0010	0110	1010	1110
0011	0111	1011	1111

$$
\begin{array}{r}
1010 \\
\underline{\;\;0110} \\
1\ 0000
\end{array}
$$

Chapter 3

BOOLEAN ALGEBRA, LOGIC FUNCTIONS and LOGIC GATES

Binary Logic

- consists of binary variables and logical operations
- resembles binary arithmetic
- use and application of binary logic are demonstrated by switching circuits
- equivalent to Boolean Algebra

Boolean Algebra

- a set of elements, a set of operators, and a number of unproven axioms or postulates
- developed by an English mathematician named George Boole

Boolean Operations

- AND
  - represented by a dot or the absence of an operator
  - 0 dominates

x	y	xy
0	0	0
0	1	0
1	0	0
1	1	1

Boolean Operations

- OR
  - represented by a plus sign
  - 1 dominates

x	y	x+y
0	0	0
0	1	1
1	0	1
1	1	1

Boolean Operations

- NOT
  - represented by a prime
  - inversion or complementation

x	x’
0	1
1	0

Boolean Theorems

- Boolean operations on constants
- Boolean operations on one variable
- Boolean operations on two or more variables

Boolean Operations on constants

AND	OR	NOT
$0 \cdot 0 = 0$	$0 + 0 = 0$	$0' = 1$
$0 \cdot 1 = 0$	$0 + 1 = 1$	$1' = 0$
$1 \cdot 0 = 0$	$1 + 0 = 1$	
$1 \cdot 1 = 1$	$1 + 1 = 1$	

Boolean Operations on one variable

AND	OR	NOT
$A \cdot 0 = 0$	$A + 0 = A$	$A'' = A$
$A \cdot 1 = A$	$A + 1 = 1$	
$A \cdot A = A$	$A + A = A$	
$A \cdot A' = 0$	$A + A' = 1$	

Boolean Operations On Two or More Variables

- Commutative laws

  $A + B = B + A$

  $AB = BA$

- Associative laws

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

  $A(BC) = (AB)C$

- Distributive laws

  $A(B + C) = AB + AC$

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

- De Morgan's laws

  $(A + B)' = A'B'$

  $(AB)' = A' + B'$

- Laws of Absorption

  $A + AB = A$

  $A(A+B) = A$

Boolean Functions

- Boolean functions are expressions formed with binary variables and boolean operators
- Representations of boolean functions:
  - algebraic expression
  - truth table

Algebraic Expression Examples

- $F_1 = xyz'$
- $F_2 = x + y'z$
- $F_3 = x'z + xy'$
- $F_4 = x'$
- $F_5 = 1$

Truth table examples

x	y	z	F_1	F_2	F_3	F_4	F_5
0	0	0	0	0	0	1	1
0	0	1	0	1	1	1	1
0	1	0	0	0	0	1	1
0	1	1	0	0	1	1	1
1	0	0	0	1	1	0	1
1	0	1	0	1	1	0	1
1	1	0	1	1	0	0	1
1	1	1	0	1	0	0	1

Simplification of Boolean functions

- $F_1 = x + x'y$

Simplification of Boolean functions

- $F_1 = x + x'y$

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

Simplification of Boolean functions

- $F_1 = x + x'y$

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

  $= 1\ (x+y)$

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- $F_1 = x + x'y$

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

  $= 1\ (x+y)$

  $= x+y$

- $F_2 = x(x'+y)$

Simplification of Boolean functions

- $F_1 = x + x'y$

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

  $= 1\ (x+y)$

  $= x+y$

- $F_2 = x(x'+y)$

  $= xx' + xy$

Simplification of Boolean functions

- $F_1 = x + x'y$

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

  $= 1\ (x+y)$

  $= x+y$

- $F_2 = x(x'+y)$

  $= xx' + xy$

  $= 0 + xy$

Simplification of Boolean functions

- $F_1 = x + x'y$

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

  $= 1\ (x+y)$

  $= x+y$

- $F_2 = x(x'+y)$

  $= xx' + xy$

  $= 0 + xy$

  $= xy$

Simplification of Boolean functions

- $F_3 \quad = xy + xy'$

Simplification of Boolean functions

- $F_3 = xy + xy'$

  $= x(y+y')$

Simplification of Boolean functions

- $F_3 = xy + xy'$

  $= x(y+y')$

  $= x$

Simplification of Boolean functions

- $F_3 = xy + xy'$

  $= x(y+y')$

  $= x$

- $F_4 = x'y'z + x'yz + xy'$

Simplification of Boolean functions

- $F_3 = xy + xy'$

  $= x(y+y')$

  $= x$

- $F_4 = x'y'z + x'yz + xy'$

  $= x'z(y'+y) + xy'$

Simplification of Boolean functions

- $F_3 = xy + xy'$

  $= x(y+y')$

  $= x$

- $F_4 = x'y'z + x'yz + xy'$

  $= x'z(y'+y) + xy'$

  $= x'z + xy'$

Binary Variables

- Forms of variables
  - normal (x)
  - complement (x')
- Forms of terms (variables x and y)
  - Minterms m_i (or standard product)

    $x'y', x'y, xy', xy$
  - Maxterms M_i (or standard sum)

    $x+y, x+y', x'+y, x'+y'$

Minterms and Maxterms for 3 variables

			MINTERM		MAXTERM	
x	y	z	Term	Designation	Term	Designation
0	0	0	x'y'z'	m0	x+y+z	M0
0	0	1	x'y'z	m1	x+y+z'	M1
0	1	0	x'yz'	m2	x+y'+z	M2
0	1	1	x'yz	m3	x+y'+z'	M3
1	0	0	xy'z'	m4	x'+y+z	M4
1	0	1	xy'z	m5	x'+y+z'	M5
1	1	0	xyz'	m6	x'+y'+z	M6
1	1	1	xyz	m7	x'+y'+z'	M7

Forms of Boolean Functions

- Canonical Form
  - Sum of minterms

    $F(x,y,z) =$

    $xyz' + x'yz$

  - Product of maxterms

    $F(x,y,z) =$

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

- Standard Form
  - Sum of products

    $F(x,y,z) = xz'+y$

  - Product of sums

    $F(x,y,z) = (x+y')z$