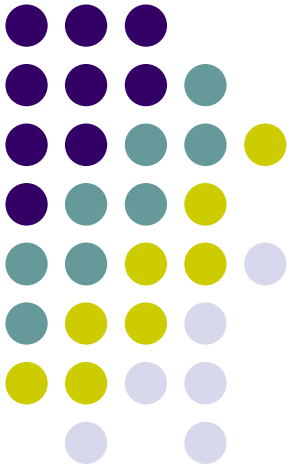
Frantz Fanon University

Break chains, visible or invisible -
build up from ruins, personal or social.

Digital Logic Design



FRANTZ FANON UNIVERSITY

COLLAGE OF COMPUTING AND IT

DEPARTMENT OF ICT

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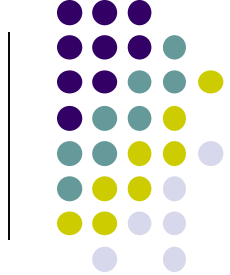
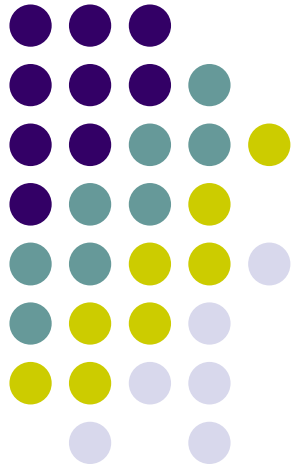
Course Contents



- Chapter 1 – Number Systems
- **Chapter 2** - Binary Arithmetic
- Chapter 3 - Logic Gates
- Chapter 4 - Boolean Algebra
- Chapter 5 - K-Map

Digital Logic Design

Chapter 2 – Binary Arithmetic



2.1 Binary Addition

- The four basic rules for adding binary digits (bits) are as follows:

0 + 0 = 0 Sum of 0 with carry of 0

0 + 1 = 1 Sum of 1 with a carry of 0

1 + 0 = 1 Sum of 1 with a carry of 0

1 + 1 = 10 Sum of 0 with a carry of 1

  - Remember, in binary **1 + 1 = 10**, not **2**

Cont....

First, let's have an example:

Add the following binary numbers:

(a) 11 + 11 **(b)** 100 + 10 **(c)** 111 + 11 **(d)** 110 + 100

Solution The equivalent decimal addition is also shown for reference.

(a)	11	3	**(b)**	100	4	**(c)**	111	7	**(d)**	110	6
	+11	+3		+10	+2		+11	+3		+100	+4
	110	6		**110**	6		**1010**	10		**1010**	10

Related Problem Add 1111 and 1100.

2.2 Binary Subtraction

- The four basic rules for subtracting bits are as follows:

0 - 0 = 0

1 - 1 = 0

1 - 0 = 1

0 - 1 = 10 0 - 1 with a borrow of 1

  - Remember, in binary 10 - 1 = 1, not 9.

Cont....

Examples:

Perform the following binary subtractions:

(a) 11 − 01 **(b)** 11 − 10

Solution

(a)

$$\begin{array}{r} 11 \\ -\,01 \\ \hline \mathbf{10} \end{array} \qquad \begin{array}{r} 3 \\ -\,1 \\ \hline 2 \end{array}$$

(b)

$$\begin{array}{r} 11 \\ -\,10 \\ \hline \mathbf{01} \end{array} \qquad \begin{array}{r} 3 \\ -\,2 \\ \hline 1 \end{array}$$

No borrows were required in this example. The binary number 01 is the same as 1.

Related Problem Subtract 100 from 111.

Subtract 011 from 101.

Solution

$$\begin{array}{r} 101 \\ -011 \\ \hline \mathbf{010} \end{array} \qquad \begin{array}{r} 5 \\ -3 \\ \hline 2 \end{array}$$

2.3 Binary Multiplication

- The four basic rules for multiplying bits are as follows:

0 * 0 = 0

0 * 1 = 0

1 * 0 = 0

1 * 1 = 1

- Binary multiplication of two bits is the same as multiplication of the decimal digits 0 & 1.

Cont.…

Examples:

Perform the following binary multiplications:

(a) 11×11 **(b)** 101×111

Solution

(a)

$$\begin{array}{rr} 11 & 3 \\ \times\ 11 & \times\ 3 \\ \hline 11 & 9 \\ +11 & \\ \hline \mathbf{1001} & \end{array}$$

Partial products

(b)

$$\begin{array}{rr} 111 & 7 \\ \times\ 101 & \times\ 5 \\ \hline 111 & 35 \\ 000 & \\ +111 & \\ \hline \mathbf{100011} & \end{array}$$

Partial products

Related Problem Multiply 1101×1010.

2.4 Binary Division

- Division in binary follows the same procedure as division in decimal, as bellow examples illustrates. The equivalent decimal divisions are also given.

Examples:

Perform the following binary divisions:

(a) $110 \div 11$ **(b)** $110 \div 10$

Solution

(a)

$$\begin{array}{r} \mathbf{10} \\ 11\overline{)110} \\ \underline{11} \\ 000 \end{array} \qquad \begin{array}{r} 2 \\ 3\overline{)6} \\ \underline{6} \\ 0 \end{array}$$

(b)

$$\begin{array}{r} \mathbf{11} \\ 10\overline{)110} \\ \underline{10} \\ 10 \\ \underline{10} \\ 00 \end{array} \qquad \begin{array}{r} 3 \\ 2\overline{)6} \\ \underline{6} \\ 0 \end{array}$$

Related Problem Divide 1100 by 100.

Exercise:

1. Perform the following binary additions:

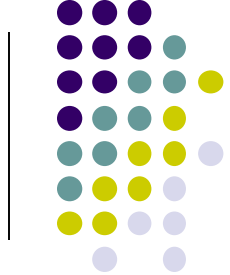
   (a) $1101 + 1010$ (b) $10111 + 01101$

2. Perform the following binary subtractions:

   (a) $1101 - 0100$ (b) $1001 - 0111$

3. Perform the indicated binary operations:

   (a) 110×111 (b) $1100 \div 011$



Thank You