

### BINARY ARITHMETIC

#### **Binary Addition & Subtraction**

- Addition and subtraction of binary numbers
  - Addition rule of carrying
    - $\bullet 0 + 0 = 0 \text{ (or } 0_{10})$
    - $\bullet 0 + 1 = 1 \text{ (or } 1_{10})$
    - 1 + 0 = 1 (or  $1_{10}$ )
    - 1 + 1 = 10 (or  $2_{10}$ )
  - Subtraction rule of borrowing
    - $\bullet \ 0 0 = 0$
    - $\bullet \ 0 1 = -1$
    - $\bullet 1 0 = 1$
    - $\bullet 1 1 = 0$



### BINARY ARITHMETIC

#### **Binary Addition**

$$11010_2 + 1100_2 = 100110_2$$



#### BINARY ARITHMETIC

#### **Binary Subtraction**



# BINARY MULTIPLICATION

#### Multiplication Rules:

$$0 \times 0 = 0$$

$$0 \times 1 = 0$$

$$1 \times 0 = 0$$

$$1 \times 1 = 1$$

Example: Binary Multiplication

				1	1	0	0
X )				1	0	1	0
				0	0	0	0
			1	1	0	0	
		0	0	0	0		
	1	1	0	0			
	1	1	1	1	0	0	0



# BINARY DIVISION

#### Division Rules:

 $0 \div 0 =$ undefined

 $0 \div 1 = 0$ 

 $1 \div 0 =$ undefined

 $1 \div 1 = 1$ 

Example: Binary Division



# OCTAL ARITHMETIC

- Octal Addition
- Octal Subtraction
- Octal Multiplication
- Octal Division



### OCTAL ADDITION

Example: Octal Addition

If the sum is greater than or equal 8, divide it by 8, bring down the remainder and carry the quotient.



## OCTAL SUBTRACTION

Example: Octal Subtraction

	0	10	13
	1	3	5
- )		4	6
		6	7

If the minuend is less than the subtrahend, it will borrow 8 from the other number



# OCTAL MULTIPLICATION

Example: Octal Multiplication

		2	3
X )		1	5
		10	15
	2	3	
	2	13	15
	1	1	
	3	6	7



## OCTAL DIVISION

Octal Division Example:

422 / 7 = 47 r. 1

#### Refer to the octal multiplication:

$$0 \times 7 = 0$$
  
 $1 \times 7 = 7$ 

$$2 \times 7 = 16$$

$$3 \times 7 = 25$$

$$4 \times 7 = 34$$

$$5 \times 7 = 43$$

$$6 \times 7 = 52$$

$$7 \times 7 = 61$$

	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7
2	0	2	4	6	10	12	14	16
3	0	3	6	11	14	17	22	25
4	0	4	10	14	20	24	30	34
5	0	5	12	17	24	31	36	43
6	0	6	14	22	30	36	44	52
7	0	7	16	25	34	43	52	61



## OCTAL DIVISION

Octal Division Example:

$$513 / 6 = 67 r. 1$$

#### Refer to the octal multiplication:

$$0 \times 6 = 0$$

$$1 \times 6 = 6$$

$$2 \times 6 = 14$$

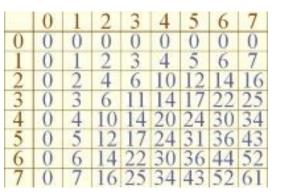
$$3 \times 6 = 22$$

$$4 \times 6 = 30$$

$$5 \times 6 = 36$$

$$6 \times 6 = 44$$

$$7 \times 6 = 52$$





### HEXADECIMAL ARITHMETIC

Addition and subtraction of hexadecimal numbers

#### □ Addition

- > Performed starting at the lowest (first from the right) digit
- > A carry to the upper digit is performed when the result is higher than 16

#### □ Subtraction

- > Performed starting at the lowest (first from the right) digit
- > A borrow from the upper digit is performed when the result is negative



## HEXADECIMAL ADDITION

#### First column from right

D + 7 = (In the decimal system: 13 + 7 = 20) = 16 (carried 1) + 4The sum of the first column is 4 and 1 is carried to the second column.

Second column from right

1 + 8 + 1 = (In the decimal system: 10) = ACarried from the first column

Third column from right

A + B = (In the decimal system: 10 + 11 = 21) = 16 (carried 1) + 5The sum of the third column is 5 and 1 is carried to the fourth column.

■ The result is  $(15A4)_{16}$ .



### HEXADECIMAL SUBTRACTION

$$\begin{bmatrix}
 & 6 & 13 & 3 \\
 & - & 1 & 7 & 4 \\
 & 5 & 5 & 15
\end{bmatrix}$$

First column from right

Since 3 - 4 = -1, a borrow is performed from D in the second digit (D becomes C). 16 (borrowed 1) + 3 - 4 = F (In the decimal system: 19 - 4 = 15)

Second column from right

C-7=5 (In the decimal system: 12-7=5)

■ Third column

$$6 - 1 = 5$$

■ The result is  $(55F)_{16}$ .



## HEXADECIMAL MULTIPLICATION

Example: Hexadecimal Multiplication

		2	3
X )		3	5
		10	15
	6	9	
	6	19	15
	1		
	7	3	$\mathbf{F}$



### HEXADECIMAL DIVISION

Hexadecimal Division Example:

67D4 / A = A62 r. 0

