CHAPTER 1 NUMBERING SYSTEM

Learning Outcomes:

At the end of this subtopic, students should be able to:

1) define numbering systems, recognize different types of numbering system, and determine binary system.
2) add and subtract in octal and hexadecimal number systems.
3) define data organization.
4) convert between four numbering systems.
5) solve binary arithmetic.

1.1 Understand Numbering System

A) Define numbering system: Binary, Octal, Decimal and Hexadecimal.

First of all, students should know the definition of a number itself. In dictionary, number is a **symbol or word representing a quantity**.

We know that 0, 1, 2, 3, 4, 5, 6, 7 and 9 are symbols of some quantities.

A number system defines how a number can be represented using distinct symbols.

A number can be represented differently in different system.

Binary	:	Only two numbers are involved which are **0 and 1**. It known as Base 2.
Octal	:	It is Base 8. Number involves is from **0 to 7.**
Decimal	:	Number consists from **0 to 9.** It is also known as Base 10.
Hexadecimal	:	This system involves numbers and alphabets. It is Base 16 and numbers involve are **0 to 9** and the alphabets are **A until F.**

1.3 Understand Hexadecimal Numbering System

Hexadecimal number system uses base 16. Thus, it has 16 possible digit symbols. It uses the digits 0 through 9 plus the letters A, B, C, D, E and F as the 16 digit symbols. Table 2 shows the relationships between hexadecimal, decimal and binary. Note that each hexadecimal digit represents a group of for binary digits. It is important to remember that hex (abbreviation for hexadecimal) digits A through F are equivalent to the decimal values 10 through 15.

Decimal Base 10	Hexadecimal Base 16	Binary Base 2
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

A) Convert hexadecimal to decimal and decimal to hexadecimal.

- **Hexadecimal to Decimal Conversion**

  Example:

  Convert $3A5_{16}$ to decimal number

  Solution:

  $3A5_{16}$

  $= (3\times16^2) + (10\times16^1) + (5\times8^0)$ → Change A into decimal number.

  $= 768 + 160 + 5$

  $= 933_{10}$

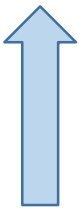
Decimal to Hexadecimal Conversion

Example :

Convert 9657_{10} into octal number.

Solution:

16	9657	=>	9
16	603	=>	11(B)
16	37	=>	5
	2	=>	2



Answer: $9657_{10} = 25B9_{16}$

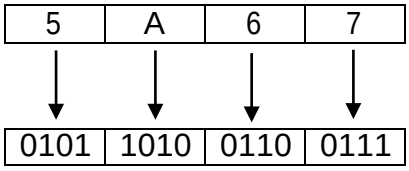
B) Convert hexadecimal to binary and binary to hexadecimal.

Convert Hexadecimal to Binary

Example:

Convert $5A67_{16}$ into binary number

Solution:



Hence, $5A67_{16} = 0101101001100111_2$

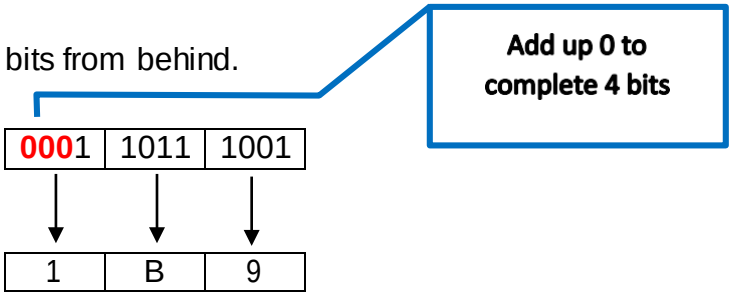
Convert Binary to Hexadecimal

Example:

Convert 110111001_2 into binary number.

Solution:

Grouping is started 4 bits from behind.



Hence, $110111001_2 = 1B_9$

C) Convert hexadecimal to octal and octal to hexadecimal.

- **Convert Hexadecimal to Octal**

Example:

Convert $B2F_{16}$ to Octal

Solution:

		B (11)	2	F (15)	
Convert to 4-bits Binary	=	1011	0010	1111	
Group to 3-bits Binary	=	101	100	101	111
Convert to Octal	=	5	4	5	7

Answer: $B2F_{16} = 5457_8$

- **Convert Octal to Hexadecimal**

Example : Convert 717_8 (Hexadecimal)

Solution:

Convert to 3-bits Binary	=	111	001	111
Group to 4-bits Binary	=	**000**1	1100	1111
Convert to Hexadecimal	=	1	C	F

Answer: $717_8 = 1CF_{16}$