Conversion

- Decimal to Binary
- Octal
- Hexadecimal

- Example :
  - $(150.65)_{10}$ = $(\ldots?\ldots..)_2$

2	150	
2	75	0
2	37	1
2	18	1
2	9	0
2	4	1
2	2	0
2	1	0
	0	1

- 0.65x2 = 1.3 = 0.3 with a carry of 1
- 0.3x2 = 0.6 = 0.6 with a carry of 0
- 0.6x2 = 1.2 = 0.2 with a carry of 1
- 0.2x2 = 0.4 = 0.4 with a carry of 0
- 0.4x2 = 0.8 = 0.8 with a carry of 0
- 0.8x2 = 1.6 = 0.6 with a carry of 1

- Ans $(10010110.101001)_2$

- Example :
  - $(150.65)_{10}$ = $(\ldots?\ldots..)_8$

Ans $(226.514631)_8$

8	150	
8	18	6
8	2	2
	0	2

- 0.65x8 = 5.2 = 0.2 with a carry of 5
- 0.2x8 = 1.6 = 0.6 with a carry of 1
- 0.6x8 = 4.8 = 0.8 with a carry of 4
- 0.8x8 = 6.4 = 0.4 with a carry of 6
- 0.4x8 = 3.2 = 0.2 with a carry of 3
- 0.2x8 = 1.6 = 0.6 with a carry of 1

- Example :
  - $(150.65)_{10} = (...?.....)_{16}$

    $(96 . A66)_{16}$

16	**150**	
16	**9**	**6**
	0	**9**

- 0.65x16 = 10.4 = 0.4 with a carry of 10
- 0.4x16 = 6.4 = 0.4 with a carry of 6
- 0.4x16 = 6.4 = 0.6 with a carry of 6

- Example :
  - $(158.75)_{10} = (...?.....)_{16}$

Conversion

- Binary to Decimal
- Octal
- Hexadecimal

- Example :
  - $(11001000.\ 101001)_2 = (\ldots?\ldots..)_{10}$

$\underline{1}$ $\underline{1}$ $\underline{0}$ $\underline{0}$ $\underline{1}$ $\underline{0}$ $\underline{0}$ $\underline{0}$

2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0

1x128 + 1x64 + 0x32 + 0x16 + 1x8 + 0x4 + 0x2 + 0x1 = 200

$\underline{1}$ $\underline{0}$ $\underline{1}$ $\underline{0}$ $\underline{0}$ $\underline{1}$

2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6}

1x 0.5 + 0 x 0.25 + 1 x 0.125 + 0x0.0625 + 0 x 0.03125 + 1 x 0.015625 = .65

- <u>Binary   to Octal</u>
- Example :
  - $(11001000.\ 101001)_2 = (\ldots?\ldots..)_8$

- $(\ \underline{011}\ \underline{001}\ \underline{000}\ .\ \underline{101}\ \underline{001})_2 = (3\ 1\ 0\ .\ 5\ 1)_8$

- <u>Binary   to Hexadecimal</u>

- Example :
  - $(11001000.\ 101001)_2 = (\ldots?\ldots..)_{16}$

  - $(\ \underline{1100}\ \underline{1000}\ .\ \underline{1010}\ \underline{01})_2$

  - $(\ \underline{1100}\ \underline{1000}\ .\ \underline{1010}\ \underline{0100})_2 = (C8\ .\ A4)_{16}$

- Octal to Decimal
- Binary
- Hexadecimal

- <u>Octal to Decimal</u>
- Example :
  - $(3\ 1\ 0\ .\ 5\ 1)_8 = (...?.....)_{10}$

$\underline{3}\quad \underline{1}\quad \underline{0}$

$8^2\quad 8^1\quad 8^0$

3 x 64 + 1 x 8 + 0x1 = 200

$.\ \underline{5}\quad \underline{1}$

$8^{-1}\quad 8^{-2}$

5x 0.125 + 1 x 0.015625 = .65

- <u>Octal to Binary</u>
- Example :
  - $(3\ 1\ 0\ .\ 5\ 1)_8 = (...?.....)_2$
  - $(\ \underline{011}\ \underline{001}\ \underline{000}\ .\ \underline{101}\ \underline{001})_2 = (11001000.\ 101001)_2$

<u>Octal to Decimal to Binary</u>

- Octal to Hexadecimal
- Example :
  - $(3\ 1\ 0\ .\ 5\ 1)_8 = (\ldots?\ldots\ldots)_2$

    - Octal <u>to Binary to</u> Hexadecimal

    - $(\underline{011}\ \underline{001}\ \underline{000}\ .\ \underline{101}\ \underline{001})_2 = (1100\ 1000.\ 1010\ 01)_2$

    - $(\underline{1100}\ \underline{1000}\ .\ \underline{1010}\ \underline{0100})_2 = (C8\ .\ A4)_{16}$

- 2^{nd} method :- Octal <u>to Decimal to</u> Hexadecimal

- Hexadecimal to Decimal
- Binary
- Octal

- Hexadecimal to Decimal
- Example :
  - $(C8 . A4)_{16} = (...?.....)_{10}$

$\underline{C}$ $\underline{8}$

16^1 16^0

12 x 16 + 8 x 1 = 200

. $\underline{A}$ $\underline{4}$

16^{-1} 16^{-2}

10 x 0.0625 + 4 x 0.015625 = .65

- Hexadecimal to Binary
- Example :
  - $(C8 . A4)_{16} = (...?.....)_2$

- $(\underline{1100}\ \underline{1000}\ .\ \underline{1010}\ \underline{0100})_2 = (11001000.\ 10100100)_2 = (11001000.\ 101001)_2$

- Hexadecimal to Octal
- Example :
  - $(C8 . A4)_{16} = (...?.....)_8$

- 1st method :- Hexadecimal to Decimal to Octal

- 2nd method :- Hexadecimal to Binary to Octal

Example of Equivalent Numbers

Binary: $1\ 0\ 1\ 0\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 1\ 1\ 1_2$

Decimal: 20647_{10}

Hexadecimal: $50A7_{16}$

Octal decimal : 50247_8

Notice how the number of digits gets smaller as the base increases.

Binary Addition

- **Rules of Binary Addition**
  - 0 + 0 = 0
  - 0 + 1 = 1
  - 1 + 0 = 1
  - 1 + 1 = 0, and carry 1 to the next more significant bit

Example:

00011010 + 00001100 = ?????

			1	*1*						*carries*
	0	0	0	1	1	0	1	0	=	$26_{(base\ 10)}$
+	0	0	0	0	1	1	0	0	=	$12_{(base10)}$
	0	0	1	0	0	1	1	0	=	$38_{(base\ 10)}$

00010011 + 00111110 = ?????

		1	*1*	*1*	*1*	*1*				*carries*
	0	0	0	1	0	0	1	1	=	$19_{(base\ 10)}$
+	0	0	1	1	1	1	1	0	=	$62_{(base10)}$
	0	1	0	1	0	0	0	1	=	$81_{(base\ 10)}$

Binary Subtraction

- **Rules of Binary Subtraction**
  - 0 - 0 = 0
  - 0 - 1 = 1, and borrow 1 from the next more significant bit
  - 1 - 0 = 1
  - 1 - 1 = 0

Example

00100101 - 00010001 = ?????

0 *borrows*

0 0 1 ^{1}0 0 1 0 1 = $37_{(base\ 10)}$

\- 0 0 0 1 0 0 0 1 = $17_{(base10)}$

0 0 0 1 0 1 0 0 = $20_{(base\ 10)}$

00110011 - 00010110 = ?????

0 ^{1}*0* *1* *borrows*

0 0 1 1 0 ^{1}0 1 1 = $51_{(base\ 10)}$

\- 0 0 0 1 0 1 1 0 = $22_{(base10)}$

0 0 0 1 1 1 0 1 = $29_{(base\ 10)}$

Binary Multiplication

- **Rules of Binary Multiplication**

○ 0 x 0 = 0

○ 0 x 1 = 0

○ 1 x 0 = 0

○ 1 x 1 = 1, and no carry or borrow bits

Example

$00101001 \times 00000110 = \ ????$

$$
\begin{array}{r}
0\ 0\ 1\ 0\ 1\ 0\ 0\ 1 \quad = \quad 41_{(base\ 10)} \\
\times\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 0 \quad = \quad 6_{(base\ 10)} \\
\hline
0\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\
0\ 0\ 1\ 0\ 1\ 0\ 0\ 1 \\
0\ 0\ 1\ 0\ 1\ 0\ 0\ 1 \\
\hline
0\ 0\ 1\ 1\ 1\ 1\ 0\ 1\ 1\ 0 \quad = \quad 246_{(base\ 10)} \\
\hline
\end{array}
$$