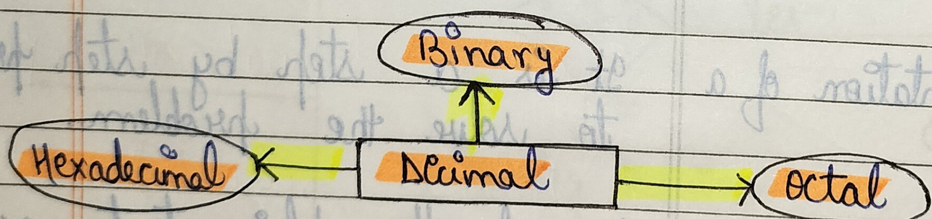
Unit - 3

Number System	Base/Radix	Symbol	Example.
Binary	2	0, 1	1001, 001, 101
Octal	8	0,- ---- ,7	254, 35, 67
Decimal	10	0, - - - - - 9	123, 45, 89
Hexadecimal	16	0, 1, 2 - - - - 9, A, B, C, D, E, F	A2B, 15D

★ Number System Conversion :—

Rule 1. Decimal to other



i) Decimal to Binary (Division Mthd)

↳ $(36)_{10} \longrightarrow (?)_2$

2	36	
2	18	0
2	9	0
2	4	1
2	2	0
	1	0

$(100100)_2$

↳ $(64)_{10} \longrightarrow (?)_2$

2	64	
2	32	0
2	16	0
2	8	0
2	4	0
2	2	0
	1	0

$(1000000)_2$

ii) Decimal to Octal

↳ $(126)_{10} \longrightarrow (?)_8$

8	126	
8	15	6
	1	7

$(176)_8$.

↳ $(444)_{10} \longrightarrow (?)_8$

	444	
	55	4
	6	7

$(674)_8$

iii) Decimal to Hexadecimal.

↳ $(444)_{10} \longrightarrow (?)_{16}$

16	444	
16	27	12
	1	11

$(1BC)_{16}$

↳ $(147)_{10} \longrightarrow (?)_{16}$

16	147	
	9	3

$(93)_{16}$

Rule 2.

Binary → Decimal

Octal → Decimal

Hexadecimal → Decimal

i) Binary to Decimal (Multiplication Mthd)

↳ $(1010)_2 \longrightarrow (?)_{10}$

$$\overset{3}{1} \quad \overset{2}{0} \quad \overset{1}{1} \quad \overset{0}{0}$$

$$\downarrow 2^3 \quad \downarrow 2^2 \quad \downarrow 2^1 \quad \downarrow 2^0$$

$$2^3 \times 1 + 2^2 \times 0 + 2^1 \times 1 + 2^0 \times 0 = 8 + 2 = (10)_{10}$$

↳ $(\underset{5}{1}\underset{4}{1}\underset{3}{0}\underset{2}{1}\underset{1}{0}\underset{0}{1})_2 \longrightarrow (?)_{10}$

$2^5 \times 1 + 2^4 \times 1 + 2^3 \times 0 + 2^2 \times 1 + 2^1 \times 0 + 2^0 \times 1$

$32 + 16 + 0 + 4 + 0 + 1 = (53)_{10}$

ii) Octal to Decimal

↳ $(\underset{2}{3}\underset{1}{1}\underset{0}{7})_8 \longrightarrow (?)_{10}$

$8^2 \times 3 + 8^1 \times 1 + 8^0 \times 7 = 192 + 8 + 7 = (207)_{10}$

↳ $(154)_8 \longrightarrow (?)_{10}$

$8^2 \times 1 + 8^1 \times 5 + 8^0 \times 4 = 64 + 40 + 4 = (108)_{10}$

10/10/24

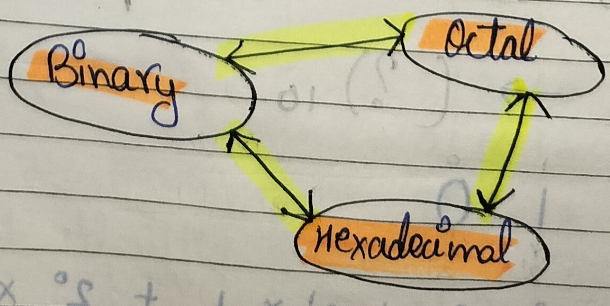
iii) Hexadecimal to Decimal

↳ $(\underset{2}{A}\underset{1}{2}\underset{0}{B})_{16} \longrightarrow (?)_{10}$

$A \times 16^2 + 2 \times 16^1 + B \times 16^0 = 10 \times 256 + 2 \times 16 + 11 \times 1$

$= (2603)_{10}$

Rule 3.



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i) Binary to Octal & Octal to Binary (Table Mthd).

Octal Table :-

Octal Number	Binary
0	0 0 0
1	0 0 1
2	0 1 0
3	0 1 1
4	1 0 0
5	1 0 1
6	1 1 0
7	1 1 1

Binary to Octal :-

↳ $(1011011)_2 \rightarrow (?)_8$

$(133)_8$

↳ $(10110101)_2 \rightarrow (?)_8$

$(265)_8$

Octal to Binary :-

↳ $(325)_8 \rightarrow (?)_2$

$(011010101)_2$

↳ $(726)_8 \rightarrow (?)_2$

$(111010110)_2$

ii) Hexa to Binary & Binary to Hexa.

Hexa digit	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

(A) 10	1010
(B) 11	1011
(C) 12	1100
(D) 13	1101
(E) 14	1110
(F) 15	1111

↳ $(101101011)_2 \rightarrow (16B)_{16}$

↳ $(101101.1011)_2 \rightarrow (2D.B)_{16}$

↳ $(10110.101101)_2 \rightarrow (16.B4)_{16}$

Hexa to Binary :-

↳ $(A2B)_{16} \longrightarrow (?)_2$

$(1010\,0010\,1011)_2$

↳ $(1f2)_{16} \rightarrow (?)_2$

$(0001\,1111\,0010)_2$

↳ $(22.31)_{16} \rightarrow (?)_2$

$(00100010.00110001)_2$

↳ $(5D.f)_{16} \rightarrow (?)_2$

$(01011101.1111)_2$

05/11/24

Hexadecimal to Octal

i. Hexa → Binary → Octal
Octal → Binary → Hexa

ii. Hexa → Decimal → Octal
Octal → Decimal → Hexa

$(1A2)_{16} \longrightarrow (?)_8$

$(1\ \overset{10}{A}\ 2)_{16} \rightarrow (\underset{421}{000}\,\underset{421}{110}\,\underset{421}{100}\,\underset{421}{010})_2$

0	0	0	1	1	0	1	0	0	0	1	0
8	4	2	1	8	4	2	1	8	4	2	1

$(642)_8$

$(732)_8 \longrightarrow (?)_{16}$

1	1	1	0	1	1	0	1	0
4	2	1	4	2	1	4	2	1

$(\overset{1}{\underset{8421}{0001}}\,\overset{D}{\underset{8421}{1101}}\,\overset{A}{\underset{8421}{1010}})_2$

$(1DA)_{16}$

$(251)_8 \longrightarrow (\ ?\ )_2$

$\underset{4}{0}\ \underset{2}{1}\ \underset{1}{0}\quad \underset{4}{1}\ \underset{2}{0}\ \underset{1}{1}\quad \underset{4}{0}\ \underset{2}{0}\ \underset{1}{1}$

$(010101001)_2$

$(2B1)_{16} \longrightarrow (\ ?\ )_2$

$\underset{8}{0}\ \underset{4}{0}\ \underset{2}{1}\ \underset{1}{0}\quad \underset{8}{1}\ \underset{4}{0}\ \underset{2}{1}\ \underset{1}{1}\quad \underset{8}{0}\ \underset{4}{0}\ \underset{2}{0}\ \underset{1}{1}$

$(001010110001)_2$

$(\underbrace{0110}_{8\,4\,2\,1}\ \underbrace{1011}_{8\,4\,2\,1})_2 \longrightarrow (\ ?\ )_{16}$

$(6B)_{16}$.

$(\underbrace{001}_{4\,2\,1}\ \underbrace{010}_{4\,2\,1}\ \underbrace{110}_{4\,2\,1})_2 \longrightarrow (\ ?\ )_8$

$(126)_8$.

Unsigned & Signed Binary Number.

Binary Number Representation

- Unsigned Representation
  → +ve nos. only
- Signed Representation
  → for both +ve & -ve nos.
  - Sign magnitude representation
  - 1's Complement form
  - 2's Complement form

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1. Unsigned Representation :-

Unsigned numbers don't have any sign, these can contain only magnitude of the number. So representation of unsigned binary numbers are all +ve numbers only.

Ex - i. Represent Decimal Number $(14)_{10}$ in Unsigned Binary Representation.

Sol^n

1 1 1 0
8 4 2 1

14 = 1110

ii. Represent $(14)_{10}$ in unsigned representation in a 8 bit

$(00001110)_2$

Sign Magnitude Representation

Store (-12). using sign mag. representation.

| Sign bit | Mag. of a no. |

12 = 1100

| 1 | 1100 |

$(-12)_{10} \rightarrow (11100)$

Store $(+25)_{10}$ using mag. rep.

$(25)_{10}$ = 11001

$(+25)_{10} \rightarrow$ | 0 | 11001 |

$(+25)_{10} \rightarrow$ 011001

Represent decimal number (-7) using sign mag. rep.

Sign bit	mag. of a no.

7 = 111

1	1 1 1

∴ Sign mag. rep of -7 = 1111

1's Complement Representation

In a binary number, if each ~~one~~ 1 is replaced by 0 & each 0 by 1, the resulting number is known as the 1's complement of the first number.

↳ 1's complement of 1011 = 0100
↳ ,, ,, ,, 0101 = 1010

Q: Store (-12) using 1's Complement Representation.

12 = 1100
1's complement = 0011

$(-12)_{10}$ = 10011

Q: Store (-16) using 1's Complement Rep.

$\underbrace{1}_{\text{Sign bit}},\underbrace{01111}_{\text{1's complement}}$

Sign bit	Mag. of no.

⇒ 101111

2's Complement Representation

★ 2's Complement = 1's Complement + 1

Binary Addition

A	B	S	FC
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Sign bit	2's Complement

Q: store (-25) using 2's Complement Rep.

25 (1's complement) = 00110

2's Complement = 00110
$\quad$ + 1
$\quad$ 00111

1	00111

Q: Store + 25 using :
a) sign mag rep. b) 1's Comp. rep. c) 2's Comp. rep.

a) 25 = 11001 b) 11001 c) 11001

NOTE : for +ve numbers, the value remains the same as it is in binary.

Q: imp find 1's & 2's Complement of a Binary number

Binary number	1's Complement	2's Complement
1011	0100	0101
0101010	1010101	1010110
1110	0001	0010
0011	1100	1101

11/11/24

BCD Code (Binary Coded Decimal)

→ 4 bit Code
→ Decimal digit will take 4 binary bit
→ 8 4 2 1 Code
→ weighted Code

	Binary	BCD Code
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001
10	1010	00010000
11	1011	00010001
12	1100	00010010
13	1101	00010011
14	1110	00010100
15	1111	00010101

$\left.\right\}$ Error Code (rows 10–15)

Ex 1. $(357)_{10}$
↓
$(?)_{BCD}$

(0011 0101 0111)

Gray Code

- → Use for analog data
- → Non weighted code.
- → Also called unit distance code
- → In gray code, Each gray code number differ from the preceding & the succeding no. by a single bit.

Decimal	Binary	Gray Code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

12/11/24 Binary to Gray Code :-

a) 101101 = 111011 b) 110110 = 101101

1010
1100

Gray Code to Binary.

a) 1010 = 1100 b) 1110 = 1011

Q. Do the following Conversion.

a. $(1010)_2 \longrightarrow (?)_8$

$\underbrace{0\,0\,1}_{4\,2\,1}\,\underbrace{0\,1\,0}_{4\,2\,1} = (12)_8$

b. $(10110)_2 \longrightarrow (?)_{Gray}$

$(10110)_2 = 11101$

c. $(357)_{10} \longrightarrow (?)_{gray}$

$(0011\,0101\,0111)_{BCD}$

d. $(1111)_{Gray} \longrightarrow (?)_{Binary}$

$(1010)_{Binary}$

e. $(11010)_2 \longrightarrow (?)_{16}$

$\underbrace{0\,0\,0\,1}_{8\,4\,2\,1}\,\underbrace{1\,0\,1\,0}_{8\,4\,2\,1} = (1A)_{16}$

f. $(25)_{10} \longrightarrow (\ ?\ )_2 = (11001)_2$

g. $(25)_{10} \longrightarrow (\ ?\ )_{BCD} = (00100101)_{BCD}$