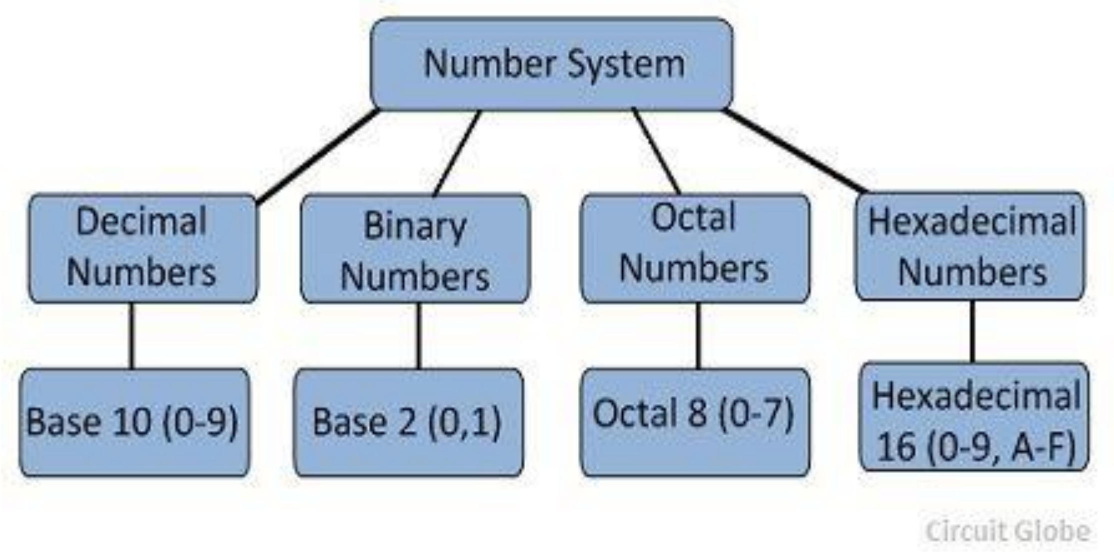
Unit-4:
Number Conversion

Number System and Code

Digital system process binary digits 0 and 1

Base 10 is important for everyday business
Base 2 is important for processing of digital circuit
Base 8 and Base 16 provide convenient shortened representation for multibit number in a digital system



Binary	*Decimal*	*Octal*	*3-Bit String*	*Hexadecimal*	*4-Bit String*
0	0	0	000	0	0000
1	1	1	001	1	0001
10	2	2	010	2	0010
11	3	3	011	3	0011
100	4	4	100	4	0100
101	5	5	101	5	0101
110	6	6	110	6	0110
111	7	7	111	7	0111
1000	8	10	—	8	1000
1001	9	11	—	9	1001
1010	10	12	—	A	1010
1011	11	13	—	B	1011
1100	12	14	—	C	1100
1101	13	15	—	D	1101
1110	14	16	—	E	1110
1111	15	17	—	F	1111

Number conversion

Methods or techniques used to convert numbers from one base to another

Decimal to Other

Step 1 – Divide the decimal number to be converted by the value of the other base.

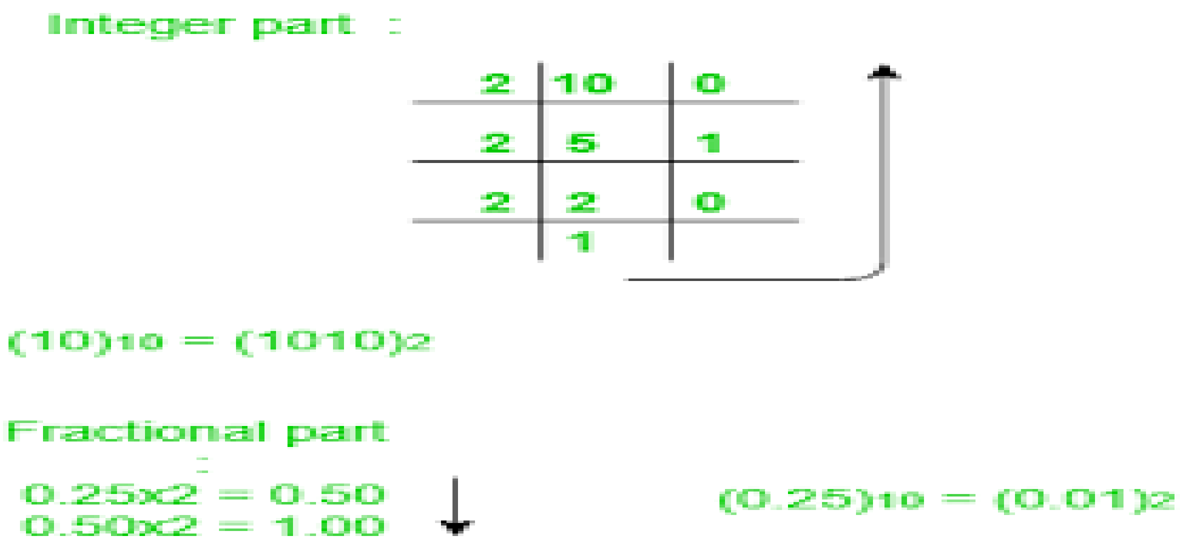
Step 2 – Get the remainder from Step 1 as (least significant digit) of new base number

Step 3 – Divide the quotient of the previous divide by the new base.

Step 4 – Record the remainder from Step 3 as the next digit

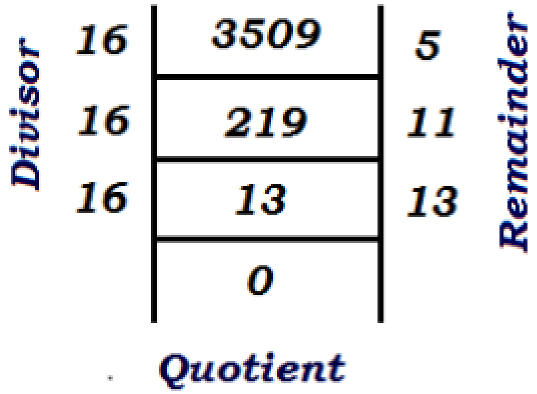
Repeat Steps 3 and 4, getting remainders until the quotient becomes zero

The last remainder thus obtained will be the Most Significant bit(MSB) of the new base number.



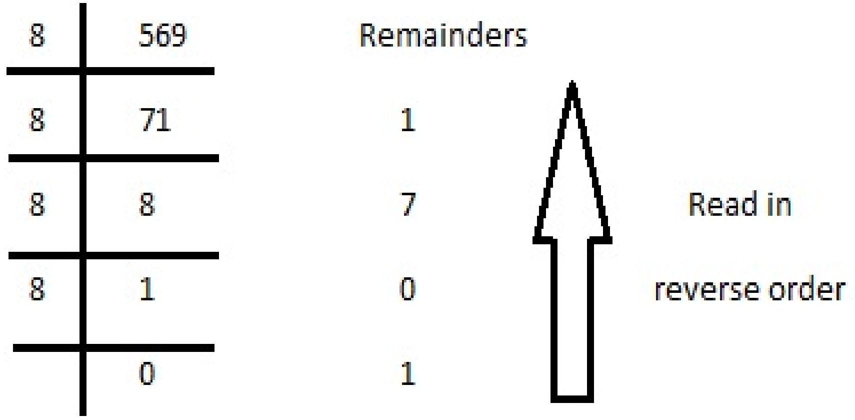
Decimal to Hexadecimal

$$(3509)_{10} = (DB5)_{16}$$



Decimal to Octal

$$(569)_{10} = (1071)_{8}$$



$0.342_{10} = ?_8$

$0.342 \times 8 = 2.736 \quad (.2_8)$

$0.736 \times 8 = 5.888 \quad (.25_8)$

$0.888 \times 8 = 7.104 \quad (.257_8)$

$0.104 \times 8 = 0.832 \quad (.2570_8)$

$0.342_{10} \approx 0.2570_8$ it's an approximation

Other Base System to Decimal System

Step 1 – Determine positional value of each digit

Step 2 – Multiply the obtained position values by the digits in the corresponding columns.

Step 3 – Sum the products calculated in Step 2.

32 16 8 4 2 1

1 0 0 1 1 1 =32 + 4 +2 +1 = (39)10

Binary Number – 11101_2

Calculating Decimal Equivalent –

Step	Binary Number	Decimal Number
Step 1	11101_2	$((1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0))_{10}$
Step 2	11101_2	$(16 + 8 + 4 + 0 + 1)_{10}$
Step 3	11101_2	29_{10}

Octal to Decimal

$$\begin{aligned}(2754)_8 &= (2\times 8^3) + (7\times 8^2) + (5\times 8^1) + (4\times 8^4) \\ &= 1024 + 448 + 40 + 4 \\ &= 1516_{10}\end{aligned}$$

Hexadecimal to Decimal

$$\begin{aligned}(54.D2)^{16} &= (5\times 16^1) + (4\times 16^0) + (13\times 16^{-1}) + (2\times 16^{-2}) \\ &= 80 + 4 + 0.8125 + 0.0078125 \\ &= 84.8203125_{10}\end{aligned}$$

Binary to Octal

Step 1 − Divide the binary digits into groups of three (starting from the right).
Step 2 − Convert each group of three binary digits to one octal digit.

Binary Number − 10101_2

Calculating Octal Equivalent −

Step	Binary Number	Octal Number
Step 1	10101_2	010 101
Step 2	10101_2	2_8 5_8
Step 3	10101_2	25_8

Octal to Binary

Step 1 − Convert each octal digit to a 3 digit binary number.
Step 2 − Combine all the resulting binary groups (of 3 digits each) into a single binary number

Octal Number − 25_8

Calculating Binary Equivalent −

Step	Octal Number	Binary Number
Step 1	25_8	010_2 101_2
Step 2	25_8	010101_2

Binary to Hexadecimal

Step 1 − Divide the binary digits into groups of four (starting from the right).
Step 2 − Convert each group of four binary digits to one hexadecimal symbol.

Binary Number − 10101_2

Calculating hexadecimal Equivalent −

Step	Binary Number	Hexadecimal Number
Step 1	10101_2	0001 0101
Step 2	10101_2	15_{16}

Hexadecimal to Binary

Step 1 − Convert each hexadecimal digit to a 4 digit binary number.
Step 2 − Combine all the resulting binary groups (4 digits each) into a single binary number.

Hexadecimal Number − 15_{16}

Calculating Binary Equivalent −

Step	Hexadecimal Number	Binary Number
Step 1	15_{16}	0001_2 0101_2
Step 2	15_{16}	00010101_2

$$8421$$
$$(1101)_2 = 8+4+1 = (13)_{10}$$
$$(0111)_2 = 7_{10}$$
$$(1010)_2 = (10)_{10} = A_{16}$$
$$(10101)_2$$

Binary Addition

0011010 + 001100 = 00100110

```
   1 1           carry
  0 0 1 1 0 1 0  = 26₁₀
 +0 0 0 1 1 0 0  = 12₁₀
 ---------------
  0 1 0 0 1 1 0  = 38₁₀
```

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 10 (which is 0 carry 1)

$$(10010)_2 + (1001)_2 = ?$$

Binary Subtraction

A	-	B	Subtract	Borrow
0	-	0	0	0
1	-	0	1	0
1	-	1	0	0
0	-	1	1	1

0011010 - 001100 = 00001110

$$\begin{array}{rl} 1\ 1 & \text{borrow} \\ 0\,0\,\cancel{1}\,\cancel{1}\,0\,1\,0 & = 26_{10} \\ -\,0\,0\,0\,1\,1\,0\,0 & = 12_{10} \\ \hline 0\,0\,0\,1\,1\,1\,0 & = 14_{10} \end{array}$$

$$(1100)_2 - (1010)_2 = ?$$

Practice Question

$$(4021.5)_5 = (\underline{\hspace{4cm}})_{10}$$

$$(B65F)_{16} = (\underline{\hspace{4cm}})_{10}$$

$$(630.4)_8 = (\underline{\hspace{4cm}})_{10}$$

$$(0.6875)_{10} = (\underline{\hspace{5cm}})_2$$

$$(0.513)_{10} = (\underline{\hspace{5cm}})_8$$

$$(306.D)_{16} = (\underline{\hspace{4cm}})_8$$

$$(10110001101011.11110010)_2 = (\underline{\hspace{4cm}})_{16}$$

$$(108)_{10} = (\underline{\hspace{2cm}})_{16}$$

$$(\underline{\hspace{4cm}})_2 = (\underline{\hspace{3cm}})_{10} = (576)_8 = (\underline{\hspace{2.5cm}})_{16}$$