📘 Number Systems aur Base Concept:

- **Decimal** = Base 10 (0 to 9)
- **Binary** = Base 2 (0 and 1)
- **Octal** = Base 8 (**0 to 7**)
- **Hexadecimal** = Base 16 (0 to 9 and A to F)

🔢 Step-by-step: Decimal to Octal Conversion

Method: Division by 8

1. **Decimal number ko 8 se divide karo.**

2. **Quotient ko dobara 8 se divide karo** jab tak quotient 0 na ho jaye.
3. **Har step ka remainder likho.**

4. **Jo remainders aaye hain unhe **bottom to top** (neeche se upar) likho — wahi aapka Octal number hai.

5. Example: Convert 156 (decimal) to Octal

Step	Divide by 8	Quotient	Remainder
1	156 ÷ 8	19	4
2	19 ÷ 8	2	3
3	2 ÷ 8	0	2

6. 📌 **Octal Number = 2 3 4 → 234_8**

🔁 Octal to Decimal Conversion

◆ Pehle ye samjho:

- Octal number ka **har digit** ek **place** (position) pe hota hai.
- **Sabse right wali digit ka position 0 hota hai**, uske baaye wali ka 1, phir 2, aur aise hi aage.
- Har digit ko **8 ki power se multiply** karte hain, aur sab add kar dete hain.

- 📓 **Example: 234_8 ko Decimal me badlo**
- Octal number: `2 3 4`
  (2 is leftmost, 4 is rightmost)

- 👉 **Step 1: Har digit ko uski power of 8 se multiply karo:**

Digit	Position	8^Position	Multiply
2	2	$8^2 = 64$	$2 \times 64 = 128$
3	1	$8^1 = 8$	$3 \times 8 = 24$
4	0	$8^0 = 1$	$4 \times 1 = 4$

128 + 24 + 4 = ✅ 156

$234_8 = 156_{10}$ (final Answer)

◆ Octal to Binary Conversion (Base-8 → Base-2)

✅ Rule:

Har **Octal digit ko 3-bit Binary** me convert karo. Kyunki:

- 1 Octal digit = 3 Binary digits (bits)
- Octal base-8 hai → $8 = 2^3$ → isliye **3 bits** ka group hota hai

- ### 📓 Example: Convert 234_8 to Binary
- Break the octal number digit by digit:

Octal Digit	Binary Equivalent (3 bits)
2	010
3	011
4	100

$234_8 = 010\ 011\ 100 = ✅ 010011100_2$

🔁 Final Answer:

📌 $234_8 = 10011100_2$

🔹 Binary to Octal Conversion (Base-2 → Base-8)

✅ Rule:

- **Binary number ko 3-3 ke groups me divide karo (right se shuru karke)**
- Har 3-bit group ko ek Octal digit me convert karo

- ### 📓 Example: Convert 10011100_2 to Octal

- **Step 1: Right se 3-3 bits ke group banao:**

10011100 → 010 011 100 (3-3 bits ka group banaye)

Note: Agar left-most group 3 bits se chhota ho, toh uske aage 0 laga do — jise padding kehte hain.

Step 2: Har group ka Octal digit likho:

Binary Group	Octal Value
010	2
011	3
100	4

✅ Final Answer:

📌 **$10011100_2 = 234_8$**

🔷 Hexadecimal Number System (Base-16)

Decimal	Hexadecimal
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	**A**
11	**B**
12	**C**
13	**D**
14	**E**
15	**F**

📌 Example: Decimal 26 ko Hexadecimal convert

Step-by-step:

1. 26 ÷ 16 = 1 (quotient), remainder = **10**
2. 1 ÷ 16 = 0 (quotient), remainder = **1**

Remainders = **1** and **10**, lekin 10 = **A** in hex

☞ Final Answer: **$1A_{16}$**

🔢 Example: Convert Decimal 123 to Hexadecimal

Step 1: Divide 123 by 16

```
123 ÷ 16 = 7 quotient, remainder = 11
```

Reminder: 11 = **B** (in Hex)

Step 2: Divide 7 by 16

```
7 ÷ 16 = 0 quotient, remainder = 7
```

🧮 Remainders (bottom to top):

7 → B

📌 Final Hexadecimal Number = $7B_{16}$

✅ Answer:

123 (decimal) = 7B (hexadecimal)

🔷 Hexadecimal (Base-16) to Decimal (Base-10)

✅ Rule:

Har digit ko **16 ki power se multiply** karo, starting from **right (position 0)**.
Phir sab values ko **add** kar do.

🧮 Example: Convert `1A` (Hex) to Decimal

🔍 Example: Convert `1A` (Hex) to Decimal

Break the number:
$1A_{16}$ = 1 (position 1) and A (position 0)

Digit	Decimal Value	Position	16^pos	Multiply
1	1	1	$16^1=16$	1×16 = 16
A	10	0	$16^0=1$	10×1 = 10

➕ Add them:

`16 + 10 = ✅ 26`

📌 Final Answer:

$1A_{16} = 26_{10}$

Binary to hexadecimal

Step-by-step Example

Binary: `11010111`

1. Group into 4-bits from the right: `1101 0111`
2. Convert each group:
    - `1101` = **D**
    - `0111` = **7**

Hex: `D7`

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Binary	Hex
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

🔁 Hex to Binary Conversion:

✅ Example

Hex: `3F`

1. Convert each hex digit:
    - `3` = `0011`
    - `F` = `1111`

Binary: `00111111`

Hex	Binary
0	0000
1	0001
2	0010
3	0011

Hex	Binary
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
A	1010
B	1011
C	1100
D	1101
E	1110
F	1111