Binary Conversion to Bases: Octal, Hexadecimal, and Decimal

1. Binary to Decimal (Base 2 to Base 10)
The decimal system (base-10) uses powers of 10, while the binary system (base-2) uses powers of 2. To convert binary to decimal, you multiply each binary digit by 2 raised to the power of its position, starting from the right (starting with 0).

Example: Convert binary 1011 to decimal:
1 × 2^3 + 0 × 2^2 + 1 × 2^1 + 1 × 2^0 = 8 + 0 + 2 + 1 = 11
So, binary 1011 is 11 in decimal.

2. Binary to Octal (Base 2 to Base 8)
The octal system (base-8) uses digits from 0 to 7, and it is closely related to binary. Each octal digit corresponds to a group of three binary digits. To convert binary to octal, group the binary digits into sets of three, starting from the right. Add leading zeros if necessary.

Example: Convert binary 101110 to octal:
Group the binary digits in sets of three: 101 110.
Convert each group to its octal equivalent:
101 (binary) = 5 (octal)
110 (binary) = 6 (octal)
So, binary 101110 is 56 in octal.

3. Binary to Hexadecimal (Base 2 to Base 16)
The hexadecimal system (base-16) uses digits 0–9 and letters A–F to represent values 10–15. Each hexadecimal digit corresponds to a group of four binary digits. To convert binary

to hexadecimal, group the binary digits into sets of four, starting from the right. Add leading zeros if necessary.

Example: Convert binary 110111 to hexadecimal:
Group the binary digits in sets of four: 0011 0111.
Convert each group to its hexadecimal equivalent:
0011 (binary) = 3 (hex)
0111 (binary) = 7 (hex)
So, binary 110111 is 37 in hexadecimal.

4. Decimal to Binary (Base 10 to Base 2)
To convert a decimal number to binary, repeatedly divide the decimal number by 2 and record the remainders. The binary number is the sequence of remainders read from bottom to top.

Example: Convert decimal 13 to binary:
13 ÷ 2 = 6 remainder 1
6 ÷ 2 = 3 remainder 0
3 ÷ 2 = 1 remainder 1
1 ÷ 2 = 0 remainder 1
So, decimal 13 is 1101 in binary.

5. Decimal to Octal (Base 10 to Base 8)
To convert a decimal number to octal, repeatedly divide the decimal number by 8 and record the remainders.

Example: Convert decimal 125 to octal:
125 ÷ 8 = 15 remainder 5
15 ÷ 8 = 1 remainder 7
1 ÷ 8 = 0 remainder 1
So, decimal 125 is 175 in octal.

6. Decimal to Hexadecimal (Base 10 to Base 16)
To convert a decimal number to hexadecimal, repeatedly divide the decimal number by 16 and record the remainders.

Example: Convert decimal 254 to hexadecimal:
254 ÷ 16 = 15 remainder 14 (which is E in hex)
15 ÷ 16 = 0 remainder 15 (which is F in hex)
So, decimal 254 is FE in hexadecimal.

7. Hexadecimal to Binary (Base 16 to Base 2)
Each hexadecimal digit corresponds to a group of four binary digits. To convert hexadecimal to binary, replace each hexadecimal digit with its four-bit binary equivalent.

Example: Convert hexadecimal A9 to binary:
A (hex) = 1010 (binary)
9 (hex) = 1001 (binary)
So, hexadecimal A9 is 10101001 in binary.

8. Octal to Binary (Base 8 to Base 2)
Each octal digit corresponds to a group of three binary digits. To convert octal to binary, replace each octal digit with its three-bit binary equivalent.

Example: Convert octal 75 to binary:
7 (octal) = 111 (binary)
5 (octal) = 101 (binary)
So, octal 75 is 111101 in binary.