NUMBER SYSTEM CONVERSION

There are many methods or techniques which can be used to convert numbers from one base to another. We'll demonstrate here the following −

- Decimal to Other Base System
- Other Base System to Decimal
- Other Base System to Non-Decimal
- Shortcut method − Binary to Octal
- Shortcut method − Octal to Binary
- Shortcut method − Binary to Hexadecimal
- Shortcut method − Hexadecimal to Binary

Decimal to Other Base System

Steps

- **Step 1** − Divide the decimal number to be converted by the value of the new base.
- **Step 2** − Get the remainder from Step 1 as the rightmost digit *leastsignificantdigit* 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 *totheleft* of the new base number.

Repeat Steps 3 and 4, getting remainders from right to left, until the quotient becomes zero in Step 3.

The last remainder thus obtained will be the Most Significant Digit *MSD* of the new base number.

Example −

Decimal Number: 29_{10}

Calculating Binary Equivalent −

Step	Operation	Result	Remainder
Step 1	29 / 2	14	1
Step 2	14 / 2	7	0
Step 3	7 / 2	3	1
Step 4	3 / 2	1	1
Step 5	1 / 2	0	1

As mentioned in Steps 2 and 4, the remainders have to be arranged in the reverse order so that the first remainder becomes the Least Significant Digit *LSD* and the last remainder becomes the Most Significant Digit *MSD*.

Decimal Number − 29_{10} = Binary Number − 11101_2.

Other Base System to Decimal System

Steps

- **Step 1** − Determine the column *positional* value of each digit *thisdependsonthepositionofthedigitandthebaseofthenumbersystem*.
- **Step 2** − Multiply the obtained column values *inStep*1 by the digits in the corresponding columns.
- **Step 3** − Sum the products calculated in Step 2. The total is the equivalent value in decimal.

Example

Binary Number − 11101_2

Calculating Decimal Equivalent −

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

Binary Number − 11101_2 = Decimal Number − 29_{10}

Other Base System to Non-Decimal System

Steps

- **Step 1** − Convert the original number to a decimal number *base*10.
- **Step 2** − Convert the decimal number so obtained to the new base number.

Example

Octal Number − 25_8

Calculating Binary Equivalent −

Step 1 − Convert to Decimal

Step	Octal Number	Decimal Number
Step 1	25_8	$((2 \times 8^1)$ + $(5 \times 8^0))_{10}$
Step 2	25_8	16 + 5_{10}
Step 3	25_8	21_{10}

Octal Number − 25_8 = Decimal Number − 21_{10}

Step 2 − Convert Decimal to Binary

Step	Operation	Result	Remainder
Step 1	21 / 2	10	1
Step 2	10 / 2	5	0
Step 3	5 / 2	2	1
Step 4	2 / 2	1	0
Step 5	1 / 2	0	1

Decimal Number − 21_{10} = Binary Number − 10101_2

Octal Number − 25_8 = Binary Number − 10101_2

Shortcut method - Binary to Octal

Steps

- **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.

Example

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

Binary Number − 10101_2 = Octal Number − 25_8

Shortcut method - Octal to Binary

Steps

- **Step 1** − Convert each octal digit to a 3 digit binary number $the octal digits may be treated as decimal for this conversion$.
- **Step 2** − Combine all the resulting binary groups $of 3 digits each$ into a single binary number.

Example

Octal Number − 25_8

Calculating Binary Equivalent −

Step	Octal Number	Binary Number
Step 1	25_8	2_{10} 5_{10}
Step 2	25_8	010_2 101_2

Step 3	25_8	010101_2

Octal Number − 25_8 = Binary Number − 10101_2

Shortcut method - Binary to Hexadecimal

Steps

- **Step 1** − Divide the binary digits into groups of four *startingfromtheright*.
- **Step 2** − Convert each group of four binary digits to one hexadecimal symbol.

Example

Binary Number − 10101_2

Calculating hexadecimal Equivalent −

Step	Binary Number	Hexadecimal Number
Step 1	10101_2	0001 0101
Step 2	10101_2	$1_{10}\ 5_{10}$
Step 3	10101_2	15_{16}

Binary Number − 10101_2 = Hexadecimal Number − 15_{16}

Shortcut method - Hexadecimal to Binary

Steps

- **Step 1** − Convert each hexadecimal digit to a 4 digit binary number *thehexadecimaldigitsmaybetreatedasdecimalforthisconversion*.
- **Step 2** − Combine all the resulting binary groups *of4digitseach* into a single binary number.

Example

Hexadecimal Number − 15_{16}

Calculating Binary Equivalent −

Step	Hexadecimal Number	Binary Number
Step 1	15_{16}	$1_{10}\ 5_{10}$
Step 2	15_{16}	$0001_2\ 0101_2$
Step 3	15_{16}	00010101_2

Hexadecimal Number − 15_{16} = Binary Number − 10101_2