Conversion of Number Systems

(Practice Worksheet)

Contents

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Conversion Techniques

All number systems – Decimal, Binary, Octal, and Hexadecimal – can be converted into one another. Here, we shall divide their conversion methods into four main categories.

- Conversion from Decimal to Binary, Octal, and Hexadecimal
- Conversion from Binary, Octal, and Hexadecimal to Decimal
- Conversion of Binary into Octal and Hexadecimal and vice versa
- Conversion of Octal to Hexadecimal and vice versa

Before delving into practice, let us look at the steps involved in all these conversion methods and validate those steps with examples.

Conversion of Number Systems

(Practice Worksheet)

Conversion from Decimal to Binary, Octal, and Hexadecimal

1. Divide the decimal number by the base of the target system (2 for binary, 8 for octal, 16 for hexadecimal).

2. Write down the remainder.

3. Repeat the division with the quotient until the quotient becomes zero.

4. Read the remainders in reverse order (from last to first). This is the equivalent number in the target base.

Example

Convert the decimal number $(2025)_{10}$ to binary, octal, and hexadecimal number systems.

Operation	Remainder (R)
2025 ÷ 2 = 1012	R(1)
1012 ÷ 2 = 506	R(0)
506 ÷ 2 = 253	R(0)
253 ÷ 2 = 126	R(1)
126 ÷ 2 = 63	R(0)
63 ÷ 2 = 31	R(1)
31 ÷ 2 = 15	R(1)
15 ÷ 2 = 7	R(1)
7 ÷ 2 = 3	R(1)
3 ÷ 2 = 1	R(1)
1 ÷ 2 = 0	R(1)

$(2025)_{10} = (11111101001)_2 \rightarrow$ Binary

OR

Prime Factorisation

2	2025	
2	1012	- 1
2	506	- 0
2	253	- 0
2	126	- 1
2	63	- 0
2	31	- 1
2	15	- 1
2	7	- 1
2	3	- 1
2	1	- 1

Operation	Remainder (R)
2025 ÷ 8 = 253	R(1)
253 ÷ 8 = 31	R(5)
31 ÷ 8 = 3	R(7)
3 ÷ 8 = 0	R(3)

$(2025)_{10} = (3751)_8 \rightarrow$ Octal

OR

Prime Factorisation

8	2025	
8	253	- 1
8	31	- 5
8	3	- 7

Operation	Remainder (R)
2025 ÷ 16 = 126	R(9)
126 ÷ 16 = 7	R(E)
7 ÷ 16 = 0	R(7)

$(2025)_{10} = (7E9)_{16} \rightarrow$ Hexadecimal

OR

Prime Factorisation

16	2025	
16	126	- 9
8	7	- E

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Conversion from Binary, Octal, and Hexadecimal to Decimal

1. Multiply each digit of the number by its base raised to the power of its position (counting from right to left, starting at 0).

2. Sum all the values obtained.

Example 1

Convert base 2 number $(11000000)_2$ into base 10 number.

$= 2^7 \times 1 + 2^6 \times 1 + 2^5 \times 0 + 2^4 \times 0 + 2^3 \times 0 + 2^2 + 0 + 2^1 \times 0 + 2^0 + 0$

$= 192$

Example 2

Convert base 8 number $(300)_8$ into base 10 number.

$= 8^2 \times 3 + 8^1 \times 0 + 8^0 + 0$

$= 192$

Example 3

Convert base 16 number $(C0)_{16}$ into base 10 number.

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

$= 16^1 \times 12 + 16^0 + 0$

$= 192$

Conversion of Number Systems

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Conversion of Binary into Octal and Hexadecimal and vice versa

Binary to Octal

1. Group the binary digits ***in sets of 3***, starting from the right (add leading zeros if necessary).

2. Convert each group into its octal equivalent.

Example

Convert $(110101)_2$ to octal number system.

Grouping → 110 101 (no padding of 0s)

Look at the table for the respective values.

Decimal	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Binary	000	001	010	011	100	101	110	111
Octal	0	1	2	3	4	5	6	7

Octal → 6 5 → or $\mathbf{(65)_8}$

Binary to Hexadecimal

1. Group the binary digits ***in sets of 4***, starting from the right (add leading zeros if needed).

2. Convert each group into its hexadecimal equivalent.

Example

Convert base 2 number 11101110 to hexadecimal.

Group → 1110 1110

Look for the respective values in the table.

Decimal	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Binary	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Hexadecimal → E E → or $\mathbf{(EE)_{16}}$

Octal/Hexadecimal to Binary

1. Convert each digit to its ***3-bit binary equivalent*** (for octal) or ***4-bit binary equivalent*** (for hexadecimal).

2. Join all binary groups together.

Note

If you reverse all the steps of last two examples, you will get Octal/Hexadecimal to Binary conversion.

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Conversion of Octal to Hexadecimal and vice versa

It is the only conversion that is executed in two stages.

Octal to Hexadecimal

1. Convert the octal number to binary (each digit to 3-bit binary).
2. Group binary digits in sets of 4 (starting from the right).
3. Convert each group to hexadecimal.

Example

Convert $(157)_8$ to hexadecimal number system.

Binary → 001 101 111 (convert using earlier method)

Re-Group → 0001 0110 1111

Consult hexadecimal table!

Hexadecimal →1 6 F → or $\mathbf{(16F)_{16}}$

Hexadecimal to Octal

1. Convert the hexadecimal number to binary (each digit to 4-bit binary).
2. Group binary digits in sets of 3 (starting from the right).
3. Convert each group to octal.

Example

Convert 0x2A into octal number system.

Binary → 0010 1010 (convert using earlier method)

Re-Group → 000 101 010

Consult octal table!

Octal → 0 5 2 → or $\mathbf{(52)_8}$

Conversion of Number Systems

(Practice Worksheet)

Practice Problems

Practice the worksheet to master the conversion between number systems.

Decimal to Binary

$45 =$ _____

$102 =$ _____

$255 =$ _____

Binary to Decimal

$1101 =$ _____

$101010 =$ _____

$11111111 =$ _____

Decimal to Octal

$64 =$ _____

$125 =$ _____

$200 =$ _____

Octal to Decimal

$77 =$ _____

$144 =$ _____

$10 =$ _____

Decimal to Hexadecimal

$31 =$ _____

$200 =$ _____

$255 =$ _____

Hexadecimal to Decimal

$1F =$ _____

$C8 =$ _____

$FF =$ _____

Binary to Octal

$101110 =$ _____

$1001011 =$ _____

$11100000 =$ _____

Binary to Hex

$101111 =$ _____

$10011011 =$ _____

$11111111 =$ _____