
Data Representation

IS 1202
Computer Systems

What is a bit?



What is bit?

- Binary Digit
- 1 or 0
- Smallest data unit

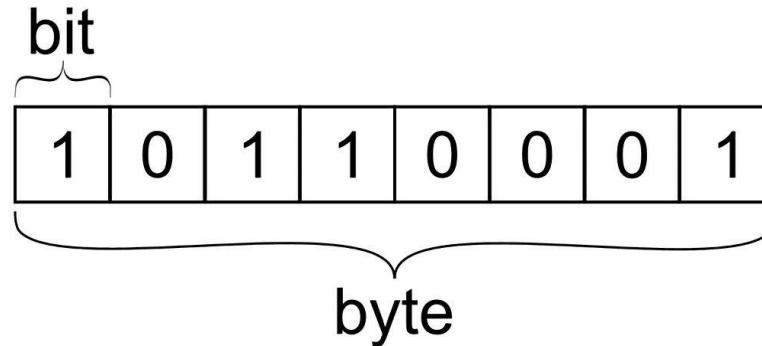


What is a byte?



What is a Byte?

- Binary Term
- 8 bits



Storage Hierarchy

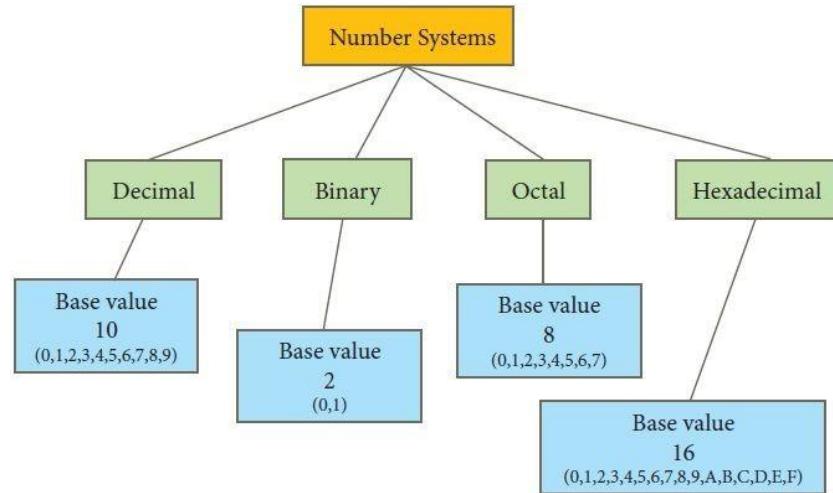
- 1 bit = 1 / 0
- 1 byte = 8 bits
- 1 kB = 1024 bytes
- 1 MB = 1024 kB
- 1 GB = 1024 MB
- 1 TB = 1024 GB
- 1 PB = 1024 TB
- 1 EB = 1024 PB

Word Size

- Number of bits processed by CPU at a one go.
- Typically 8 , 16 , 32 or 64 bits.

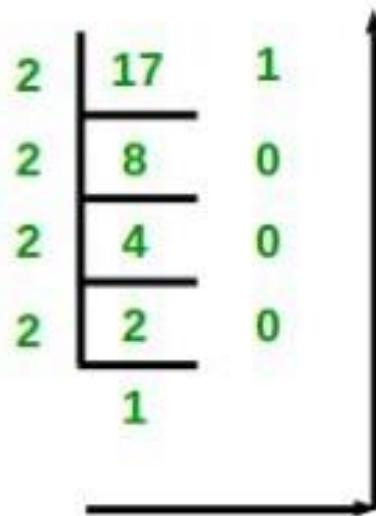
Numbering System

- Binary 0,1
- Octal 0,1,2,3,4,5,6,7
- Decimal 0,1,2,3,4,5,6,7,8,9
- Hexadecimal 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F



How to convert Decimal to Binary

Decimal number : 17



Binary number: 10001

Converting Decimal To Binary

$$5_{10} = ?_2$$

Answer : 101_2

Converting Decimal To Binary cont.

$$20_{10} = ?_2$$

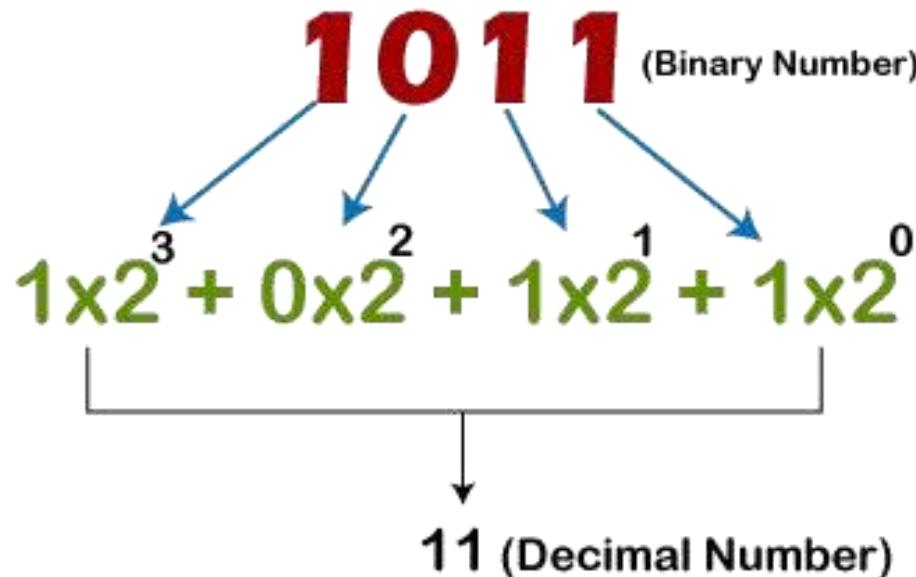
Answer : 10100_2

Converting Decimal To Binary cont.

$$128_{10} = ?_2$$

Answer : 10000000_2

How to convert Binary to Decimal



Converting Binary to Decimal cont.

$$111_2 = ?_{10}$$

Answer : 7_{10}

Converting Binary to Decimal cont.

$$101010_2 = ?_{10}$$

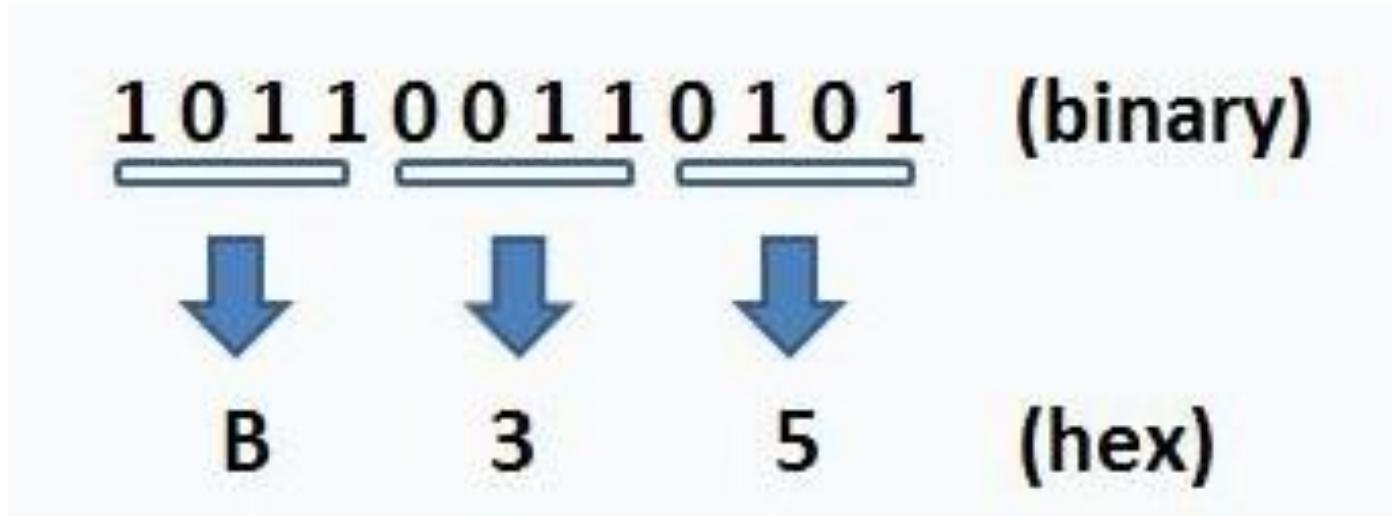
Answer : 42_{10}

How to convert Binary to Hexadecimal

Hexadecimal Notation

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

How to convert Binary to Hexadecimal



Converting Binary to Hexadecimal cont.

$$11001000_2 = ?_{16}$$

Answer : C8₁₆

HEX	Bit Pattern	HEX	Bit Pattern
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
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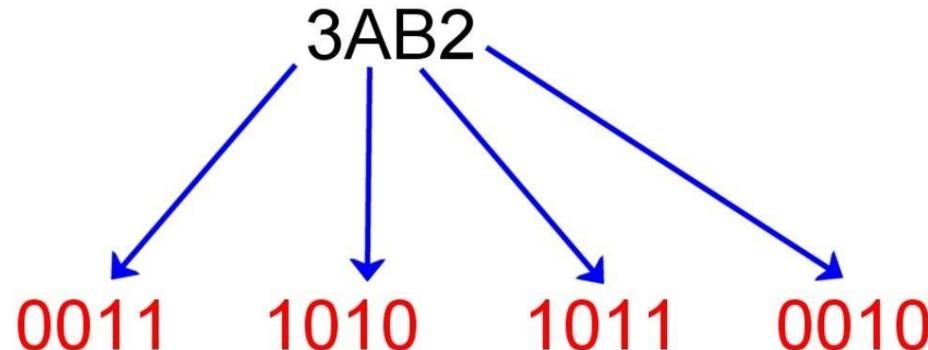
Converting Binary to Hexadecimal cont.

$$1010011010_2 = ?_{16}$$

Answer : 29A₁₆

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

How to convert Hexadecimal to Binary



$$3AB2_{16} = 11101010110010_2$$

Converting Hex to Binary

$$7A_{16} = ?_2$$

Answer : 1111010_2

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

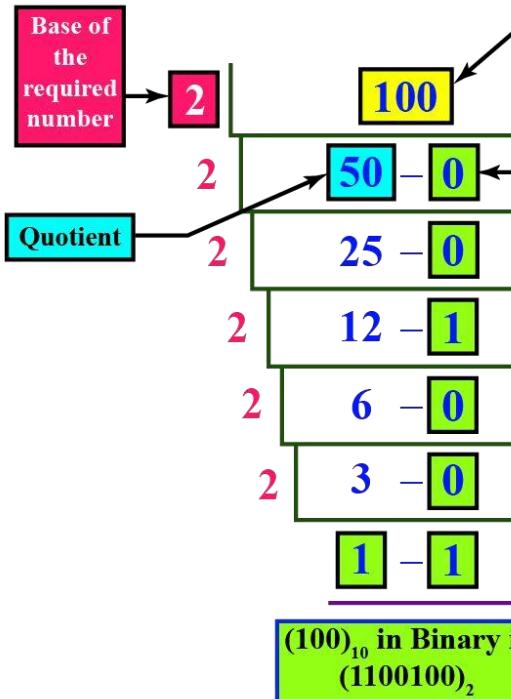
Converting Hex to Binary

$$230_{16} = ?_2$$

Answer : 1000110000_2

How to convert Decimal to Hexadecimal

- Decimals \rightarrow Binary \rightarrow Hex



1100100
0110 0100
↓ ↓
6 4

Converting Decimals to Hexadecimals

$$25_{10} = ?_{16}$$

Answer : 19_{16}

Converting Decimals to Hexadecimals

$$1024_{10} = ?_{16}$$

Answer : 400_{16}

How to convert Hexadecimal to Decimal

Hexadecimal Value = **2A5**

2	A	5
16^2	16^1	16^0

$$256 \times 2 = 512 \quad 16 \times 10 = 160 \quad 1 \times 5 = 5$$

$$\begin{array}{r} 512 + 160 + 5 \\ \hline \downarrow \\ 677 \end{array}$$

$$(2A5)_{16} = (677)_{10}$$

Converting Hexadecimals to Decimals

$$\text{FF}_{16} = ?_{10}$$

Answer : 255_{10}

Converting Hexadecimals to Decimals

$$1C2_{16} = ?_{10}$$

Answer : 450_{10}

How to convert Binary to Octal

0 1 1 0 1 0 1 1 0 (binary)

3 2 6 (octal)

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

Converting Binary to Octal

$$101110_2 = ?_8$$

Answer : 56_8

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

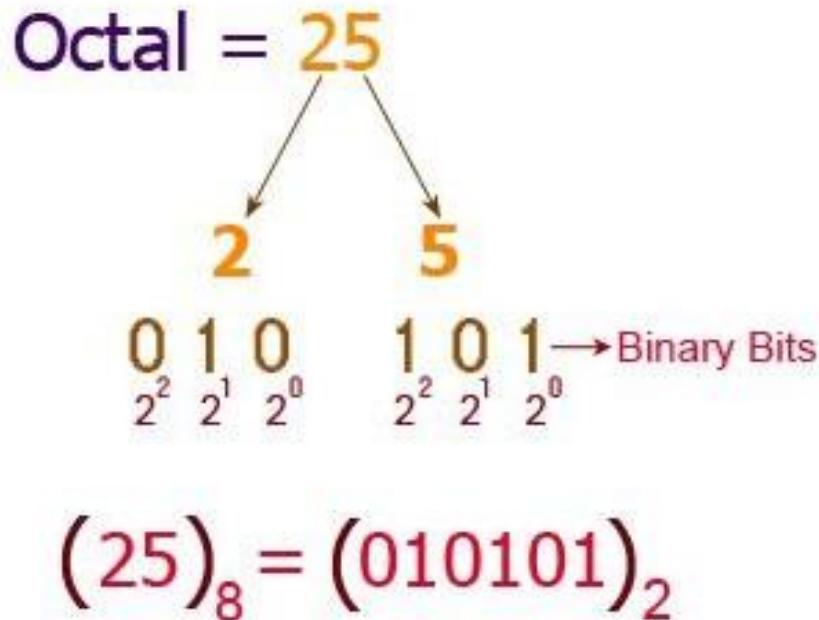
Converting Binary to Octal

$$11101001_2 = ?_8$$

Answer : 351_8

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

How to convert Octal to Binary



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

Converting Octal to Binary

$$21_8 = ?_2$$

Answer : 10001_2

Converting Octal to Binary

$$317_8 = ?_2$$

Answer : 11001111_2

How to convert Octal to Decimal

Octal = $\begin{array}{r} 25 \\ \downarrow \\ 2 \quad 5 \\ 8^1 \quad 8^0 \end{array}$

$8 \times 2 = 16 \quad 1 \times 5 = 5$

$16 + 5$

\downarrow

21

$$(25)_8 = (21)_{10}$$

Converting Octal to Decimal

$$45_8 = ?_{10}$$

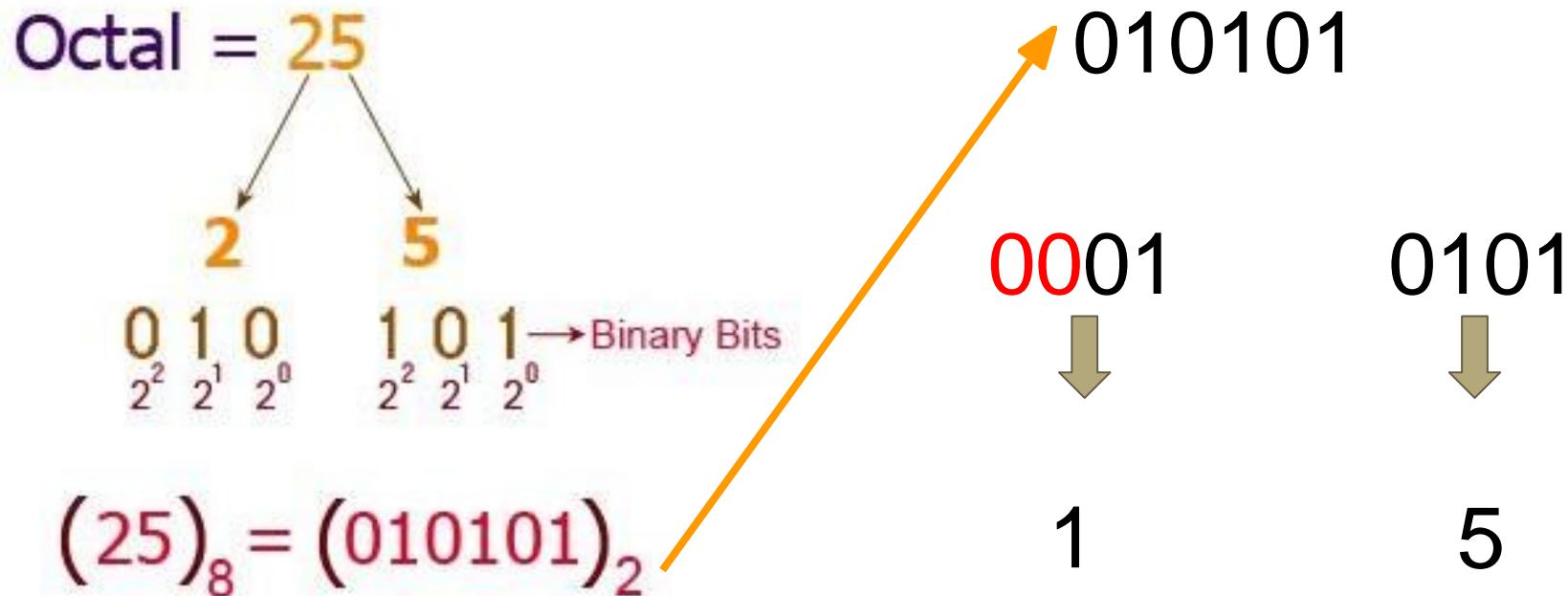
Answer : 37_{10}

Converting Octal to Decimal

$$102_8 = ?_{10}$$

Answer : 66_{10}

How to convert Octal to Hexadecimal



Converting Octal to Hex

Octal \rightarrow Binary \rightarrow Hex

$$30_8 = ?_{16}$$

Answer : 18_{16}

Converting Octal to Hex

Octal \rightarrow Binary \rightarrow Hex

$$1750_8 = ?_{16}$$

Answer : 3E8₁₆

How to Convert Decimal to Octal

Decimal Number: 33



Octal Number: 41

How to Convert Decimal to Octal

$$13_{10} = ?$$

Answer=15₈

How to Convert Decimal to Octal

$342_{10} = ?$

Answer= 526_8

How to Convert Decimal to Octal

$133_{10} = ?$

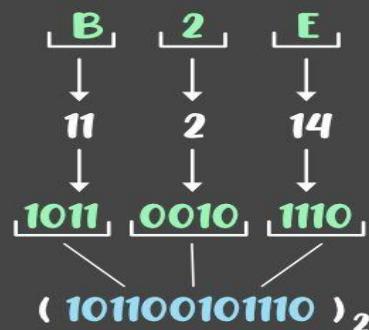
Answer = 205_8

How to Convert Hexadecimal to Octal

Hexadecimal to Octal Conversion

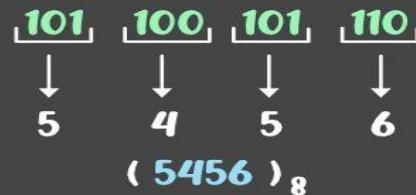
Hexadecimal to Binary

$$(\text{B2E})_{16} \longrightarrow (?)_8$$



Binary to octal

$$(101100101110)_2$$



How to Convert Hexadecimal to Octal

$1D_{16} = ?$

Answer= 35_8

How to Convert Hexadecimal to Octal

$1DA_{16} = ?$

Answer = 732_8

How to Convert Hexadecimal to Octal

$345_{16} = ?$

Answer = 1505_8

Exercise

1. Convert following decimal numbers to binary.
 - a. 63_{10}
 - b. 75_{10}
 - c. 452_{10}
2. Convert following binary numbers to decimals.
 - a. 110110110_2
 - b. 11010011_2
 - c. 1000110000_2
3. Convert following hex number to binary
 - a. $41F_{16}$
 - b. $7D0_{16}$

Exercise cont.

4. Convert following binary number to hex
 - a. 100101001_2
 - b. 100111011_2
 - c. 1110110_2
5. Convert following decimal number to hex
 - a. 2000_{10}
 - b. 3333_{10}
6. Convert following hex number to decimal
 - a. $1F4_{16}$
 - b. 457_{16}

Exercise cont.

7. Convert following binary number to octal

- a. 11101001_2
- b. 10010110_2
- c. 1001011000_2

8. Convert following octal number to hex

- a. 3720_8
- b. 11610_8

Answers

1. Convert following decimal numbers to binary.
 - a. 63_{10} - 111111_2
 - b. 75_{10} - 1001011_2
 - c. 452_{10} - 111000100_2
2. Convert following binary numbers to decimals.
 - a. 110110110_2 - 438_{10}
 - b. 11010011_2 - 211_{10}
 - c. 1000110000_2 - 560_{10}
3. Convert following hex number to binary
 - a. $41F_{16}$ - 1000001111_2
 - b. $7D0_{16}$ - 11111010000_2

Answers

4. Convert following binary number to hex
 - a. 100101001_2 - 129_{16}
 - b. 100111011_2 - $13B_{16}$
 - c. 1110110_2 - 76_{16}
5. Convert following decimal number to hex
 - a. 2000_{10} - $7D0_{16}$
 - b. 3333_{10} - $D05_{16}$
6. Convert following hex number to decimal
 - a. $1F4_{16}$ - 500_{10}
 - b. 457_{16} - 1111_{10}

Answers

7. Convert following binary number to octal

- a. 11101001_2 - 351_8
- b. 10010110_2 - 226_8
- c. 1001011000_2 - 1130_8

8. Convert following octal number to hex

- a. 3720_8 - $7D0_{16}$
- b. 11610_8 - 1388_{16}