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# Data Representation

**IS 1202**

**Computer Systems**

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# What is a bit?



# What is bit?

- Binary Digit
- 1 or 0
- Smallest data unit

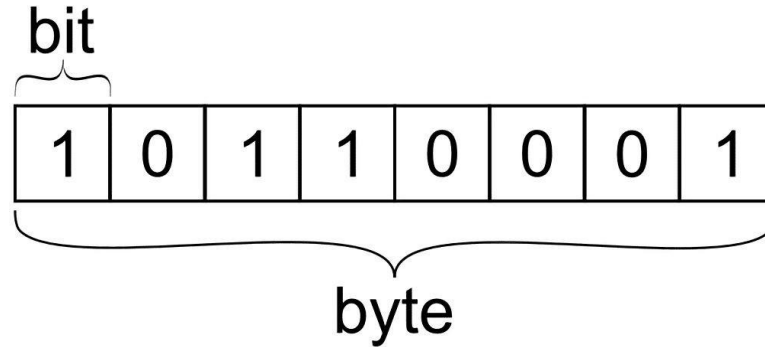


# What is a byte?



# What is a Byte?

- Binary Term
- 8 bits



# Storage Hierarchy

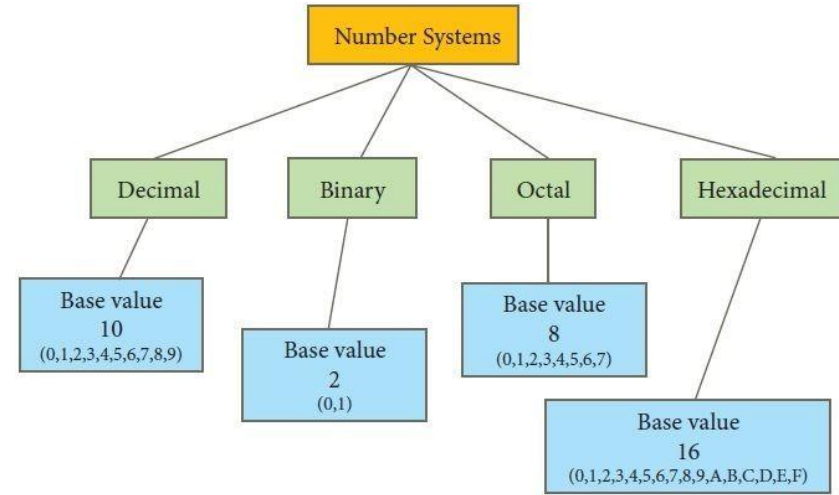
- 1 bit = 1 / 0
- 1 byte = 8 bits
- 1 kB = 1024 bytes
- 1 MB = 1024 kBs
- 1 GB = 1024 MBs
- 1 TB = 1024 GBs
- 1 PB = 1024 TBs
- 1 EB = 1024 PBs

# Word Size

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

# Numbering System

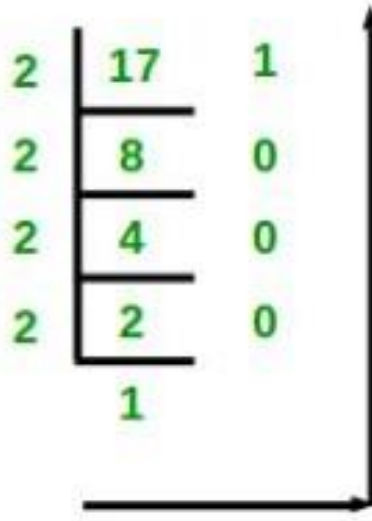
- Binary 0,1
- Octal 0,1,2,3,4,5,6,7
- Decimal 0,1,2,3,4,5,6,7,8,9
- Hexadecimal 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F





# 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.

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

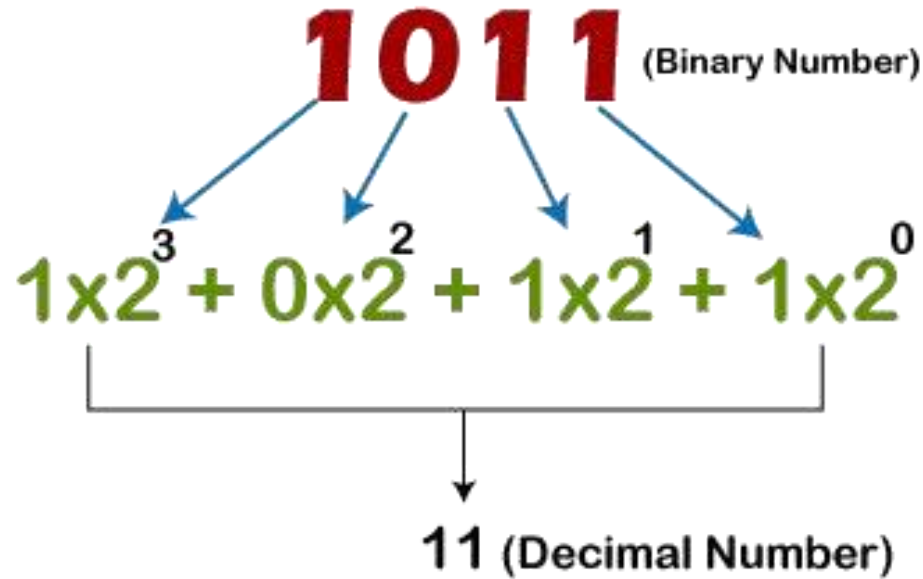
Answer :  $10100_2$

## 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

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



B



3



5

(hex)

# Converting Binary to Hexadecimal cont.

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

Answer : C8<sub>16</sub>

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

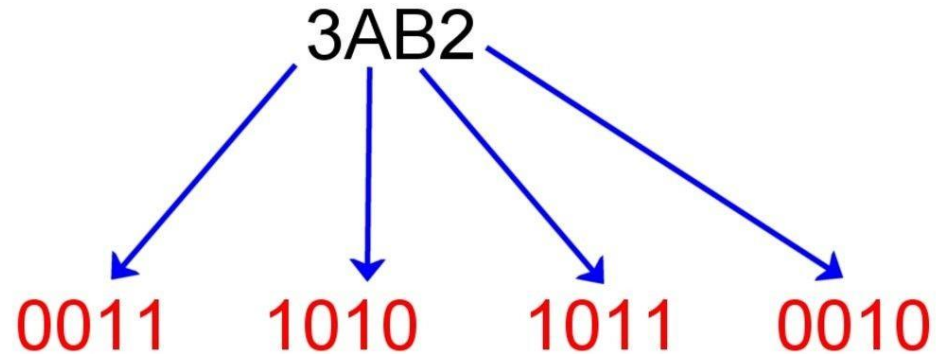
# Converting Binary to Hexadecimal cont.

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

Answer :  $29A_{16}$

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

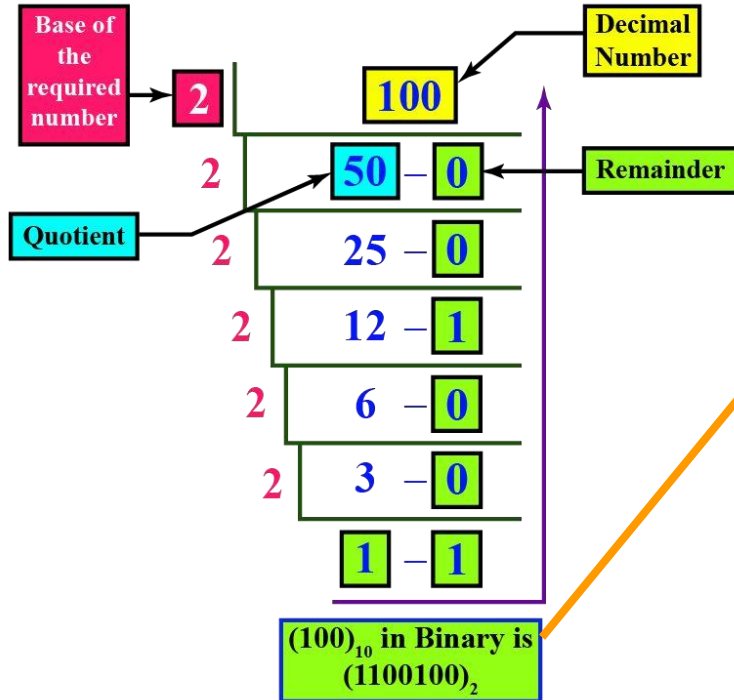
# Converting Hex to Binary

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

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
$16^2$	$16^1$	$16^0$

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

512 + 160 + 5



**677**

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

# Converting Hexadecimals to Decimals

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

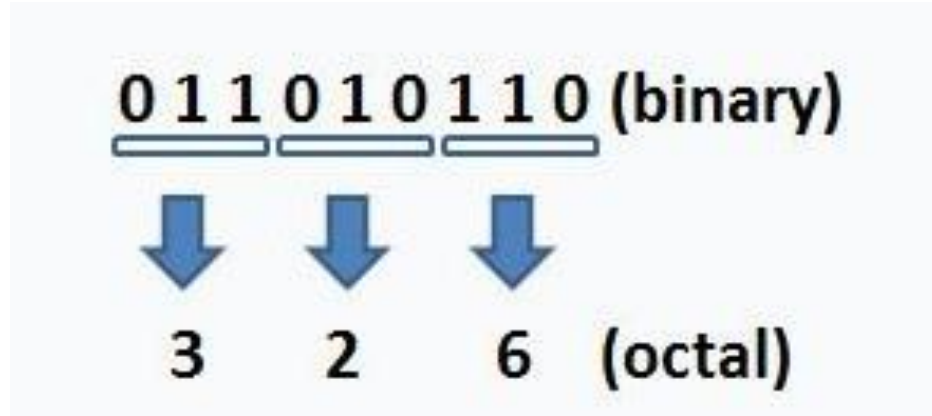
Answer :  $255_{10}$

# Converting Hexadecimals to Decimals

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

Answer :  $450_{10}$

# How to convert Binary to Octal



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

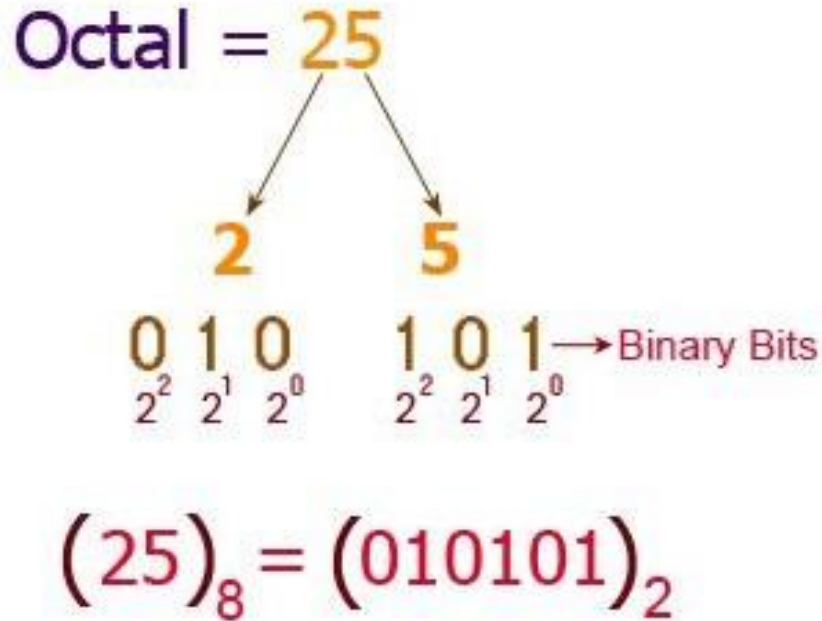
# Converting Binary to Octal

$$11101001_2 = ?_8$$

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 = 25

↓

2      5

$8^1$        $8^0$

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

$16 + 5$

↓

**21**

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

# Converting Octal to Decimal

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

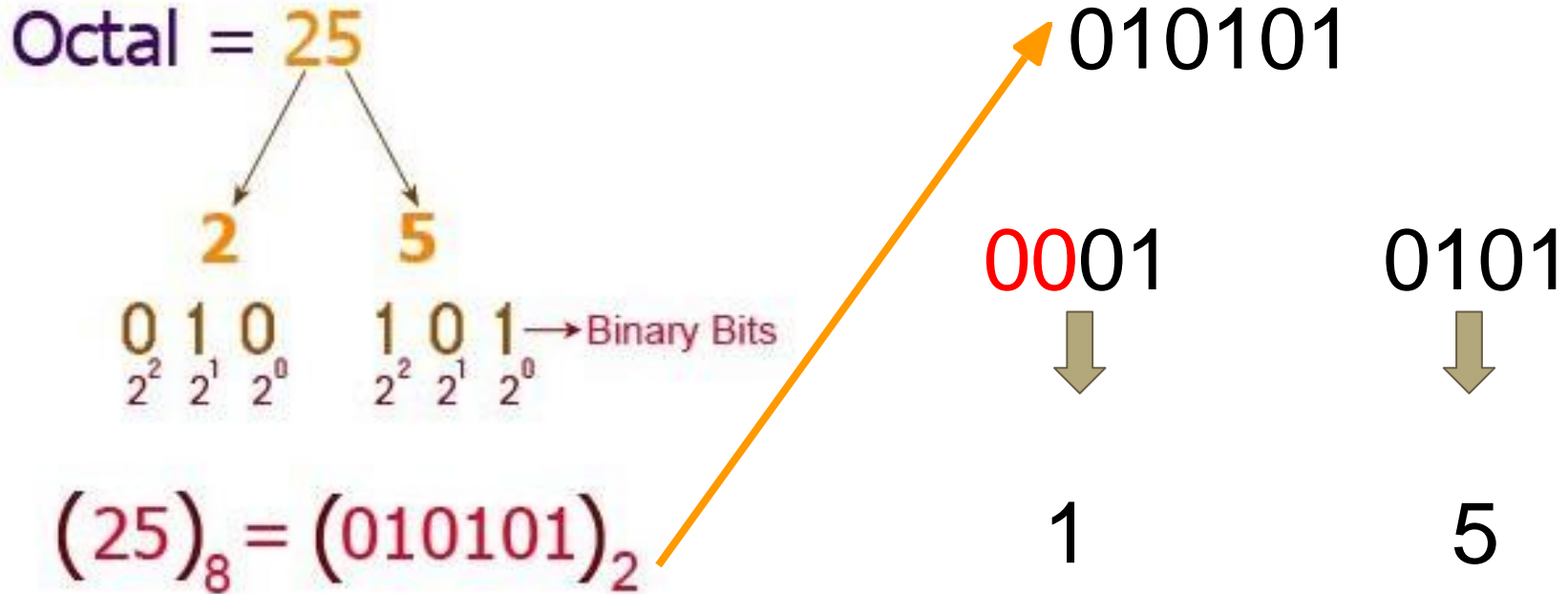
Answer :  $37_{10}$

# Converting Octal to Decimal

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

Answer :  $66_{10}$

# How to convert Octal to Hexadecimal



# Converting Octal to Hex

Octal  $\longrightarrow$  Binary  $\longrightarrow$  Hex

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

Answer :  $18_{16}$

# Converting Octal to Hex

Octal  $\longrightarrow$  Binary  $\longrightarrow$  Hex

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

Answer :  $3E8_{16}$



# How to Convert Decimal to Octal

Decimal Number: 33

8	33	1	↑ remainder
8	4	4	
	0		

Octal Number: 41

# How to Convert Decimal to Octal

$$13_{10} = ?$$

$$\text{Answer} = 15_8$$

# How to Convert Decimal to Octal

$$342_{10} = ?$$

$$\text{Answer} = 526_8$$

# How to Convert Decimal to Octal

$$133_{10} = ?$$

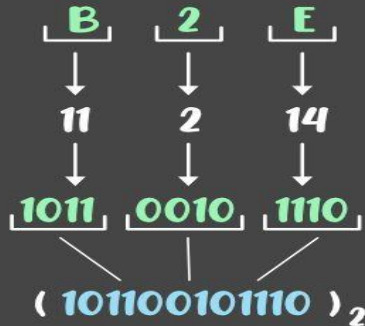
$$\text{Answer} = 205_8$$

# How to Convert Hexadecimal to Octal

## Hexadecimal to Octal Conversion

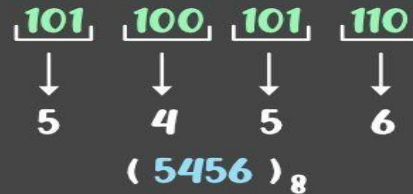
Hexadecimal to Binary

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



Binary to Octal

$(101100101110)_2$



# How to Convert Hexadecimal to Octal

$$1D_{16} = ?$$

$$\text{Answer} = 35_8$$

# How to Convert Hexadecimal to Octal

$$1DA_{16} = ?$$

$$\text{Answer} = 732_8$$

# How to Convert Hexadecimal to Octal

$$345_{16} = ?$$

$$\text{Answer} = 1505_8$$



# 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.  $7Do_{16}$

## 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.  $41F_{16} - 10000011111_2$
  - b.  $7Do_{16} - 11111010000_2$

# 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.  $11610_8 - 1388_{16}$