

أوقات الدرس



ساعتين أسبوعيًا

الاثنين الأربعاء

08:00



09:00

PM



OL Academy

CSC103

Lesson (1)

مدرس المقرر



أحمد كريم

عن بعد حضورياً

خصوصي

Numbering Systems

www.olearninga.com

[@olearninga](https://www.instagram.com/olearninga)

66939059



Watch
Video

Number Systems

```
graph TD; A[Number Systems] --> B[Decimal]; A --> C[Binary]; A --> D[Octal]; A --> E[Hexadecimal]; B --> B1[Base10]; C --> C1[Base2]; D --> D1[Base8]; E --> E1[Base16]; B1 --> B2[0-9]; C1 --> C2[0,1]; D1 --> D2[0-7]; E1 --> E2[0-9 A-F];
```

Decimal

Base10

0-9

Binary

Base2

0,1

Octal

Base8

0-7

Hexadecimal

Base16

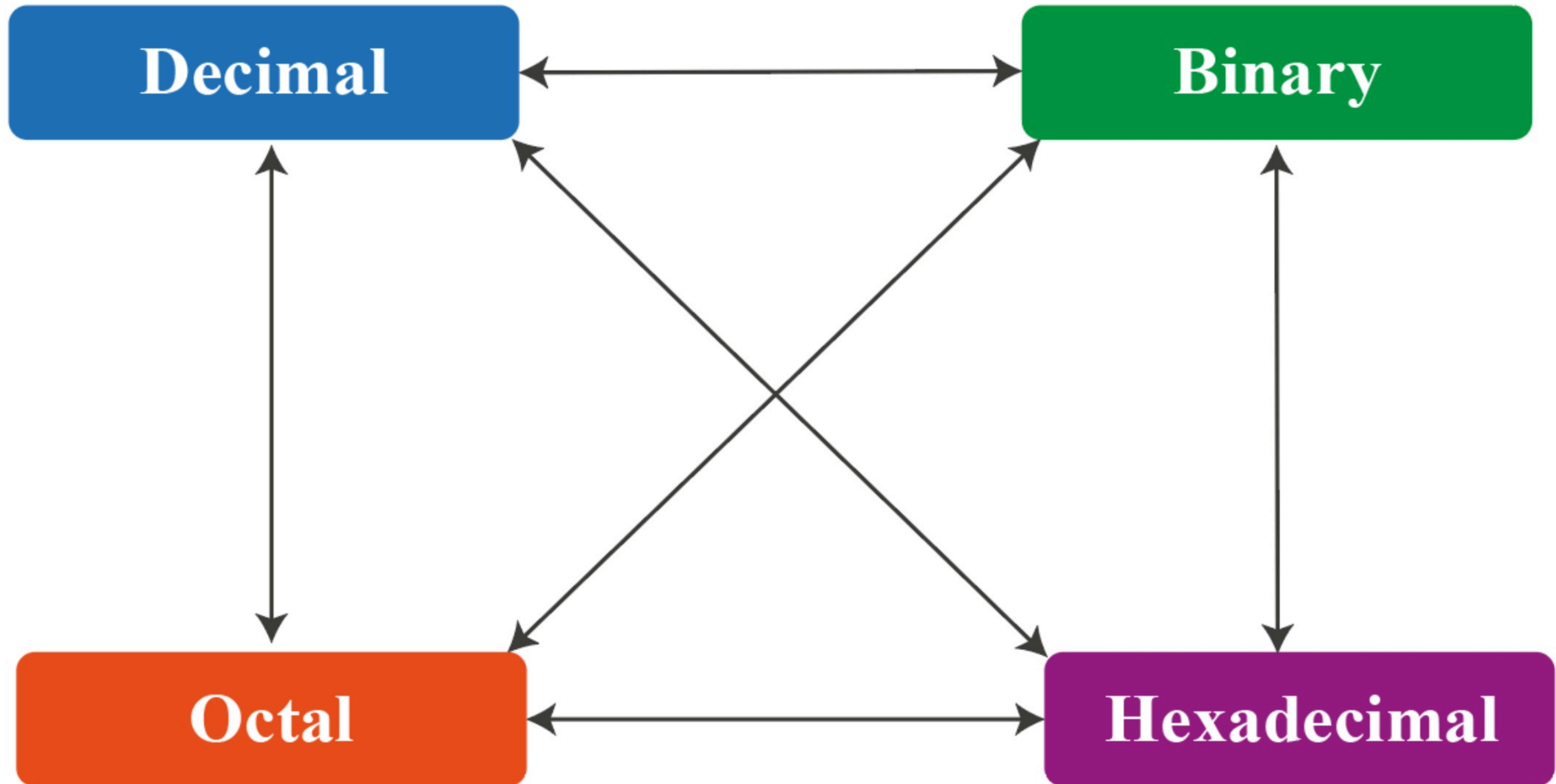
**0-9
A-F**

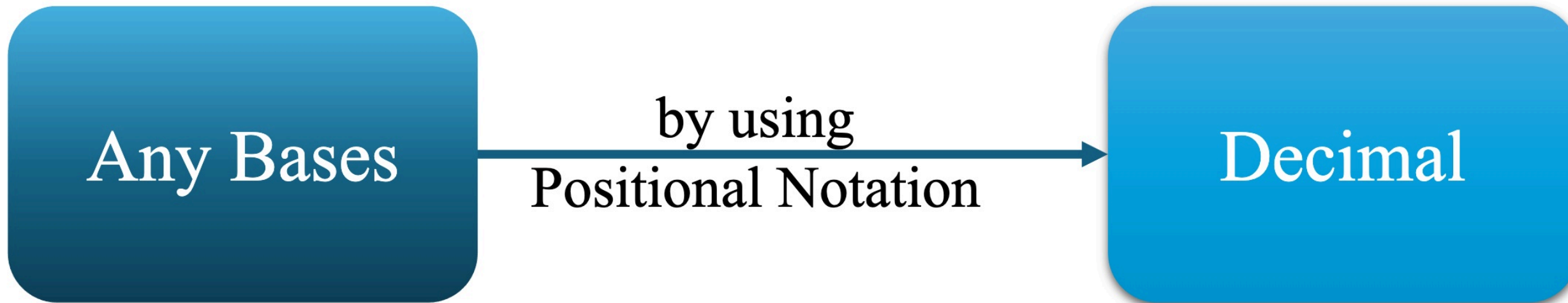
Decimal (base 10) 0-9	Binary (base 2) 0,1	Octal (base 8) 0-7	Hexadecimal (base 16) 0-F
0	0000	000	0000
1	0001	001	0001
2	0010	002	0002
3	0011	003	0003
4	0100	004	0004
5	0101	005	0005
6	0110	006	0006
7	0111	007	0007
8	1000	010	0008
9	1001	011	0009
10	1010	012	A
11	1011	013	B
12	1100	014	C
13	1101	015	D
14	1110	016	E
15	1111	017	F

2^3 2^2 2^1 2^0

8 4 2 1
 5 0 1 0 1
 6 0 1 1 0
 7 0 1 1 1
 10 1 0 1 0
 15 1 1 1 1

Conversion Among Bases





Binary to Decimal

Octal to Decimal

Hexadecimal to Decimal

2^3 2^2 2^1 2^0

Multiply 2^n

Multiply 8^n

Multiply 16^n

Where n is the "weight" of the bit

Base
10

Quick Example

10^3	10^2	10^1	10^0
1000	100	10	1

$$n^0 = 1$$

(1 4 6)₁₀

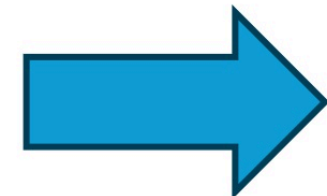
10^2 10^1 10^0

Base Weight

$$6 \times 10^0 = 6$$

$$4 \times 10^1 = 40$$

$$1 \times 10^2 = 100$$



$$6 + 40 + 100 = (146)_{10}$$

1. Multiply each bit by 10^n , where n is the "weight" of the bit.
2. The weight is the position of the bit, starting from 0 on the right
3. Add the results

Base

2

Binary to Decimal

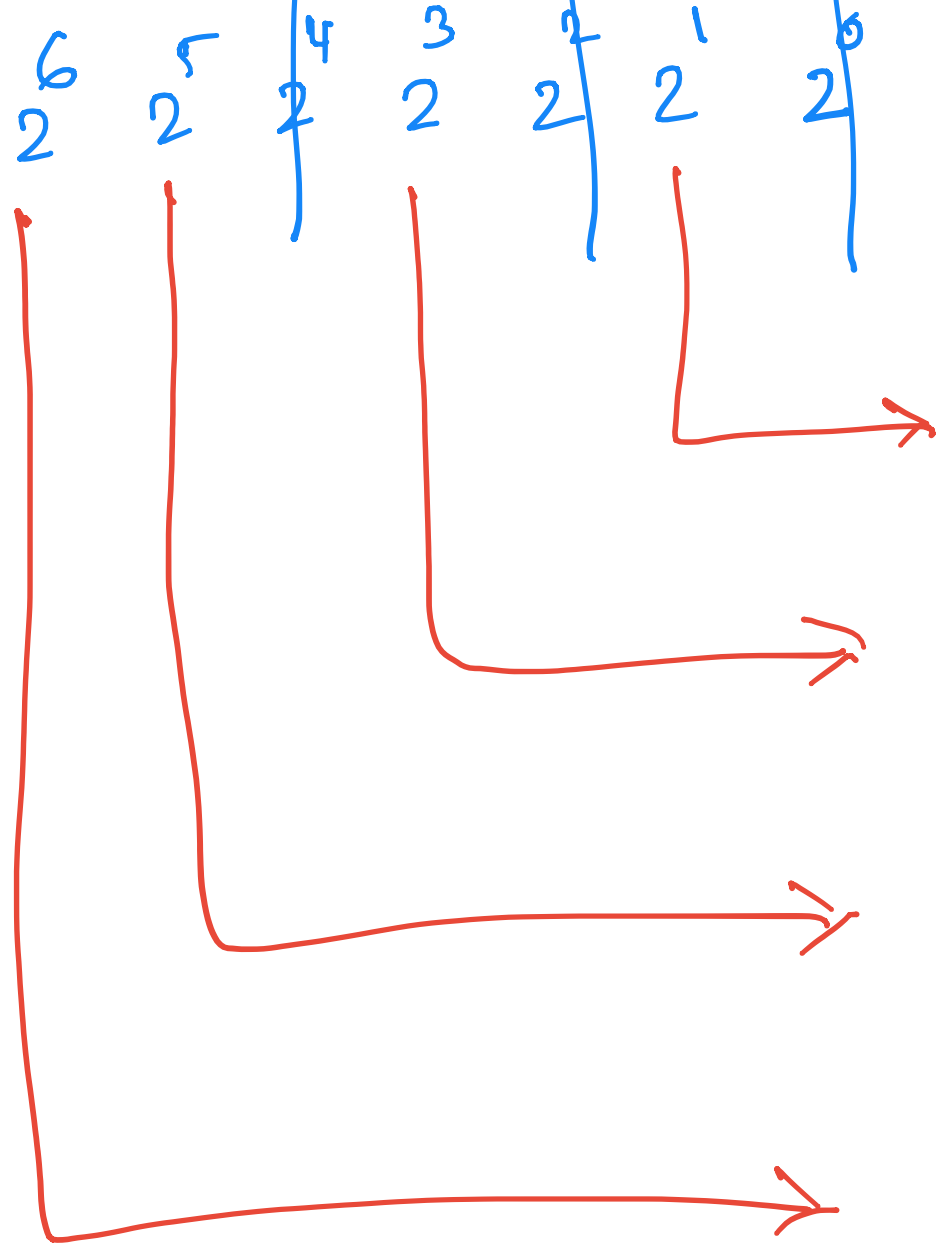
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

Multiply each bit by 2^n

$(1\ 1\ 0\ 1\ 0\ 1\ 0)_2$



$(106)_{10}$



$$\begin{aligned} 1 \times 2^1 &= 2 \\ 1 \times 2^3 &= 8 \\ 1 \times 2^5 &= 32 \\ 1 \times 2^6 &= 64 \end{aligned}$$

$$\begin{aligned} &\Rightarrow 2 + 8 + 32 + 64 \\ &= (106)_{10} \end{aligned}$$

Base

2

Binary to Decimal

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

Multiply each bit by 2^n

$$\begin{matrix} 64 & 32 & 16 & 8 & 4 & 2 & 1 \\ (1 & 1 & 0 & 1 & 0 & 1 & 0)_2 \end{matrix} \longrightarrow (\quad)_{10}$$

$$64 + 32 + 8 + 2 = 106$$



Binary to Decimal

$$(1\ 0\ 0\ 1\ 1\ 0\ 1)_2 \longrightarrow (\quad)_{10}$$



$(77)_{10}$

Base
8

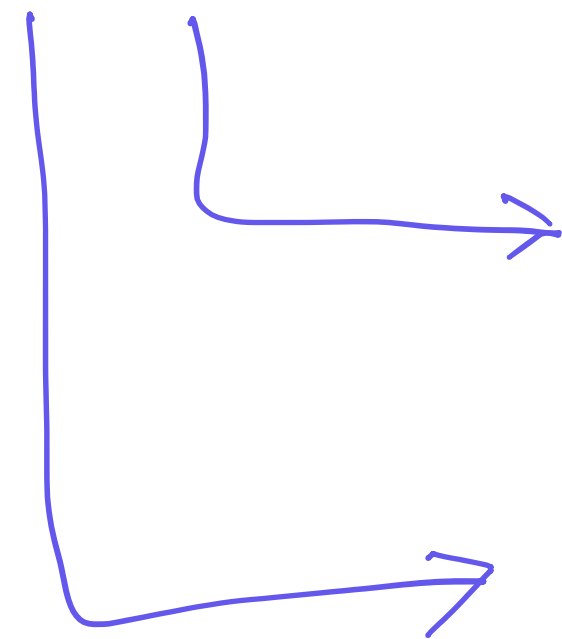
Octal to Decimal

8^3	8^2	8^1	8^0
512	64	8	1

Multiply each bit by 8^n

$$(7\ 5)_8 \longrightarrow (61)_{10}$$

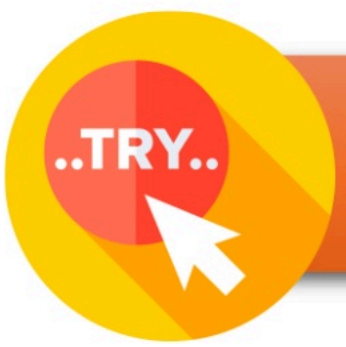
8^1 8^0



$$\begin{aligned} 5 \times 8^0 &= 5 \\ 7 \times 8^1 &= 56 \end{aligned}$$

\implies

$$5 + 56 = 61$$



Octal to Decimal

$$(7\ 2\ 4)_8 \longrightarrow (\quad)_{10}$$



(468)₁₀

Base
16

Hexadecimal to Decimal

16^3	16^2	16^1	16^0
4096	256	16	1

Multiply each bit by 16^n

$$(A2)_{16} \longrightarrow (162)_{10}$$

Handwritten calculation showing the conversion of (A2)₁₆ to (162)₁₀:

Arrows point from the powers of 16 to the digits in (A2)₁₆:

- 16^1 points to 'A' (10)
- 16^0 points to '2' (2)

Calculations:

$$2 \times 16^0 = 2$$
$$10 \times 16^1 = 160$$

$$(162)_{10}$$

10	A
11	B
12	C
13	D
14	E
15	F



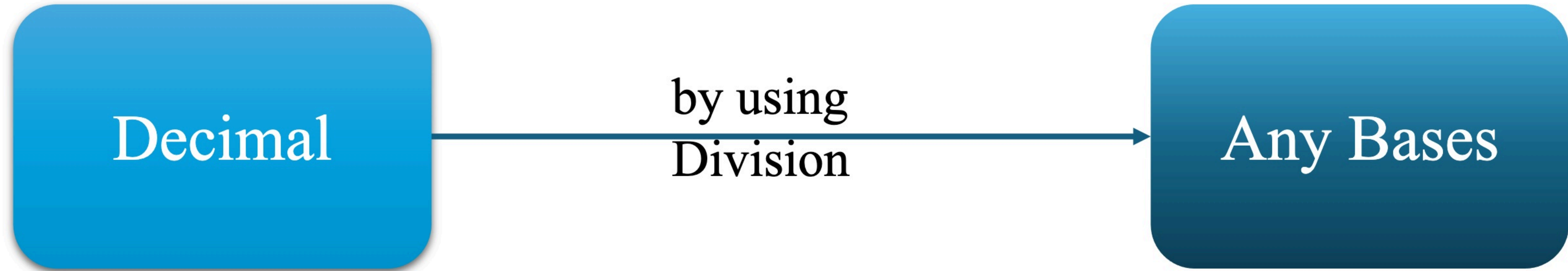
Hexadecimal to Decimal

$$(ABC)_{16} \longrightarrow (\quad)_{10}$$

$$\begin{array}{ccc} 10 & 11 & 12 \\ 16^2 & 16^1 & 16^0 \end{array}$$



(2748)₁₀



Decimal to Binary

Divide by 2

Decimal to Octal

Divide by 8

Decimal to Hexadecimal

Divide by 16

Base

2

Decimal to Binary

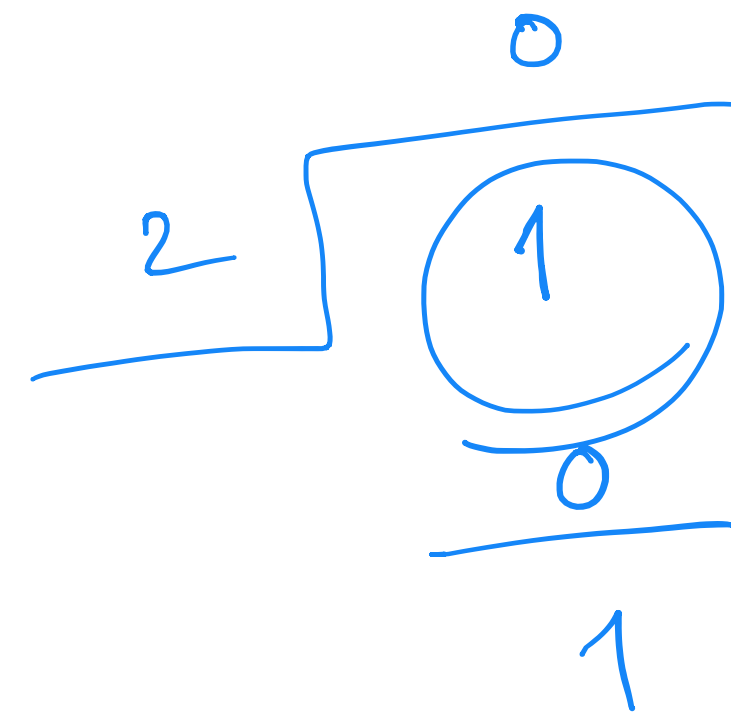
Divide by 2

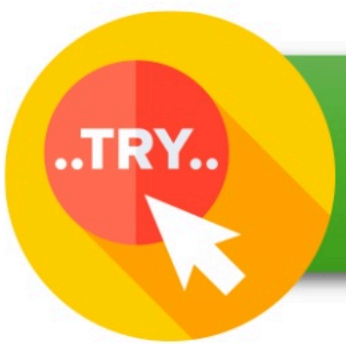
$$(99)_{10} \longrightarrow (1100011)_2$$

99		2
49		2
24		2
12		2
6		2
3		2
1		2

Result	Reminder
49	1
24	1
12	0
6	0
3	0
1	1
0	1

2^6	2^5	2^4	2^3	2^2	2^1	2^0
64	32	16	8	4	2	1
1	1	0	0	0	1	1





Decimal to Binary

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

$$(13)_{10} \longrightarrow (\quad)_2$$



(1101)₂

Base
8

Decimal to Octal

Divide by 8

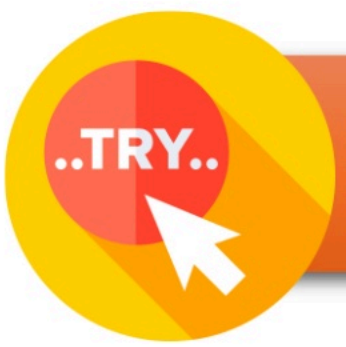
8^3	8^2	8^1	8^0
512	64	8	1

$$(465)_{10} \longrightarrow (721)_8$$

$$\begin{array}{r|l} 465 & 8 \\ 58 & 8 \\ 7 & 8 \end{array}$$

$$\begin{array}{r|l} 58 & 1 \uparrow \\ 7 & 2 \\ 0 & 7 \end{array}$$

$$\begin{array}{r} 0 \\ 8 \overline{) 70} \\ \underline{70} \\ 0 \\ 7 \end{array}$$



Decimal to Octal

$$(2548)_{10} \longrightarrow (\quad)_8$$



(2764)₈

Base
16

Decimal to Hexadecimal

16^3	16^2	16^1	16^0
4096	256	16	1

$$(4259)_{10} \longrightarrow (10A3)_{16}$$

4259	16	266	3
266	16	16	A
16	16	1	0
1	16	0	1

10	A
11	B
12	C
13	D
14	E
15	F

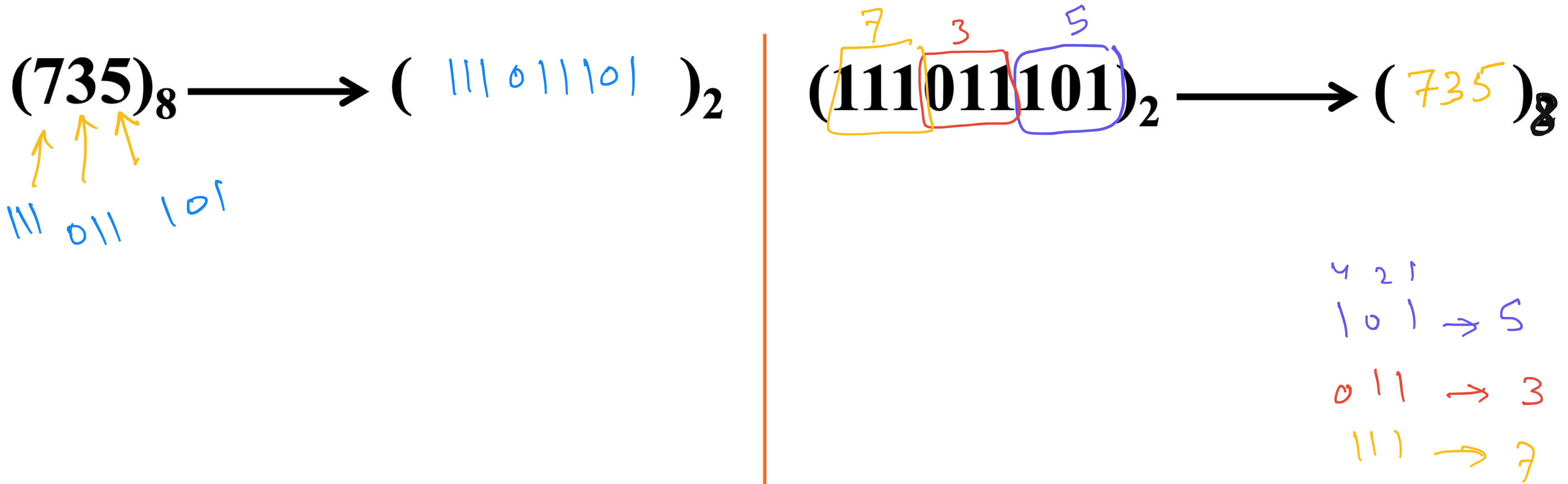
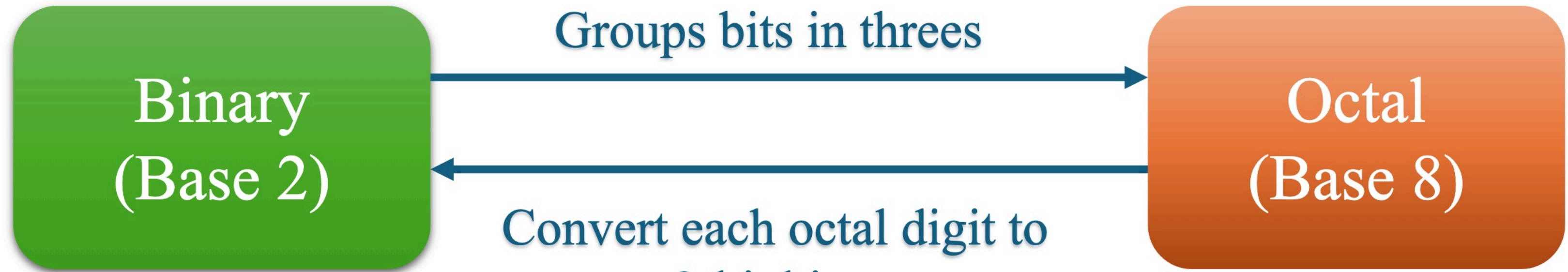


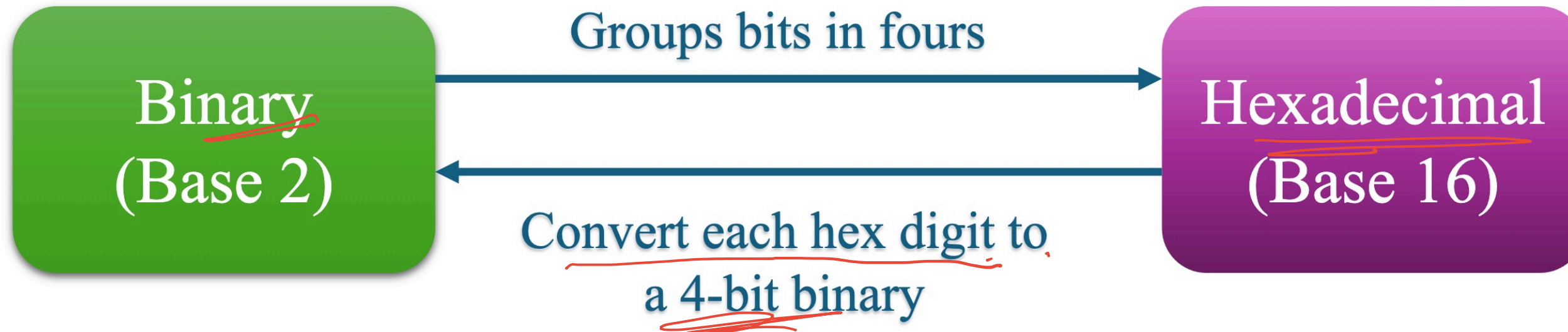
Decimal to Hexadecimal

$$(108)_{10} \longrightarrow (\quad)_{16}$$



(6C)₁₆





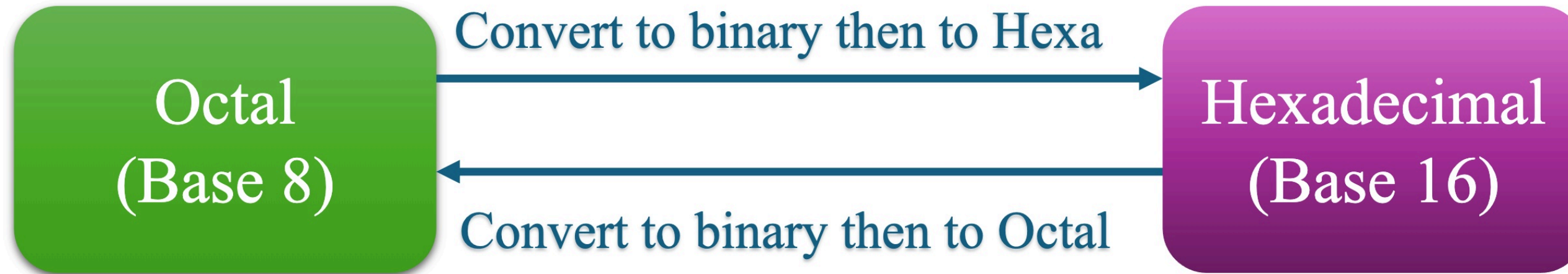
$(1001101)_2 \rightarrow (4D)_{16}$

Handwritten notes: A red circle around the first '1' and a blue box around '1101'. A red '4' is written below the first '1'. A blue 'D' is written above '1101'. A blue box around '1101' has an arrow pointing to 'D'. A blue '8421' is written above '1101'.

$(A7)_{16} \rightarrow (10100111)_2$

Handwritten notes: A red circle around 'A7'. A red '8421' is written above '0111'. A red '7' has an arrow pointing to '0111'. A red 'A' has an arrow pointing to '1010'. The final '2' in the binary result is circled in red.

A	B	C	(D)	E	F
10	11	12	13	14	15



$$(375)_8 \longrightarrow (FD)_{16}$$

① Convert to Binary

3 7 5
 011 111 101

② 011111101
 FD

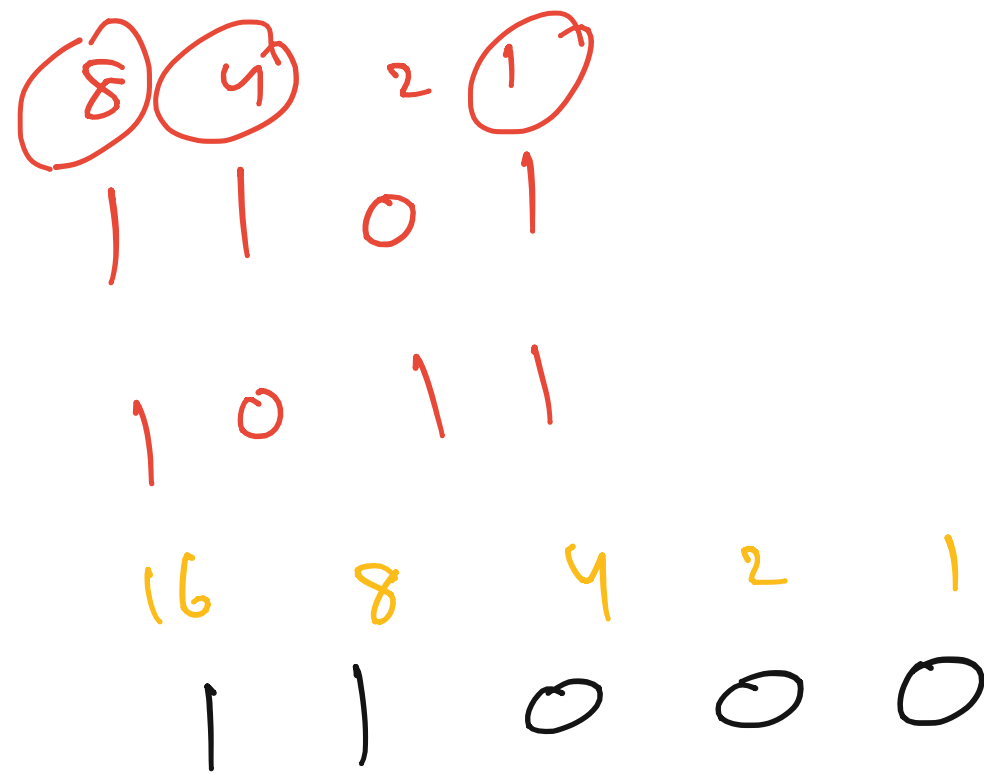
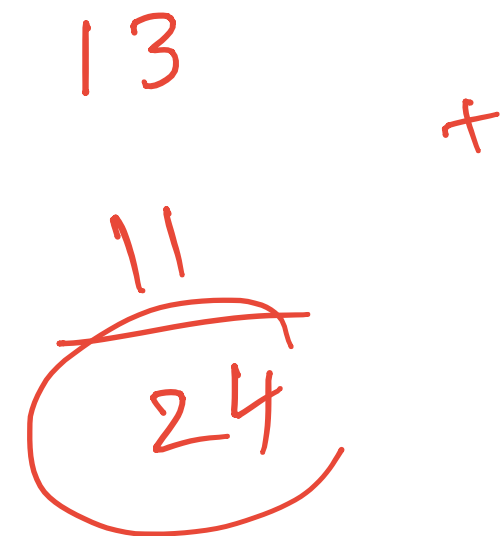
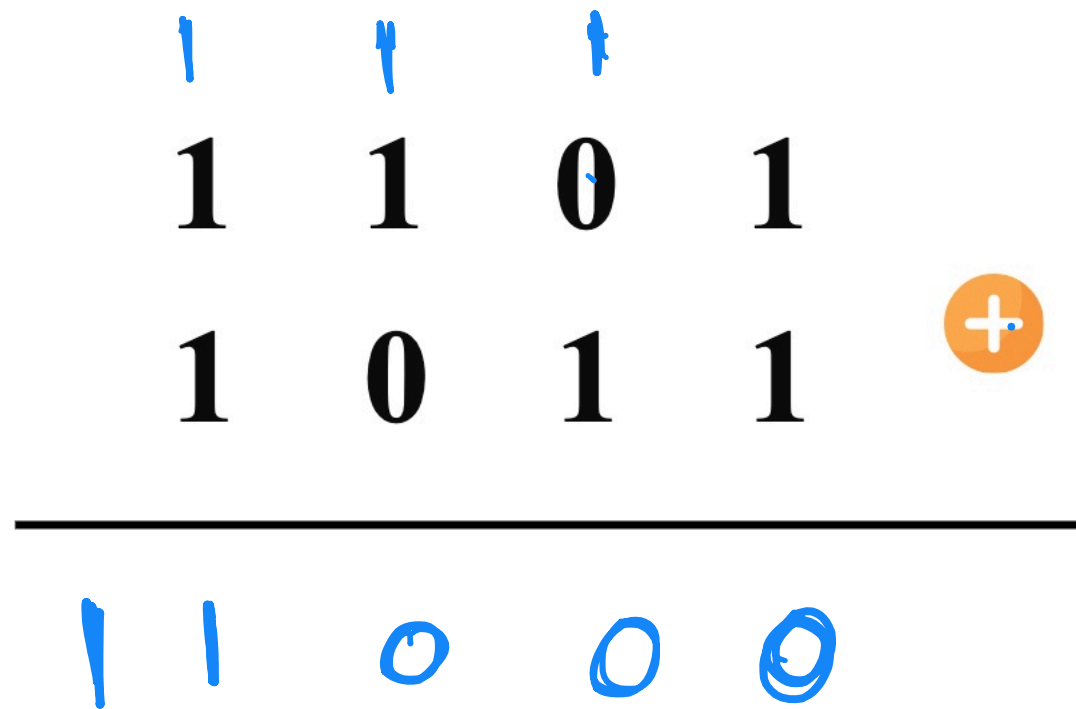
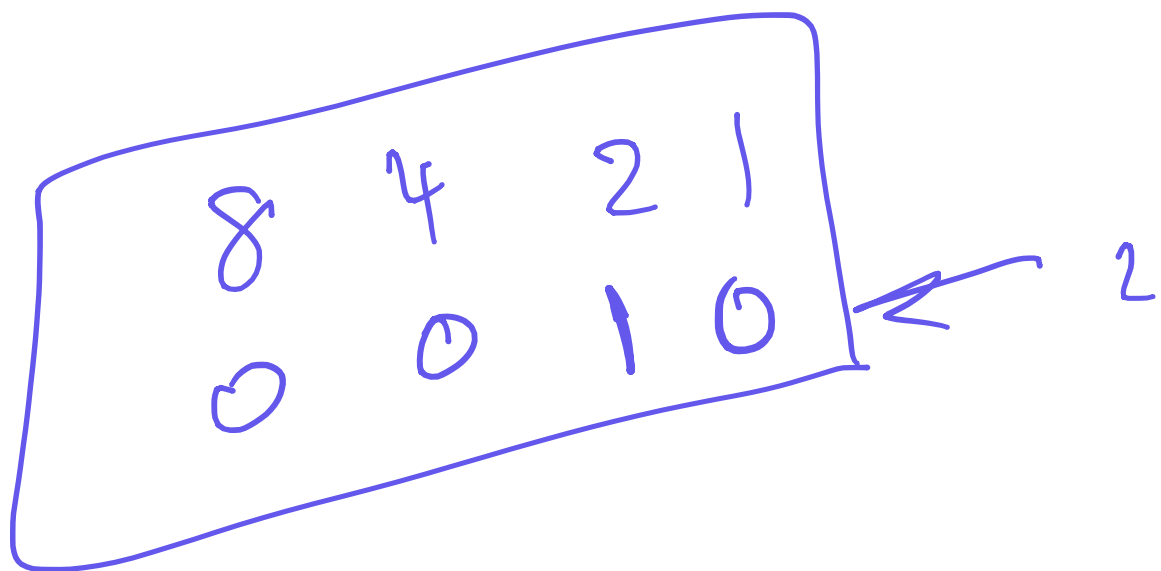
$$(A7)_{16} \longrightarrow (247)_8$$

A 7 \rightarrow to binary
 010100111
 2 4 7



Binary Addition

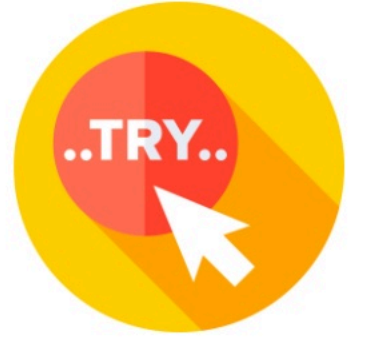
0	+	0	=	0
0	+	1	=	1
1	+	0	=	1
1	+	1	=	10



24



Binary Addition



$$\begin{array}{r} \textcircled{1} \quad \textcircled{1} \quad \textcircled{1} \\ 1 \quad 0 \quad 1 \quad 1 \\ + \quad 1 \quad 1 \quad 1 \\ \hline 1 \quad 0 \quad 0 \quad 1 \quad 0 \end{array}$$

$$\begin{array}{r} 1 \quad 0 \quad 1 \quad 1 \\ 1 \quad 0 \quad 1 \quad 1 \\ + \quad 1 \quad 1 \quad 1 \quad 1 \end{array}$$



$(100101)_2$



Binary Multiplication

$$0 \times 0 = 0$$

$$0 \times 1 = 0$$

$$1 \times 0 = 0$$

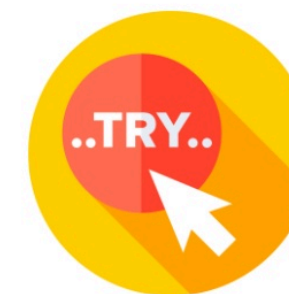
$$1 \times 1 = 1$$

$$\begin{array}{r} 111 \\ \times 101 \\ \hline 111 \\ 000 \\ 111 \\ \hline 10011 \end{array}$$

The diagram illustrates the binary multiplication of 111 and 101. The multiplicand 111 is in the top row. The multiplier 101 is in the second row, with the first '1' and the '0' circled in blue. An orange 'x' symbol is to the right of the multiplier. A horizontal black line separates the multiplier from the partial products. The first partial product is 111, with the first '1' circled in blue. The second partial product is 000, with the first '0' circled in blue. The third partial product is 111, with the first '1' circled in blue. A blue '+' sign is to the right of the partial products. A horizontal blue line separates the partial products from the final result, 10011, which is written in blue below the line.



Binary Multiplication



$$\begin{array}{r} \begin{array}{cccc} 8 & 4 & 2 & 1 \\ 1 & 1 & 1 & 1 \\ & & 1 & 0 \end{array} \times 15 \\ \hline \begin{array}{cccc} 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 \end{array} + \\ \hline \begin{array}{cccc} 1 & 1 & 1 & 0 \end{array} \\ \hline \begin{array}{cccc} 16 & 8 & 4 & 2 & 1 \\ 1 & 1 & 1 & 1 & 0 \end{array} = 30 \end{array}$$

$$\begin{array}{r} 101110 \\ \times 101 \\ \hline \end{array}$$



$(11100110)_2$

Chapter 1 | Number System – Exam Questions

EXAM

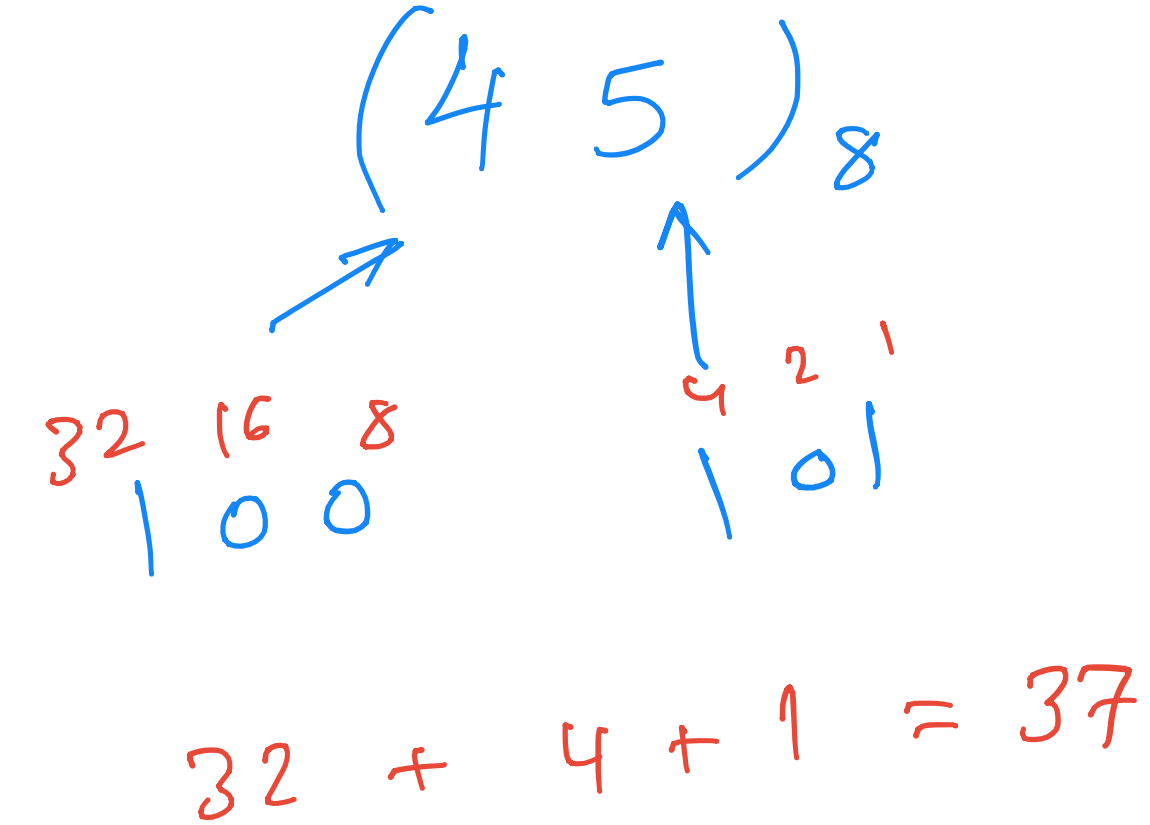
(1) The octal number $(45)_8$ is equivalent to the Decimal number:

(a) $(29)_{10}$

(b) $(37)_{10}$

(c) $(44)_{10}$

(d) $(49)_{10}$



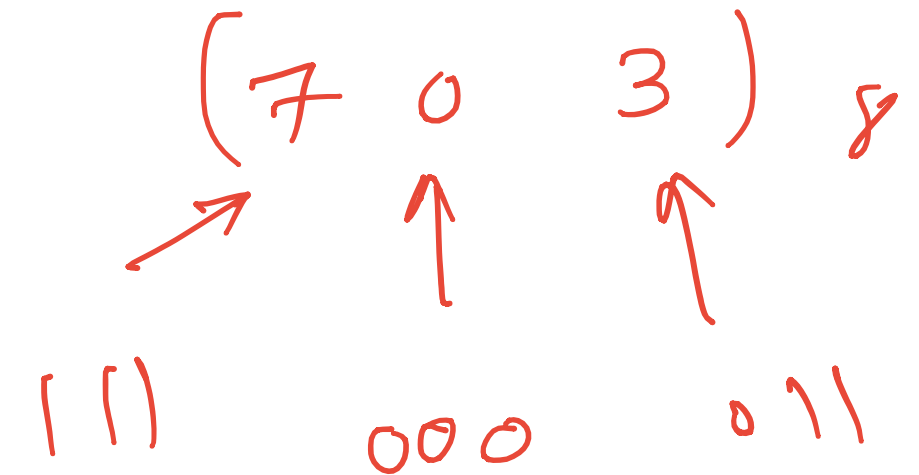
(2) The octal number $(703)_8$ is equivalent to the Binary number:

(a) $(111000011)_2$

(b) $(101000111)_2$

(c) $(011100000011)_2$

(d) $(11111110111)_2$



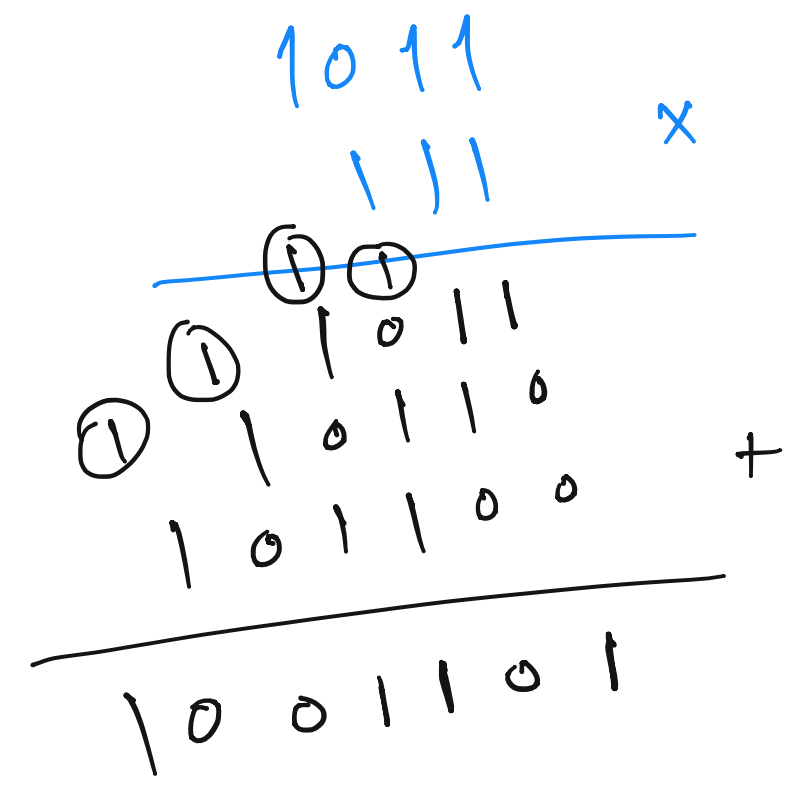
(3) The number $(1100\overset{C}{\boxed{1011}}\overset{A}{\boxed{1010}})_2$ is equivalent to the Hexa-decimal number:

8 4 2 1
A 1 0 1 0
B 1 0 1 1
C 1 1 0 0

- (a) $(00CBA)_{16}$
- (b) $(0ABC)_{16}$
- (c) $(121110)_{16}$
- (d) $(9B8)_{16}$

(4) The binary multiplication (product) of 1011 and 111 is:

- (a) $(1010101)_2$
- (b) $(10110010)_2$
- (c) $(1001101)_2$
- (d) $(1101001)_2$



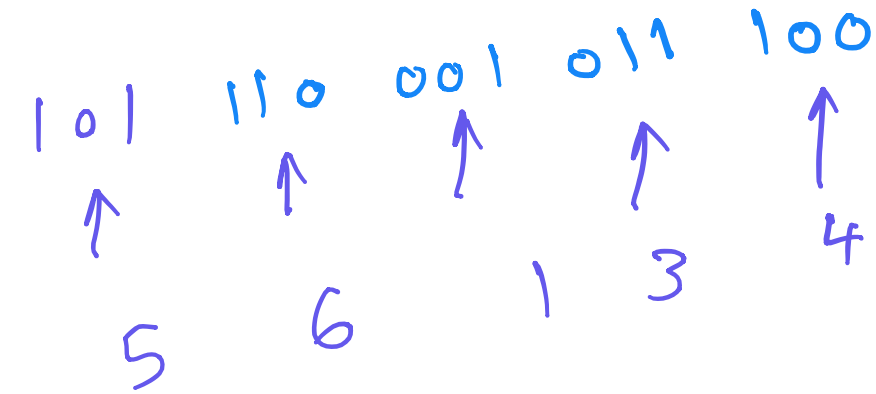
(5) The binary number (101110001011100) is equivalent to the octal number

(a) $(44632)_8$

(b) $(23644)_8$

(c) $(5757)_8$

(d) $(56134)_8$



(6) The Hexadecimal number (F4C2) is equivalent to the Binary number:

(a) $(1010101000101011)_2$

(b) $(1110001010100010)_2$

(c) $(0010101000101010)_2$

(d) $(1111010011000010)_2$

A	10
B	11
C	12
D	13
E	14
F	15

