

أوقات الدرس



ساعتين أسبوعيًا

الأربعاء

الاثنين

08:00



09:00

PM



OL Academy

ITCE250/112/114

Lesson (1)

مدرس المقرر



أسماء الطارش

Number Systems and Conversion



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66939059

Number Systems

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

Decimal

Base10

0-9

Binary

Base2

0,1

Octal

Base8

0-7

Hexadecimal

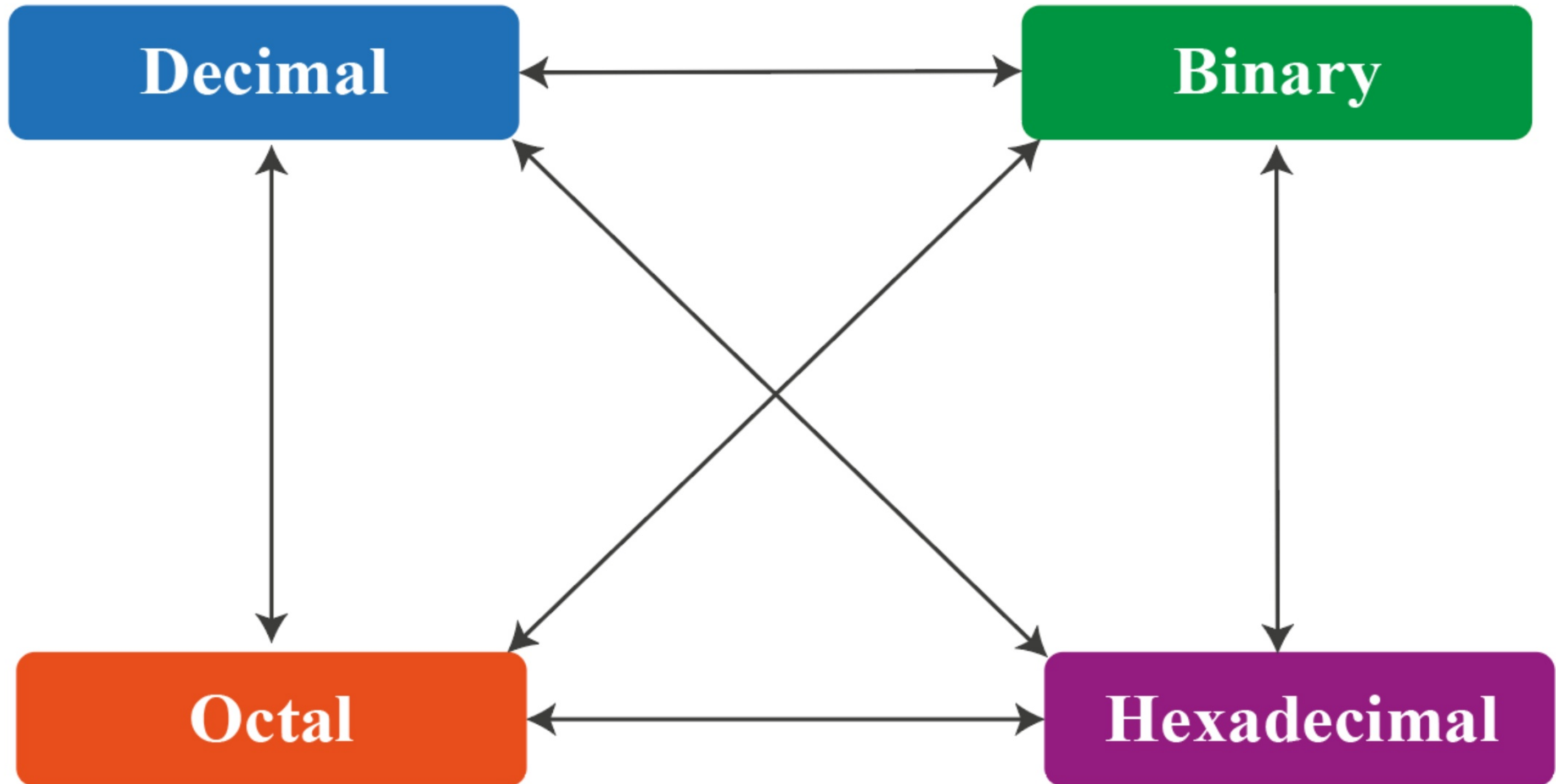
Base16

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

→ 15
→ 9 A B C D E F
for 10 11 12 13 14 15

Conversion Among Bases



Any Bases

baseⁿ
baseⁿ
binary
octal
hexadecimal

by using
Positional Notation

Decimal

multiply

Binary to Decimal

Octal to Decimal

Hexadecimal to Decimal

base
16

Multiply 2^n base

Multiply 8^n base

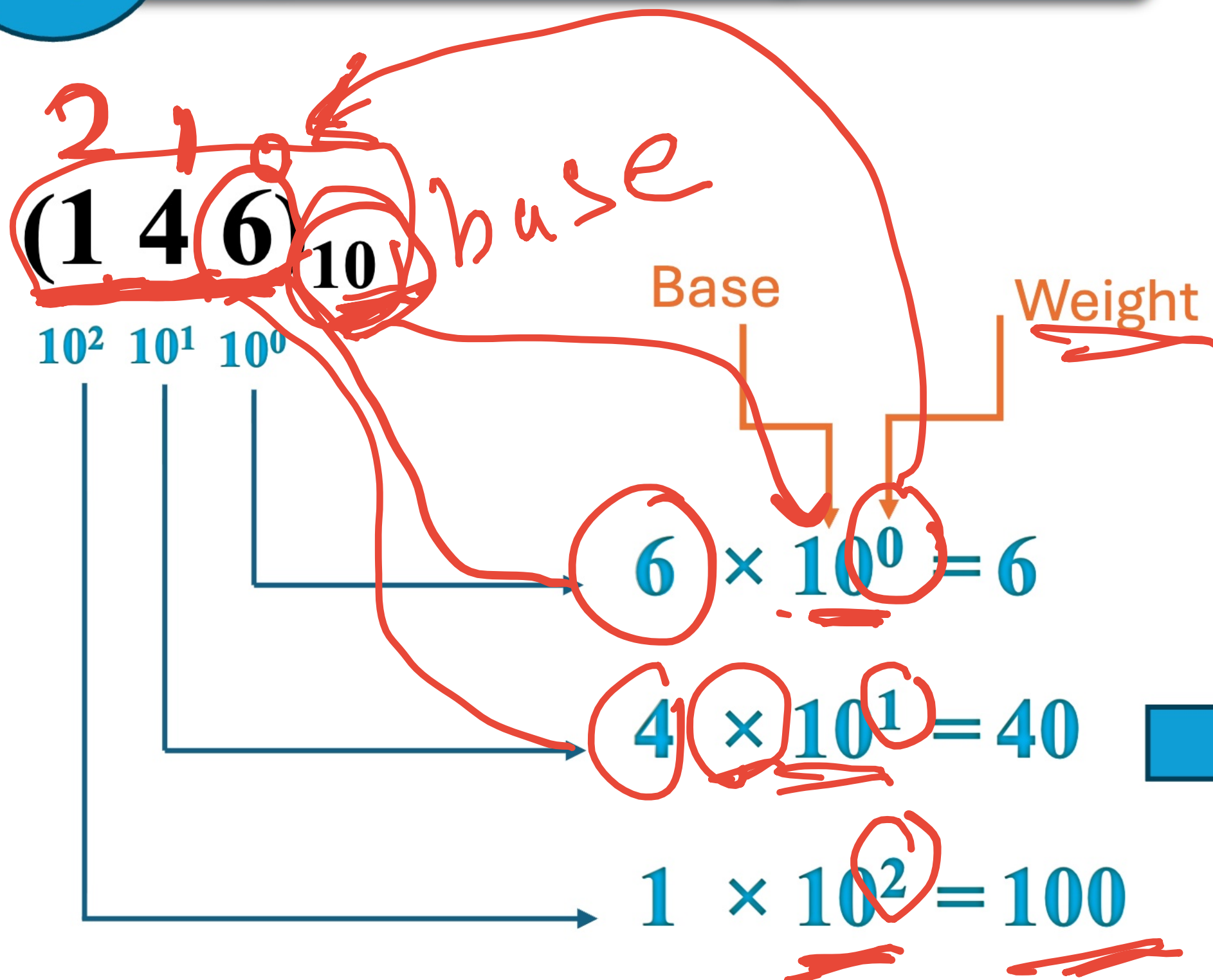
Multiply 16^n base

Where n is the "weight" of the bit

Base
10

Quick Example

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



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

$$6 + 40 + 100 = (1\ 4\ 6)_{10}$$

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

multiply by the base

(6) 5 4 3 2 1 0 -1 -2 -3 base

(1 1 0 1 0 1 0 . 1 0 1)₂ → ()₁₀

$$1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 + 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3}$$

$$= (106.625)_{10}$$

Base
8

Octal to Decimal

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

Multiply each bit by 8^n

$(75.34)_8 \longrightarrow (\quad)_{10}$

$$7 \times 8^1 + 5 \times 8^0 + 3 \times 8^{-1} + 4 \times 8^{-2}$$

$$= 61.4375$$

Base
16

Hexadecimal to Decimal

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

Multiply each bit by 16^n

$$\overset{1}{1} \overset{0}{0} \overset{-1}{.} \overset{-2}{1} \overset{-2}{3} \text{ (A2.13)}_{16} \longrightarrow (\quad)_{10}$$

$$\begin{aligned} & \textcircled{A} \times 16^1 + 2 \times 16^0 + 1 \times 16^{-1} + 3 \times 16^{-2} \\ & = 10 \times 16^1 + 2 \times 16^0 + 1 \times 16^{-1} + 3 \times 16^{-2} \end{aligned}$$

$$= 162.0742$$

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

Base

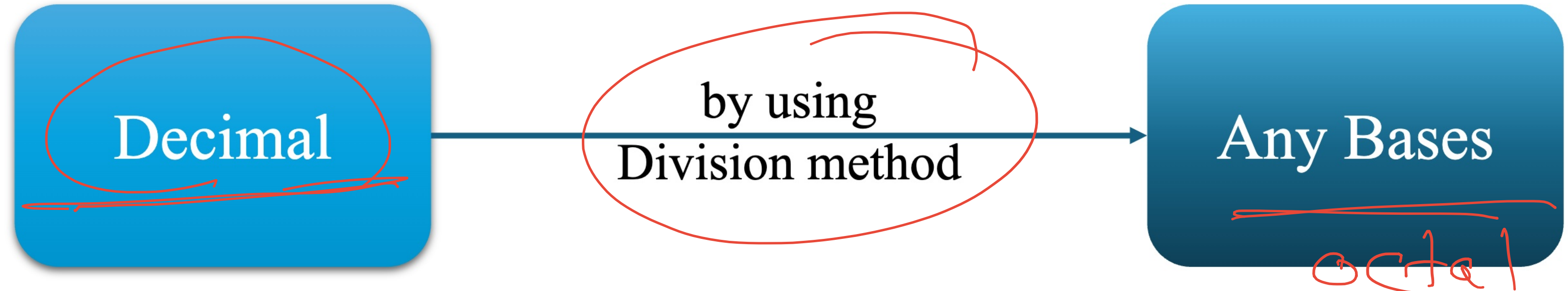
5

Base 5 to Decimal

$$\overset{210}{(323)}_5 \longrightarrow (\quad)_{10}$$

$$= 3 \times 5^2 + 2 \times 5^1 + 3 \times 5^0$$

$$= (88)_{10}$$



octal

hexadecimal

Decimal to Binary

base 2

Decimal to Octal

base 8

Decimal to Hexadecimal

base 16

Divide by 2

base

Divide by 8

Divide by 16

Base

2

Decimal to Binary

Divide by 2

$$(21)_{10} \longrightarrow (10101)_2^{\text{base}}$$

$$\begin{array}{r|l} 2 & 21 \\ \hline 10 & 2 \\ 5 & 2 \\ 2 & 2 \\ 1 & 2 \\ 0 & \end{array}$$

Reminder

1
0
1
0
1

resy 1x

64	32	16	8	4	2	1

Base
2

Decimal to Binary

Divide by 2

$$(15.7)_{10} \longrightarrow (1111.10110)_2$$

$$\begin{array}{r|l} 15 & 2 \\ 7 & 2 \\ 3 & 2 \\ 1 & 2 \\ 0 & \end{array}$$

Remainder
1
1
1
1
0

$$\begin{array}{r} 0.7 \\ \times 2 \\ \hline 1.4 \\ \hline 0.4 \\ \times 2 \\ \hline 0.8 \\ \hline 0.8 \\ \times 2 \\ \hline 1.6 \\ \hline 0.6 \\ \times 2 \\ \hline 1.2 \\ \hline 0.2 \\ \times 2 \\ \hline 0.4 \\ \hline \end{array}$$

1.0

Base

2

Decimal to Binary

Divide by 2

$$(0.625)_{10} \longrightarrow (0.101)_2$$

Handwritten conversion steps for 0.625_{10} to binary:

- $0.625 \times 2 = 1.25$ (The integer part 1 is circled in green.)
- $0.25 \times 2 = 0.5$ (The integer part 0 is circled in red.)
- $0.5 \times 2 = 1.0$ (The integer part 1 is circled in red.)

Red arrows indicate the sequence of decimal parts: $0.625 \rightarrow 0.25 \rightarrow 0.5$. A green circle highlights the first '1' and the final '0.25' is crossed out with a green X.

Base
8

Decimal to Octal

Divide by 8

(61)₁₀



)₈

61 | 8
7 | 8
0

5 |
7

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

0
8 7
5
7

Base
16

Decimal to Hexadecimal

divide by 16

$(590)_{10} \longrightarrow (24E)_{16}$

Handwritten division of 590 by 16:

590	16
36	16
2	16
0	

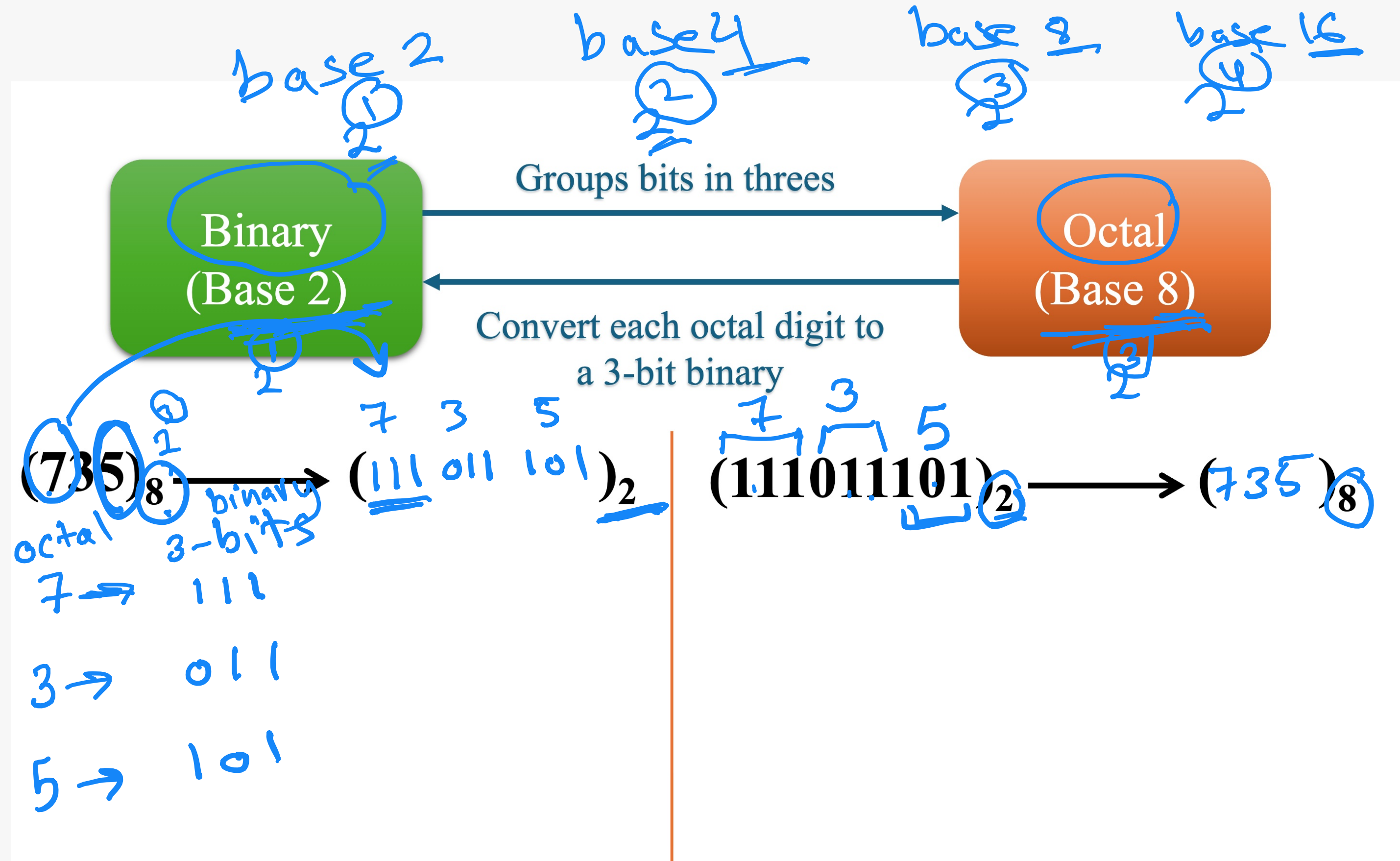
Handwritten remainder calculation:

Reminder

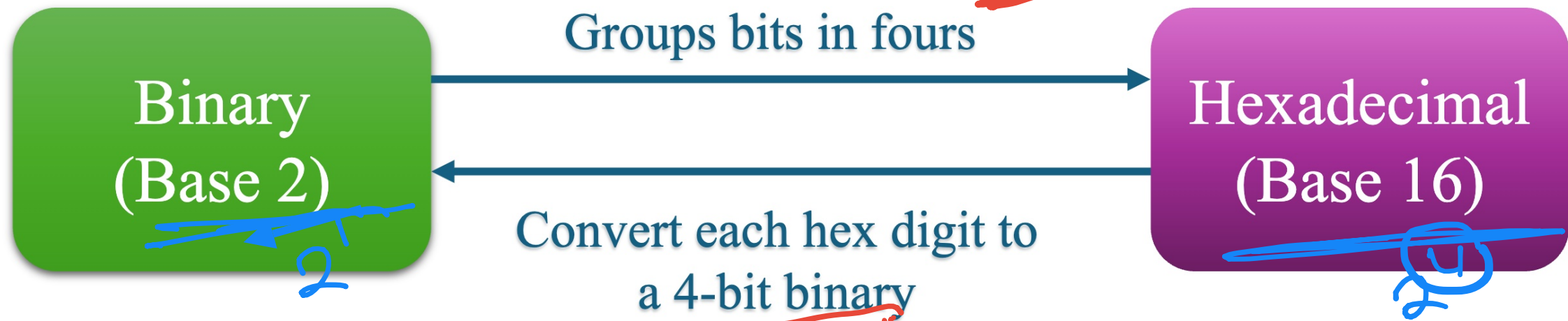
14
4
2

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

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

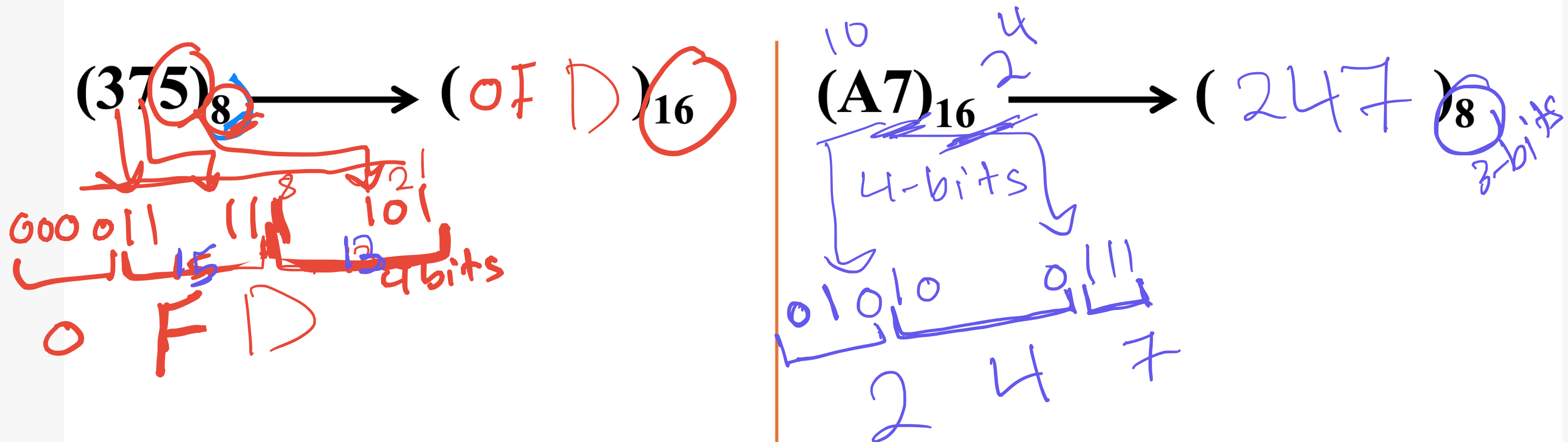
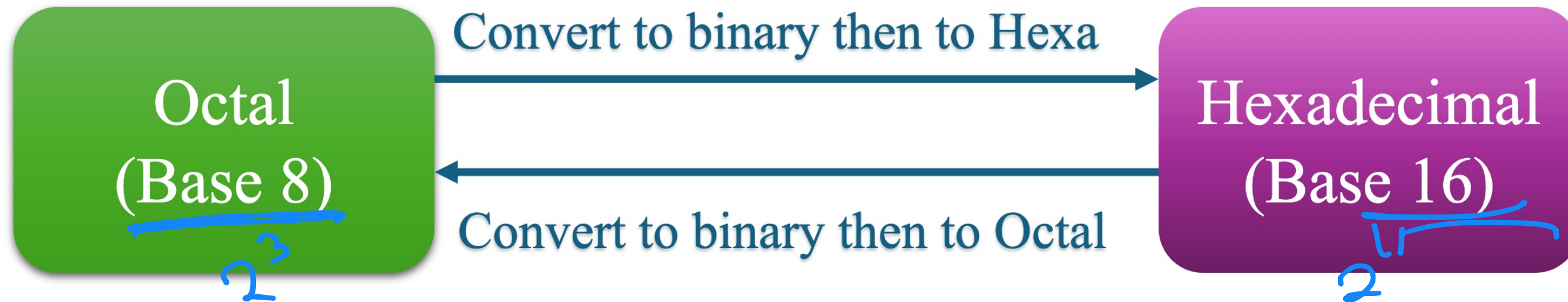


8 4 2 1
 1 0 1 0
 10
 A B C D E F



$(01001101)_2 \rightarrow (4D)_{16}$

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



$$\overset{2}{\underset{\cdot}{(6)}}\overset{1}{\underset{\cdot}{4}}\overset{0}{\underset{\cdot}{2}}\underset{7}{)} \longrightarrow (144)_{16}$$

2 steps

① convert from base 7 to decimal by multiply by 7

$$(\overset{2}{\underset{\cdot}{6}}\overset{1}{\underset{\cdot}{4}}\overset{0}{\underset{\cdot}{2}})_{\underline{\underline{7}}} \rightarrow (\quad)_{10}$$

$$6 \times 7^2 + 4 \times 7^1 + 2 \times 7^0 = (324)_{10}$$

② convert from decimal to base 16 by division

$$(324)_{10} = (\underline{\underline{144}})_{16}$$

Reminder

$$\begin{array}{r|l} 324 & 16 \\ 20 & 16 \\ 1 & 16 \\ 0 & \end{array}$$

$$\begin{array}{c} 4 \\ 4 \\ 1 \end{array} \uparrow$$