OL Academy

CSC103

Lesson (1)

Numbering Systems

أوقات الدرس

ساعتين أسبوعيًا

الاثنين الأربعاء

08:00
09:00 PM

حضوريًا عن بعد
خصوصي

مدرس المقرر

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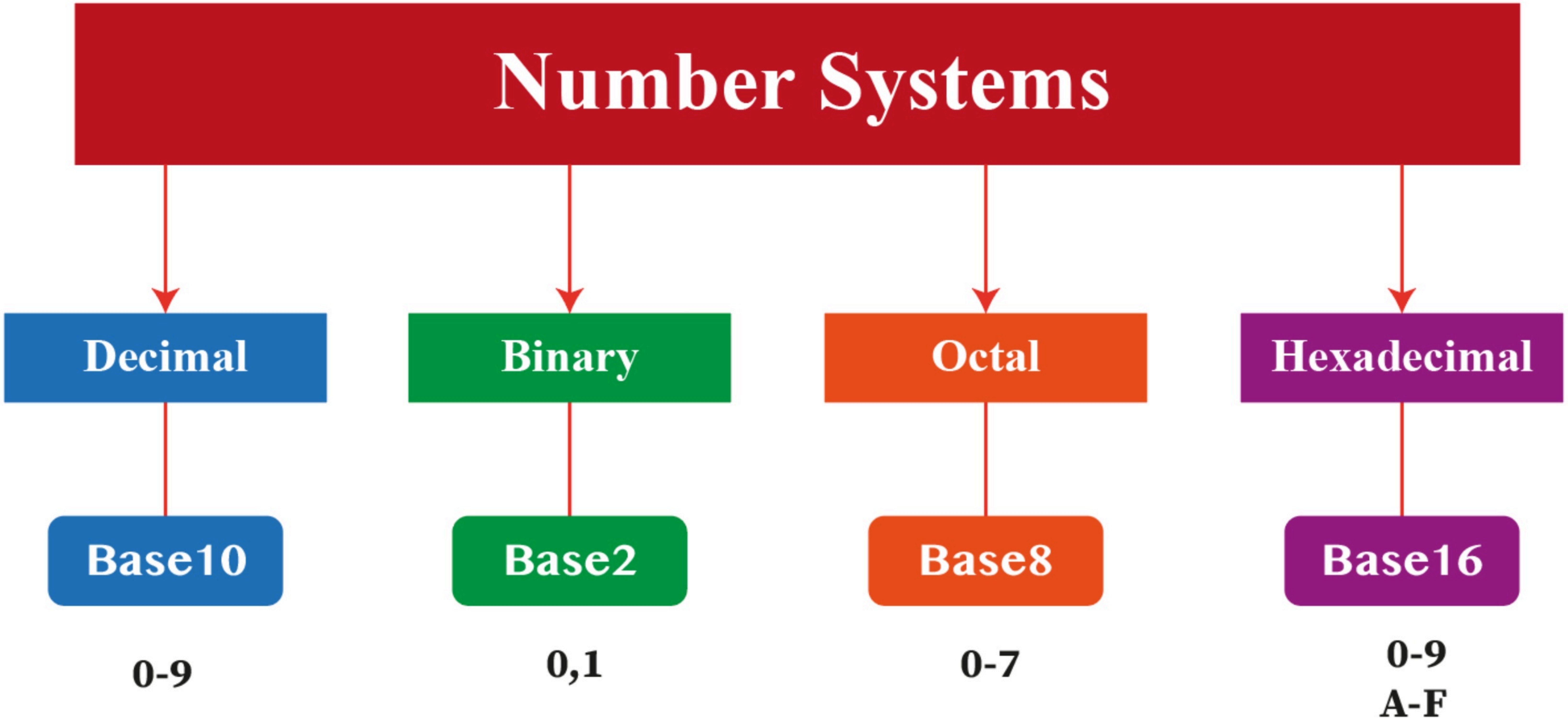
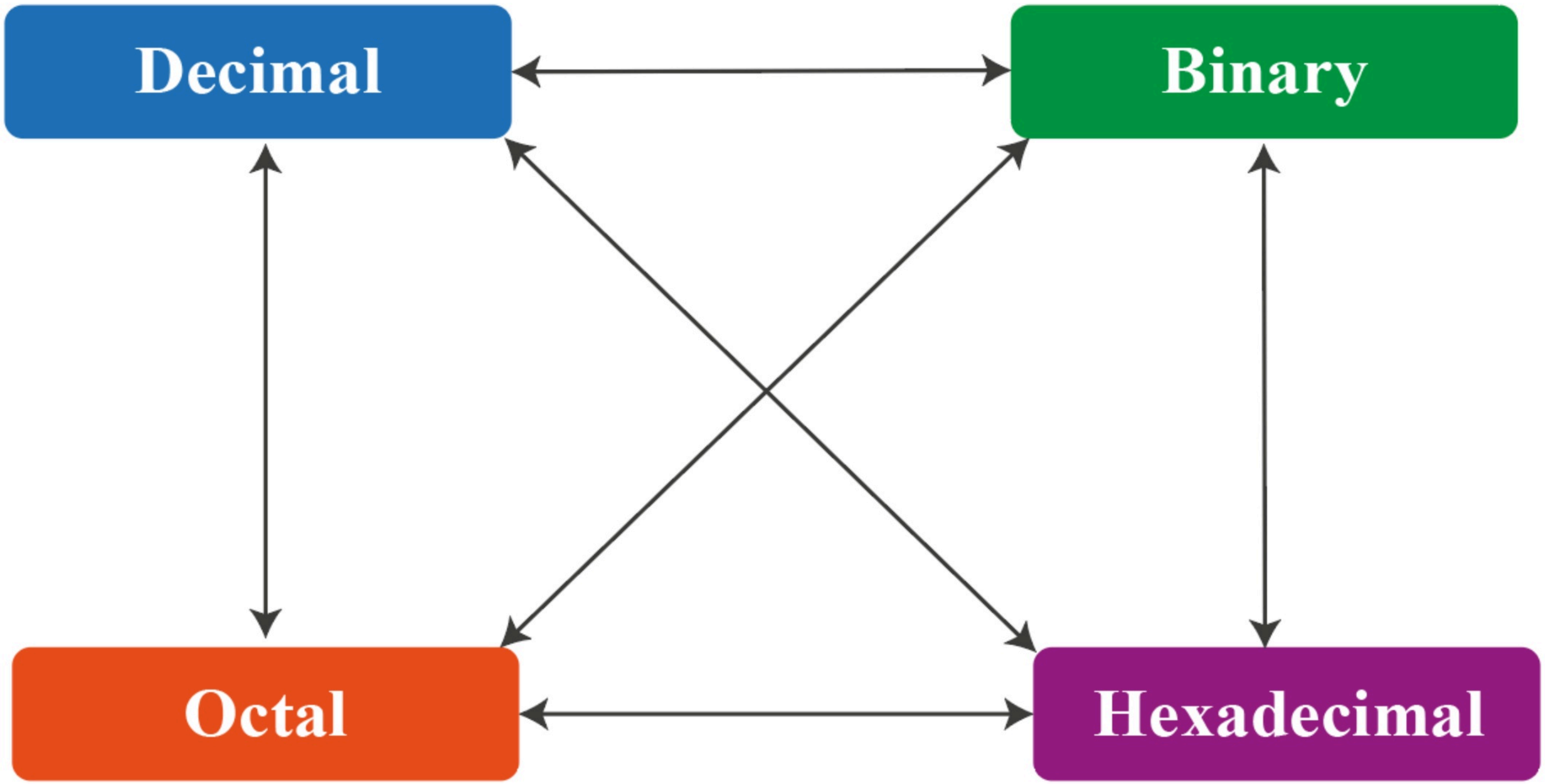

Number Systems
Decimal
Binary
Octal
Hexadecimal
Base10
Base2
Base8
Base16
0-9
0,1
0-7
0-9
A-F

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

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

	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



Any Bases $\xrightarrow[\text{Positional Notation}]{\text{by using}}$ Decimal

2^{3} 2^{2} 2^{1} 2^{0}

Binary to Decimal — Multiply 2^n

Octal to Decimal — Multiply 8^n

Hexadecimal to Decimal — 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

$6 \times 10^0 = 6$

$4 \times 10^1 = 40$

$1 \times 10^2 = 100$

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

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

$$(1\ 1\ \cancel{0}\ 1\ \cancel{0}\ 1\ \cancel{0})_2 \longrightarrow (\ 106\ )_{10}$$

$2^6 \quad 2^5 \quad 2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0$

$1 \times 2^1 = 2$

$1 \times 2^3 = 8$

$1 \times 2^5 = 32$

$1 \times 2^6 = 64$

$\Rightarrow 2 + 8 + 32 + 64$

$= (106)_{10}$

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

64 32 16 8 4 2 1

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

$64 + 32 + 8 + 2 = 106$

Binary to Decimal

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

$(77)_{10}$

Base 8

Octal to Decimal

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

Multiply each bit by 8^n

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

$8^1 \quad 8^0$

$5 \times 8^0 = 5$

$7 \times 8^1 = 56$

$\Rightarrow 5 + 56 = 61$

..TRY..

Octal to Decimal

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

$(468)_{10}$

Base 16

Hexadecimal to Decimal

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

Multiply each bit by 16^n

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

$16^1 \quad 16^0$

$2 \times 16^0 = 2$

$10 \times 16^1 = 160$

$(162)_{10}$

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

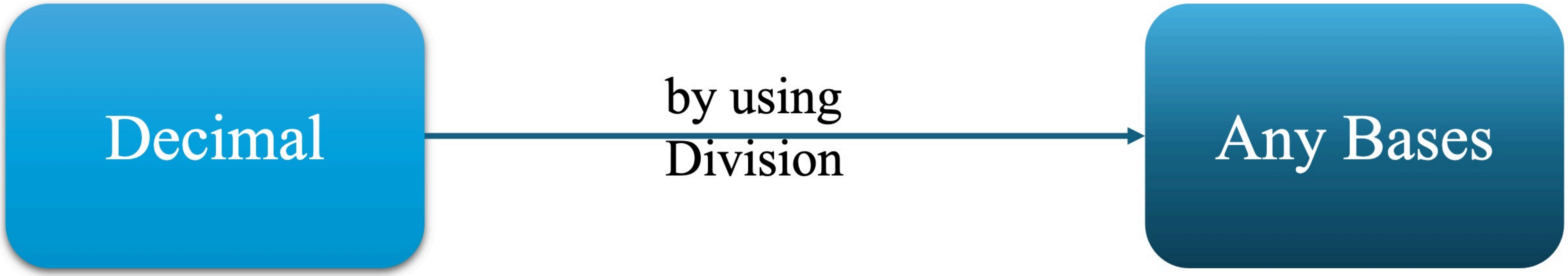
..TRY.. Hexadecimal to Decimal

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

10 11 12

16^2 16^1 16^0

$(2748)_{10}$



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

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

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

..TRY..

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

$(1101)_2$

Base
8

Decimal to Octal

Divide by 8

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

$$(4\ 6\ 5)_{10} \longrightarrow (\ 721\ )_8$$

465	8
58	8
7	8

58	1
7	2
0	7

$$8 \overline{)\,7\,}\quad 0$$

0

7

Decimal to Octal

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

$(2764)_8$

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

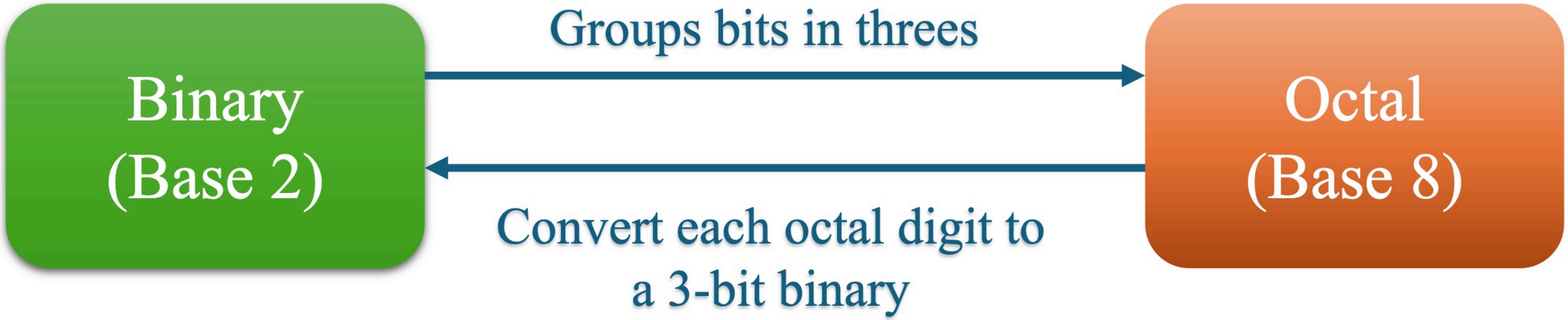
10	A
11	B
12	C
13	D
14	E
15	F

..TRY..

Decimal to Hexadecimal

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

$(6C)_{16}$



$$(735)_8 \longrightarrow (\ 111011101\ )_2$$

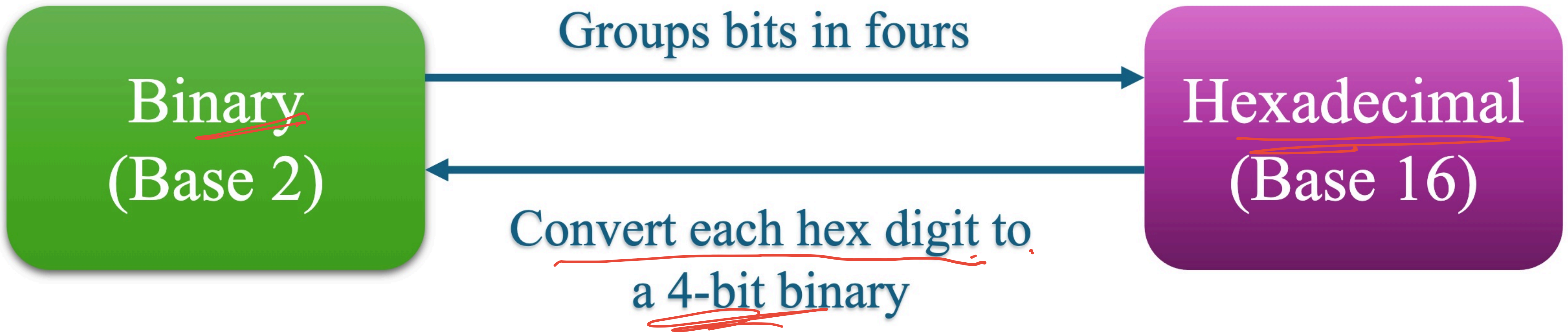
111 011 101

$$(\overset{7}{\boxed{111}}\overset{3}{\boxed{011}}\overset{5}{\boxed{101}})_2 \longrightarrow (\ 735\ )_8$$

$$\begin{array}{ccc} 4 & 2 & 1 \\ 1 & 0 & 1 \end{array} \rightarrow 5$$

$$011 \rightarrow 3$$

$$111 \rightarrow 7$$



$$(0100\overset{D}{\boxed{1101}})_2 \longrightarrow (\ 4D\ )_{16}$$

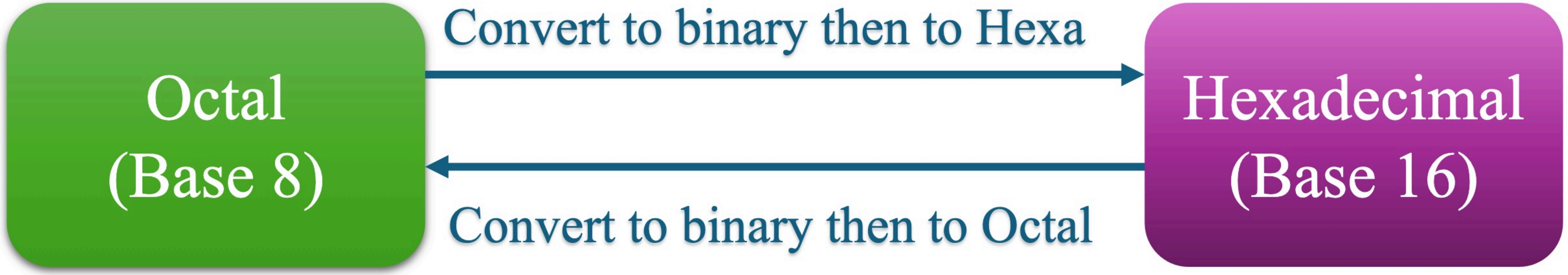
4

8 4 2 1
1101 → D

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

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

8 4 2 1
7 → 0111
A → 1010



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

① Convert to Binary

3 7 5

011 111 101

8 4 2 1

② 0 11 111 1 101

FD

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

A 7 → to binary

010 100 111

2 4 7

Binary Addition

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

8 4 2 1
0 0 1 0

2

```
 1 1 1
  1 1 0 1
+ 1 0 1 1
----------
1 1 0 0 0
```

13
+
11
~~24~~

8 4 2 1
1 1 0 1

1 0 1 1

16 8 4 2 1
1 1 0 0 0

= 24

Binary Addition

```
  1 1 1
  1 0 1 1
+   1 1 1
---------
1 0 0 1 0
```

```
  1 0 1 1
  1 0 1 1
+ 1 1 1 1
---------
```

..TRY..

$(100101)_2$

Binary Multiplication

0	×	0	=	0
0	×	1	=	0
1	×	0	=	0
1	×	1	=	1

$$
\begin{array}{r}
111 \\
\times\; 101 \\
\hline
111 \\
1\;\;1\;\;\;\;\;\; \\
10000 \\
11100 \;+ \\
\hline
100011
\end{array}
$$

Binary Multiplication

8 4 2 1

1 1 1 1 15

1 0 × 2

---

0 0 0 0

1 1 1 1 0 +

---

1 1 1 1 0

16 8 4 2 1

1 1 1 1 0 = 30

1 0 1 1 1 0

1 0 1 ×

$(11100110)_2$

Chapter 1 | Number System – Exam Questions

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

(a) $(29)_{10}$ (b) $(37)_{10}$

(c) $(44)_{10}$ (d) $(49)_{10}$

$(4\ 5)_8$

32 16 8
1 0 0

4 2 1
1 0 1

$32 + 4 + 1 = 37$

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

(a) $(111000011)_2$ (b) $(101000111)_2$

(c) $(011100000011)_2$ (d) $(11111110111)_2$

$(7\ 0\ 3)_8$

111 000 011

C B A

(3) The number $(110010111010)_2$ 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:

$$\begin{array}{r} 1011 \\ \times\ 111 \\ \hline 1011 \\ 10110 \\ +\ 101100 \\ \hline 1001101 \end{array}$$

(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) $(56134)_8$

101 110 001 011 100

5 6 1 3 4

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

(a) $(1010101000101011)_2$ (b) $(1110001010100010)_2$

(c) $(0010101000101010)_2$ (d) $(1111010011000010)_2$

F 4 C 2

F 4 C 2

1111 0100 1100 0010

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