Number Systems Operation:-

1- Decimal Numbers.

2- Binary Numbers.

3- Octal Numbers.

4- Hexadecimal Numbers.

 1. ***Decimal Numbers***: - In the decimal number system each of the ten digits (10digits), 0 through 9 (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9).

Decimal weight … …10^4 10^3 10^2 10^1 10^0. 10^{-1} 10^{-2} 10^{-3} ….

Example (1): $(345)_{10}$

$$300+40+5=10^2*3+10^1*4+10^0*5=345=(345)_{10}$$

$$\downarrow \qquad \downarrow \quad \downarrow$$
$$3 \qquad 4 \quad\ 5$$

Example (2): $(234)_{10}$

$$200+30+4=10^2*2+10^1*3+10^0*4=234=(234)_{10}$$

$$\downarrow \qquad \downarrow \ \downarrow$$
$$2 \qquad 3 \ \ 4$$

Example (3): $23.5 = (23.5)_{10}$

$$10^1*2 + 10^0*3 +10^{-1}*5 = 20+3+0.5=23.5$$

Where $10^0 =1$

Example (4): $45.5 = (45.5)_{10}$

$$10^1*4 + 10^0*5 +10^{-1}*5 = 40+4+0.5=45.5$$

2- Binary Numbers: The binary number system its two digits a base-two system. The two binary digits (bits) are 1 and 0 (1, 0).

Binary weight   …. 2^3 2^2 2^1 2^0

Weight value   … **8 4 2 1**

 where $2^0 =1$

EX:

(1 1 0 1 1)2

A- Binary – to – Decimal Conversion:

Example:

Convert Binary number$(1101101)_2$ into Decimal

(1 1 0 1 1 0 1)

 2^6 2^5 2^4 2^3 2^2 2^1 2^0 = $2^6*1+ 2^5*1 + 2^4*0+ 2^3*1+ 2^2*1+ 2^1*0+ 2^0*1$

$=\ $ 64*1+ 32*1+ 16*0 + 8*1 +4*1+2*0 + 1*1

=64+32+0+8+4+0+1 ➡ $(109)_{10}$

   $(1101101)_2$ ➡ $(109)_{10}$

Example (6):
Convert (1001)$_2$ into Decimal number
(1 0 0 1)2 Into ( )$_{10}$
2^3 2^2 2^1 2^0 $= 2^3*1 + 2^2*0 + 2^1*0 + 2^0*1$
$$= 8*1 + 4*0 + 2*0 + 1*1$$
$$= 8+0+0+1 \rightarrow (9)_{10}$$

ملاحظة : توضع الاوزان(weight) من اليمين الى اليسار

*The Fractional binary number(0.1011)$_2$

ملاحظة : توضع الاوزان في حالة الكسر من اليسار الى اليمن

Example (7) :
Convert (1.1011)$_2$ to Decimal number
1 . 1 0 1 1

$2 . 2^{-1}$ 2^{-2} 2^{-3} 2^{-4} $= 1*2 . 1*2^{-1} + 0*2^{-2} + 1*2^{-3} + 1*2^{-4}$
$$= 1 . 0.5 + 0 + 0.125 + 0.0625 \rightarrow (1.6875)_{10}$$

Example (8):
Convert (0.1100)2 to Decimal number
(0. 1 1 0 0)

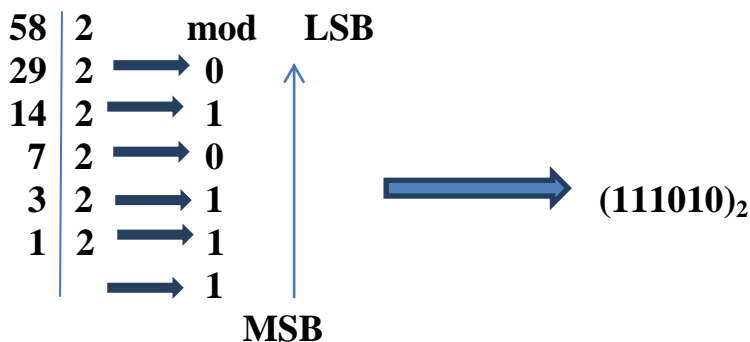$2 . 2^{-1}$ 2^{-2} 2^{-3} 2^{-4} $= 0*2 . 1*2^{-1} + 1*2^{-2} + 0*2^{-3} + 0*2^{-4}$
$$= 0. 0.5 + 0.125 + 0 + 0 \rightarrow (0.625)_{10}$$

B- Decimal – to – Binary Conversion:

1- Convert a decimal whole number to binary using the repeated
   division – by – 2
2- Convert a decimal fraction to binary using the repeated
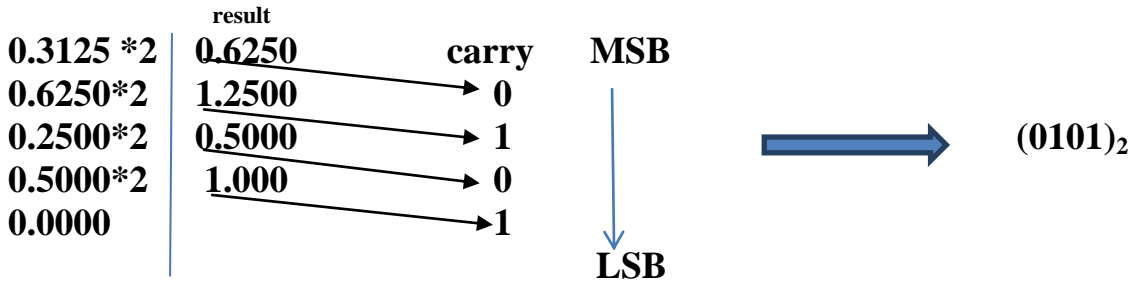   Multiplication – by – 2 .

Example:
Convert the number (58)$_{10}$ to Binary ( )$_2$

58	2	mod	LSB
29	2	0	
14	2	1	
7	2	0	
3	2	1	→ (111010)$_2$
1	2	1	
		1	

MSB

ملاحظة : يكتب الرقم النهائي من الاسفل الى الاعلى ومن اليسار الى اليمين
عندما يكون الرقم الناتج من القسمة اصغر من رقم الاساس نتوقف

Example:

Convert the number (0.3125)$_{10}$ to Binary (   )$_2$

result

|		carry	**MSB**
0.3125 *2	**0.6250**		
0.6250*2	**1.2500**	→ 0	
0.2500*2	**0.5000**	→ 1	
0.5000*2	**1.000**	→ 0	
0.0000		→ 1	

(0101)$_2$

LSB

ملاحظة : عدما نصل الى الصفر اي يكون الرفم بعد النقطة العشرية كله صفر نتوقف اما في حالة تكرار عملية الضرب لمرات كثيره الا ان نصل الى الصفر ففي هذه الحالة نحدد عدد الارقام بعد الفاصلة العشريه مثلا خمسة مراتب بعد الفاصلة اي نقوم بعملية الضرب لخمسة مرات ونتوقف
ملاحظة : في حالة الرقم العشري يكتب الرقم النهائي من الاعلى الى الاسفل ومن اليسار والى اليمين
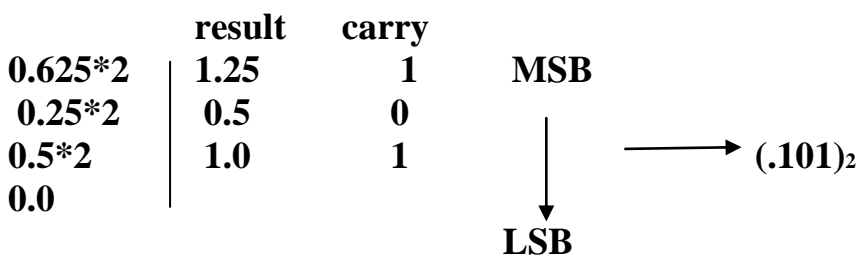
Example;

Convert (20 . 625) 10 to (   )$_2$

في حالة ان الرقم يحتوي على جزء صحيح وجزء كسري نقوم بالتالي
١ـ ناخذ الجزء الصحيح ونجري عليه عملية القسمة على ٢ كالاتي

		mod	**LSB**
20	2		
10	2	→ 0	
5	2	→ 0	
2	2	→ 1	
1	2	→ 0	
		→ 1	

(10100)$_2$

MSB
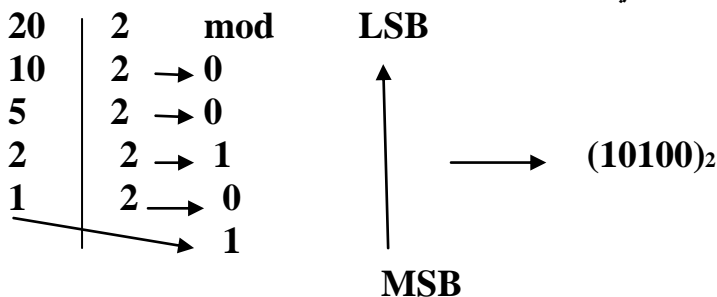
٢ـ ثم ناخذ الجزء الكسري ونجري عليه عملية الضر ب

	result	carry	
0.625*2	1.25	1	**MSB**
0.25*2	0.5	0	
0.5*2	1.0	1	
0.0			

(.101)$_2$

LSB

ثم نقوم بدمج الرقمين الثنائين (10100.101)

(20.625)$_{10}$ ⟶ (10100. 101)$_2$

3- Octal Numbers: The octal number system is composed of eight digits, which are
0, 1, 2, 3, 4, 5, 6, and 7.

A- Octal – to – Decimal conversion:

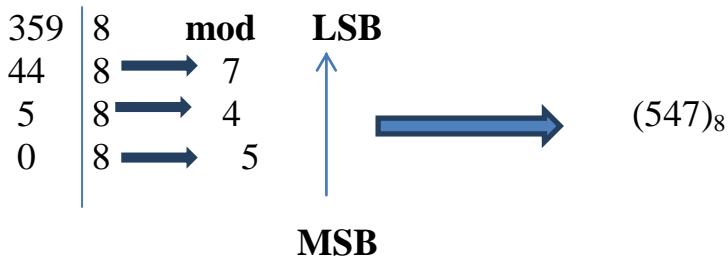Weight   … … 8^3 8^2 8^1 8^0

Ex:

(6 7 5)$_8$

Example (11):

Convert Octal number(2374)$_8$ to Decimal number ( )$_{10}$

$(2374)_8 = 8^3 * 2 + 8^2 * 3 + 8^1 * 7 + * 8^0 * 4$

$= 512*2 + 46*3 + 8*7 + 1*4$

$= 1024 + 192 + 56 + 4$

$= (1276)_{10}$

B- Decimal – to – Octal Conversion:

Example (12):

Convert decimal number $(359)_{10}$ to Octal number ( )$_8$

```
359 | 8     mod    LSB
 44 | 8 ➜    7      ↑
  5 | 8 ➜    4            ➜       (547)₈
  0 | 8 ➜    5
                   MSB
```

Convert decimal number $(87)_{10}$ to Octal number ( )$_8$

```
87 | 8     mod    LSB
10 | 8 ➜    7      ↑
 1 | 8 ➜    2            ➜       (127)₈
            1
                  MSB
```
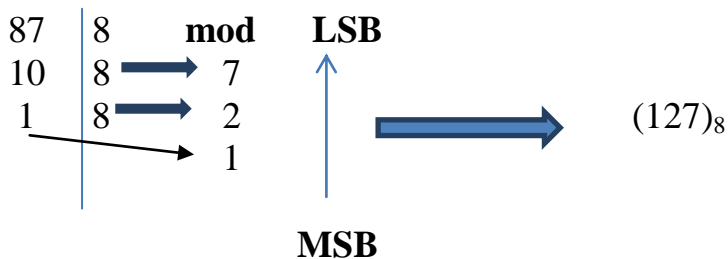
Ex: Convert decimal number $(39. 125)_{10}$ to Octal number ( )$_8$

```
39 | 8     mod    LSB                      result    carry   M SB
 4 | 8 ➜    7      ↑              0.125*8 |  1.0    |   1      ↓
            4            ➜  (47)₈   0.0   |  STOP   |          LSB
                  MSB
```

SO $(0.125)_{10}$ ⟶ $(. 1)_8$
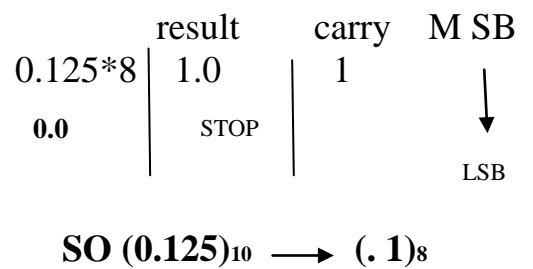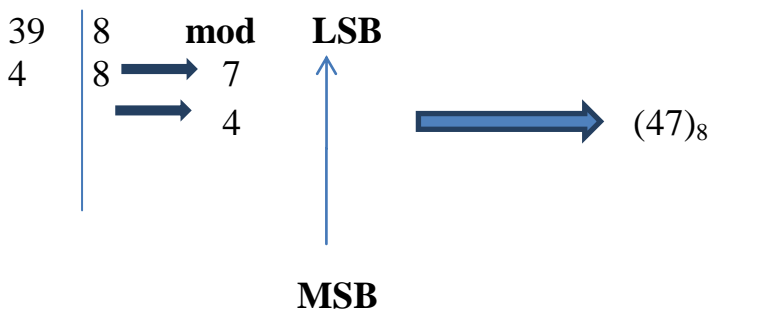
ندمج الجزئين $(47.1)_8$

$(93.125)_{10}$ ⟶ $(47.1)_8$

C- Octal – to – Binary Conversion:

Octal digit can be represented by a 3-bit binary number.

Octal digit binary

0	1	2	3	4	5	6	7
↓	↓	↓	↓	↓	↓	↓	↓

000 001 010 011 100 101 110 111

Example

Convert $(25)_8$ to ( )$_2$

$(25)_8$
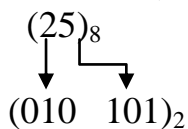
$(010 \quad 101)_2$

Example

Convert $(140)_8$ to ( )$_2$

$(1 \quad 4 \quad 0)_8$

$(001\ 100\ 000)_2$
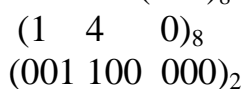
example:

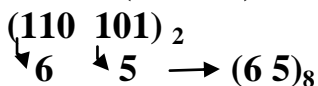**convert $(43 . 6)_8$ into ( )$_2$**
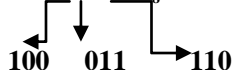
100   011   110

$(43.6)_8 \longrightarrow (100011 .110)_2$

D- Binary – to – Octal Conversion:

Conversion binary number to octal number is start with right – most groups of three bits and moving from right to left.

Example

Convert $(110101)_2$ to ( )$_8$

$(110\ 101)_2$

6   5 $\longrightarrow (6\ 5)_8$

Examples

Convert $(101111001)_2$ to ( )$_8$

$(101\ 111\ 001)_2$

5   7   1 $\longrightarrow (571)_8$
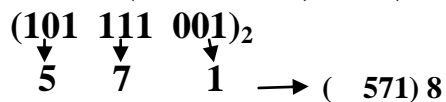
example

Convert $(11011.1101)_2$ to ( )$_8$

(011 011 . 110   100)

(3   3 . 6   4) $\longrightarrow (33.64)_8$

4- Hexadecimal Numbers: The hexadecimal number system has a base of sixteen; it is composed of 16 digits and alphabetic characters.

Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

A- Binary – to – Hexadecimal conversion:
4-bit groups, starting at the right-most bit.

Example
Convert $(1100101001010111)_2$ to (   )$_{16}$

1100   1010   0101   0111

** C   A   5   7**
$(1100101001010111)_2$ ======(CA57)$_{16}$

Example:
Convert $(11010110111)_2$ to (   )$_{16}$
        (0110 1011 0111)$_2$

        (6   B   7) →(6B7)$_{16}$

 Example:
Convert (110110. 110)$_2$ to (   )$_{16}$
(0011 0110 . 1100) 2

(3   6 . C) ⟶ (36C)$_{16}$

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B- Hexadecimal – to – Binary Conversion:
Example (18):
Convert $(10A4)_{16}$ to ( )$_2$

1	0	A	4
0001	0000	1010	0100

$(10A4)_{16}$========$(1000010100100)_2$

Ex.
Convert (12C. A5)$_{16}$ to ( )$_2$

1	2	C	. A	5
0001	0010	1100 .	0101	0101

$(12C.A5)_{16}$ $\longrightarrow$ $(000100101100.01010101)_2$

C- Hexadecimal – to –Decimal Conversion:By two method
* First method:
Example (19):

convert $(A85)_{16}$ to ( )$_{10}$

1- Convert to binary number.
2- Convert from binary number to decimal number.

A	8	5
1010	1000	0101 =

$2^{11}*1+2^{10}*0+2^9*1+2^8*0+2^7*1+2^6*0+2^5*0+2^4*0+2^3*0+2^2*1+2^1*0+2^0*1=$
$2^{11}+2^9+2^7+2^2+2^0=2048+512+128+4+1=2693= (2693)_{10}$
$(A85)_{16}$====$(2693)_{10}$

* Second method:
Example(20):
Covert (E5)$_{16}$ to ( )$_{10}$

$(E5)16=16^1*E+E16^0*5$
$\quad\quad 16*14+1*5 =224+5=229= (229)_{10}$
$(E5)_{16}$ =======$(229)_{10}$

D- Decimal – to – Hexadecimal Conversion:
Example(21) : Convert the decimal number 650 to hexadecimal by repeated division by 16.

650	16		**mod**	**LSB**
40	16	➡	10	
2	16	➡	8	$(28A)_{16}$
0		➡	2	
				MSB

$(650)_{10}$=====$(28A)_{16}$
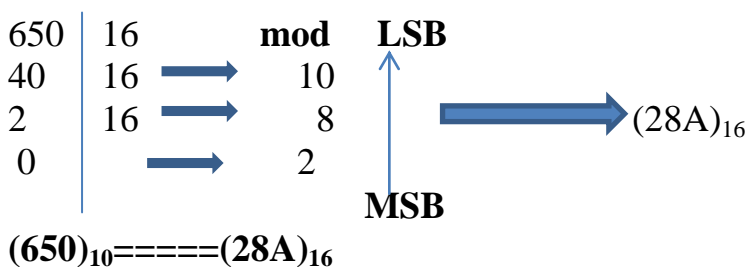
EX

convert (43.125)$_{10}$ into (   )$_{16}$

ناخذ اولا الجزء الصحيح

43	16		**mod**	**LSB**
2	16	→	11	
			2	

MSB

$(2B)_{16}$
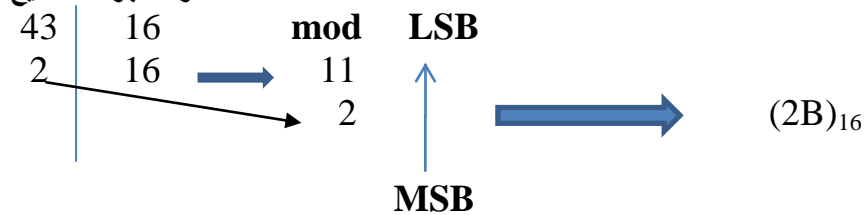
ثم ناخذ الجزء الكسري

	Result	**carry**	**MSB**
0.125 *16	**2.0**	**2**	↓
0.0	**stop**		**LSB**

ثم ندمج الجزئين   (2B.2)$_{16}$

(43.125)$_{10}$ →   (2B.2)$_{16}$

E- Octal to HexaDecimal

1- convert from Octal to Binary

2- convert from Binary to HexaDecimal

Ex:

Convert (753)$_8$ to (   )$_{16}$

1 –(7   5   3)$_8$

(111   101   011)$_2$

2-(0001 1110 1011)$_2$

(1   E   B) 16

(753)$_8$ →   (1EB)$_{16}$

F- HexaDecimal   to Octal

1-conert from Hexa to Binary

2- convert from Binary to Octal

Ex:

$(56A)_{16}$ into (   )$_8$

1- (5   6   A)$_{16}$

   (0101   0110   1010)$_2$

2- (010 101 101 010)$_2$

   (2   5   5   2)$_8$

$(56A)16$ $\longrightarrow$ $(2552)8$

H.W

1-$(1010111)_2$ TO   (   )$_{10}$

2-$(10100.101)_2$ TO   (   )$_{10}$

3-$(17)_{10}$ TO   (   )$_2$

4-$(155)_{10}$ TO   (   )$_2$

5-$(55.750)_{10}$ TO (   )$_2$

6- $(205)_8$ TO (   )$_{10}$

7-$(122.62)_8$ TO (   )$_{10}$

8-$(87)_{10}$ TO (   )$_8$

9-$(156)_{10}$ TO (   )$_8$

10-$(150)_8$ TO (   )$_2$

11$(235,740)_8$ TO (   )$_2$

12-$(1111011)_2$ to (   )$_8$

13-$(101110.11011)_2$ TO (   )$_8$

14-$(110110.110)_2$ TO (   )$_{16}$

15-$(11011101)_2$ TO (   )$_{16}$

16-$(153.B3)_{16}$ TO   (   )$_2$

17-$(2A11)_{16}$ TO   ( )$_2$

18-$(35)_{16}$ TO ( )$_{10}$

19- $(2C.43)_{16}$ TO   (   )$_{10}$

17-(680)₁₀ TO ( )₁₆

18-(72B)₁₆ TO ( )₈

19-(882.2A)₁₆ TO ( )₈

20-(202)₈ TO ( )₁₆

21-(115. 65)₈ TO ( )₁₆

المحاضرة الاولى

المرحلة الاولى

تقنيات الحاسبة

مدرسة المادة : وداد عبد الخضر