

# (النظم العددية) Numbering systems.

## 1] Decimal system.

- 10 digits (0 → 9)
- The base is 10

النظام العشري  
"عشري"  
العشرة 1.

## 2] Binary system.

- 2 digits (0, 1)
- The base is 2

النظام الثنائي (لغة المبرمج)

## 3] Octal system

- 8 digits (0 → 7)
- The base is 8

نظام الثماني

## 4] Hexadecimal system

- 16 digits (0 → 9, A → F)
- The base is 16

النظام السادس عشر

1010 :-

4 digits

4 bits

nibble

$\frac{1}{2}$  byte.

- \* 4 bits form a NIBBLE
- \* 8 bits form a byte
- \* 1 digit form a bit
- \* 2 bytes form a word
- \* 16 bits form a word

⇒ converting from decimal to any other system:-

$$\left( \quad \right)_{10} \longrightarrow \left( \quad \right)_{2, 8, 16}$$

□ From decimal to Binary:-

$$\square \left( 22 \right)_{10} = \left( \quad \right)_2$$

$22/2 \rightarrow 11$	$R = 0$	↑ The Remainder of 0 → LSB R of 1 R of 1 R of 0 R = 1 → MSB
$11/2 \rightarrow 5$	$R = 1$	
$5/2 \rightarrow 2$	$R = 1$	
$2/2 \rightarrow 1$	$R = 0$	
$1/2 \rightarrow 0$	$R = 1$	

$$(22)_{10} \rightarrow (10110)_2$$

الرقم في بقية الكاسوس

$$\square (13)_{10} \rightarrow \left( \quad \right)_2$$

$13/2 \rightarrow 6$	$R = 1$	↑
$6/2 \rightarrow 3$	$R = 0$	
$3/2 \rightarrow 1$	$R = 1$	
$1/2 \rightarrow 0$	$R = 1$	

$$(13)_{10} \rightarrow (1101)_2$$

$$\square (220)_{10} = \left( \quad \right)_2$$

$220/2 \rightarrow 110$	$R = 0$	↑ (11011100) 2
$110/2 \rightarrow 55$	$R = 0$	
$55/2 \rightarrow 27$	$R = 1$	
$27/2 \rightarrow 13$	$R = 1$	
$13/2 \rightarrow 6$	$R = 1$	
$6/2 \rightarrow 3$	$R = 0$	
$3/2 \rightarrow 1$	$R = 1$	
$1/2 \rightarrow 0$	$R = 1$	



$$\boxed{4} \quad (21)_{10} \rightarrow ( )_2$$

$$21/2 \rightarrow 10 \quad R=1$$

$$10/2 \rightarrow 5 \quad R=0$$

$$5/2 \rightarrow 2 \quad R=1$$

$$2/2 \rightarrow 1 \quad R=0$$

$$1/2 \rightarrow 0 \quad R=1$$

$$(21)_{10} \rightarrow (10101)_2$$

---

$$\boxed{5} \quad (15)_{10} \rightarrow (1111)_2$$

$$15/2 \rightarrow 7 \quad R=1$$

$$7/2 \rightarrow 3 \quad R=1$$

$$3/2 \rightarrow 1 \quad R=1$$

$$1/2 \rightarrow 0 \quad R=1$$

---

From Decimal to Octal :-

$$( )_{10} \rightarrow ( )_8$$

$$\boxed{II} \quad (39)_{10} \rightarrow (47)_8$$

$$39/8 \rightarrow 4 \quad R=7$$

$$4/8 \rightarrow 0 \quad R=4$$

طريقة الحل :  $\therefore \frac{39}{8} = 4.875$

$$0.875 \times 8 = 7$$

$$\frac{4}{8} = 0.5$$

$$0.5 \times 8 = 4$$

From Decimal to Hexadecimal :-

$$(39)_{10} \longrightarrow (27)_{16}$$

$$39/16 \longrightarrow 2 \quad R = 7$$

$$2/16 \longrightarrow 0 \quad R = 2$$

$$\text{Ans. } \frac{39}{16} = \overset{\text{Result}}{\underset{=}{2.4375}}$$

$$0.4375 \times 16 = 7$$

$$\frac{2}{16} = 0.125$$

$$0.125 \times 16 = 2$$



$$\Rightarrow (29)_{10} \longrightarrow (11101)_2$$

$$29/2 \rightarrow 14 \quad R = 1$$

$$14/2 \rightarrow 7 \quad R = 0$$

$$7/2 \rightarrow 3 \quad R = 1$$

$$3/2 \rightarrow 1 \quad R = 1$$

$$1/2 \rightarrow 0 \quad R = 1$$



$$\Rightarrow (29)_{10} \longrightarrow (35)_8$$

$$29/8 \rightarrow 3 \quad R = 5$$

$$3/8 \rightarrow 0 \quad R = 3$$

$$\Rightarrow (29)_{10} \longrightarrow (1D)_{16}$$

$$29/16 \rightarrow 1 \quad R = 13 \rightsquigarrow D$$

$$1/16 \rightarrow 0 \quad R = 1$$

$$\Rightarrow (29)_{10} \longrightarrow (104)_5$$

$$29/5 = 5 \longrightarrow R = 4$$

$$5/5 = 1 \longrightarrow R = 0$$

$$1/5 = 0 \longrightarrow R = 1$$

converting from any other system to decimal.

Rule  $\Rightarrow (453)_{10} = 4 \times 10^2 + 5 \times 10^1 + 3 \times 10^0 = 400 + 50 + 3 = 453$

$\Rightarrow$  Binary to Decimal:-

$(10110)_2 \rightarrow (22)_{10}$

$1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 16 + 0 + 4 + 2 + 0 = 22$

$(1010)_2 \rightarrow (10)_{10}$

$1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 8 + 2 = 10$

$(0010)_2 \rightarrow (2)_{10}$

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

$(101)_2 \rightarrow (5)_{10}$

$1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 4 + 0 + 1 = 5$

$\Rightarrow$  Octal to Decimal:-

$(47)_8 \rightarrow (39)_{10}$

$4 \times 8^1 + 7 \times 8^0 = 32 + 7 = 39$

$\Rightarrow$  Hexadecimal to decimal:-

$(27)_{16} \rightarrow (39)_{10}$

$2 \times 16^1 + 7 \times 16^0 = 32 + 7 = 39$



$$\Rightarrow (11101)_2 \longrightarrow ( \quad )_{10}$$

$$1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 16 + 8 + 4 + 0 + 1 = 29$$

$$\Rightarrow (35)_8 \longrightarrow ( \quad )_{10}$$

$$3 \times 8^1 + 5 \times 8^0 = 24 + 5 = 29$$

$$\Rightarrow (1D)_{16} \longrightarrow ( \quad )_{10}$$

$$1 \times 16^1 + 13 \times 16^0 = 16 + 13 = 29$$

$$\Rightarrow (104)_5 \longrightarrow ( \quad )_{10}$$

$$1 \times 5^2 + 0 \times 5^1 + 4 \times 5^0 = 25 + 0 + 4 = 29$$

⇒ Convert from Binary to other systems:-

### Binary to Octal

$$(100101010)_2 \longrightarrow (\quad)_8$$

الطريقة الأولى (الطريقة) بحول من Binary إلى Decimal ثم إلى ثمانية:

$$1 \times 2^8 + 0 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 =$$
$$256 + 0 + 0 + 32 + 0 + 8 + 0 + 2 + 0 = 298$$

$$(298)_{10} \longrightarrow (452)_8$$

$$298/8 \rightarrow 37 \quad R=2$$

$$37/8 \rightarrow 4 \quad R=5$$

$$4/8 \rightarrow 0 \quad R=4$$

الطريقة الثانية (الطريقة) بقسم لنظام ثلثيات

$$(100 \quad 101 \quad 010) \Rightarrow (452)_8$$
$$1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0 = 4$$
$$1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 5$$
$$0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 2$$



# Binary to Hexadecimal :-

$$\underline{10010101}_2 = (95)_h$$

$$1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 8 + 0 + 0 + 1 = 9$$

$$0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 0 + 4 + 0 + 1 = 5$$

$$(11101)_2 \longrightarrow (35)_8$$

$$011 \quad 101$$

$$0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 35$$

$$(0111011110111)_2 \longrightarrow (75757)_8$$

$$00 \overset{8421}{(11101)}_2 \longrightarrow (1D)_{16}$$

$$(11100011)_2 \longrightarrow (E3)_{16}$$

## Binary to any other systems:

$$\left( \overset{4}{1} \overset{3}{1} \overset{2}{1} \overset{1}{0} \overset{0}{1} \right)_2 \longrightarrow \left( \quad \quad \quad \right)_5$$

$$1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 16 + 8 + 4 + 0 + 1 = 29$$

$$\left( 29 \right)_{10} \longrightarrow \left( 104 \right)_5$$

$$29/5 \rightarrow 5 \quad R = 4$$

$$5/5 \rightarrow 1 \quad R = 0$$

$$1/5 \rightarrow 0 \quad R = 1$$



حل سؤال :-

1)  $(35)_{10} \rightarrow (100011)_2$

$$\begin{array}{l} 35/2 \rightarrow 17 \quad R=1 \\ 17/2 \rightarrow 8 \quad R=1 \\ 8/2 \rightarrow 4 \quad R=0 \\ 4/2 \rightarrow 2 \quad R=0 \\ 2/2 \rightarrow 1 \quad R=0 \\ 1/2 \rightarrow 0 \quad R=1 \end{array}$$



2)  $(1110111)_2 \rightarrow (119)_{10}$   
 $1 \times 2^6 + 1 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 64 + 32 + 16 + 0 + 4 + 2 + 1 = 119$

3)  $(DEF)_{16} \rightarrow (000111011111)_2$

4)  $(375)_8 \rightarrow (253)_{10}$   
 $3 \times 8^2 + 7 \times 8^1 + 5 \times 8^0 = 192 + 56 + 5 = 253$

5)  $(1213111321)_4 \rightarrow (100111010101111001)_2$

لماذا نستخدم النظام الثنائي في النظام الثماني ونستخدم النظام الرباعي في النظام العشري؟

1	01
2	10
3	11

6)  $(F1F5)_{16} \rightarrow (61941)_{10}$   
 $15 \times 16^3 + 1 \times 16^2 + 15 \times 16^1 + 5 \times 16^0 = (61941)_{10}$

$$\begin{array}{l} 61941/8 \rightarrow 7742 \quad R=5 \\ 7742/8 \rightarrow 967 \quad R=6 \\ 967/8 \rightarrow 120 \quad R=7 \\ 120/8 \rightarrow 15 \quad R=0 \\ 15/8 \rightarrow 1 \quad R=7 \\ 1/8 \rightarrow 0 \quad R=1 \end{array}$$

$(170765)_8$







# Signed numbers :-

الأرقام السالبة

← عملية الطرح عبارة عن عملية جمع لرقم سالب

هناك ثلاث طرق لتمثيل الأرقام السالبة

- signed magnitude ← ①
- one's complement ← ②
- two's complement ← ③

## ① Signed magnitude :-

① يتم تمييز رقم زيادة ونقصان الرقم يسمى sign bit

② ← 0 إذا الرقم موجب (P)

③ ← 1 إذا الرقم سالب (N)

Ex:-  $(6)_{10} = (110)_2$

$6/2 \rightarrow 3 \quad R=0$

$3/2 \rightarrow 1 \quad R=1$

$1/2 \rightarrow 0 \quad R=1$

+ positive 6  $\rightarrow = 0110$  → sign bit.

- Negative 6  $\rightarrow 1110$

المسألة التي نواجهها هي عدم معرفة إذا كان هذا bit يمثل sign bit أو الرقم نفسه يعني (1110) هل تمثل 6 - أو 14

الحل هو 1's complement و 2's



# One's Complement:

1] change all bits that are 1 to 0 and all bits that are 0 to 1  
 (بتغير البت انقلب) 0 تصبح 1 / 1 تصبح 0

2] Reversing the digits in this way is called complementing a number.

3] if x is positive (+) convert x to binary (2) اذا الرقم موجب بعضه يحوّل  
 4] " " " negative (-) " the positive value of x in bin

5] Reverse each bit

Ex: How to represent 1, -1, 5 and -5?  
← تحويل → Decimal

$$(1)_{10} \rightarrow (1)_2$$

$$1/2 \rightarrow 0 \quad R=1$$

بصفتنا 4 bits ٣ ارقام الى اليسار حتى يكونوا

$$1 \rightarrow 0001$$

الرقم 1 هو به ما ياتي دائي نقل 1 comp

$$-1 \rightarrow 0001 \xrightarrow{\text{نقل}} 1110 \quad 1's \text{ comp.}$$

$$5 \rightarrow 0101$$

↓  
بنا عددي

$$-5 \rightarrow 0101 \rightarrow 1010 \quad 1's \text{ comp}$$

$$5/2 \rightarrow 2 \quad R=1$$

$$2/2 \rightarrow 1 \quad R=0$$

$$1/2 \rightarrow 0 \quad R=1$$



## Two's complement:-

- ⇒ adding 1 to 1's comp.
- ⇒ إذا الرقم موجب يسر تحول إلى نظام ثنائي
- ⇒ إذا الرقم سالب، يكتب العدد الموجب ويحول إلى نظام ثنائي
- ⇒ يعكس 0 ← 1 أو 1 ← 0
- ⇒ يضيف 1 على الرقم

### Examples:

How to represent 1, -1, -5, and 5?

$$\Rightarrow (1)_{10} \rightarrow (0001)_2$$

$$\Rightarrow (-1)_{10} \rightarrow (0001) \rightarrow (1110) \text{ 1's comp } + 1$$

$$\begin{array}{r} 1110 \\ \underline{1+} \\ 1111 \end{array}$$

$$= 1111 \text{ 2's complement.}$$

$$\Rightarrow (5)_{10} \rightarrow (0101)_2$$

$$\Rightarrow (-5)_{10} \rightarrow (0101) \rightarrow 1010 \text{ 1's comp}$$

$$\begin{array}{r} 1010 \\ \underline{1+} \\ 1011 \end{array} \text{ 2's complement.}$$

perform the following subtraction using two's complement:-

$$\Rightarrow (7)_{10} - (1)_{10} \Rightarrow$$

$$(7)_{10} \rightarrow (0111)$$

$$7/2 \rightarrow 3 \text{ R} = 1$$

$$3/2 \rightarrow 1 \text{ R} = 1$$

$$1/2 \rightarrow 0 \text{ R} = 1$$

$$(1)_{10} \rightarrow (0001) \rightarrow (1110) \text{ 1's complement}$$

$$\begin{array}{r} 1 + \\ \hline 1111 \text{ 2's complement} \end{array}$$

$$(7)_{10} + (-1)_{10} = (0111) + (1111) = (0110)_2$$

$$\begin{array}{r} \phantom{0}111 \\ 0111 + \\ \underline{1111} \\ \hline 110110 \end{array}$$

Overflow bit

↳ 2's comp 3

$$(7)_{10} + (-1)_{10} = (6)_{10}$$



$$\Rightarrow (16)_8 - (B1)_{16} \Rightarrow (16)_8 + (-B1)_{16}$$

$$(16)_8 \rightarrow (00001110)_2$$

$$(B1)_{16} = (10110001) = 01001110 \quad 1^{\text{comp}}$$

$$\underline{\hspace{10em} 1 \hspace{1em} +}$$

$$01001111 \quad 2^{\text{complement}}$$

$$\begin{array}{r} 00001110 \\ + 01001111 \\ \hline 01011101 \end{array}$$

$$(14)_{10} - (177)_{10} = -(163)_{10}$$

الاجابة :-

to check take complement and add 1

$$\begin{array}{r} 10100010 \\ \underline{\hspace{10em} 1 \hspace{1em} +} \\ 10100011 \rightarrow = 163 \end{array}$$

الجواب  
(-)  
الاجابة  
1 ← 0  
0 ← 1

perform the following subtraction using 1's and 2's complements-

$$(7)_{10} - (1101001)_2 =$$

$$(7)_{10} \rightarrow (00000111)_2$$

$$\begin{array}{r} 01101001 \\ 10010110 \quad 1's \text{ comp} \\ \hline 10010111 \quad 1 + 2's \text{ comp} \end{array}$$

$7/2 = 3 \quad R=1$   
 $3/2 = 1 \quad R=1$   
 $1/2 = 0 \quad R=1$

$$(7)_{10} + (10010111)$$

الاجابة

$$\begin{array}{r} 0000 \quad 111 \\ 10010111 \quad + \\ \hline 10011110 \end{array}$$

8<sup>4</sup> 2<sup>1</sup>



## converting Fractions

□ From Decimal to other system:-

**Rule** Multiply the number by the target base and take in right order (من اليمين لليسار)

Ex:  $\Rightarrow (0.25)_{10} \rightarrow (0.01)_2$

$$0.25 \times 2 = 0.5$$

$$0.5 \times 2 = 1.0$$

↑

بجزء في (2) له ما

يسمى العدد جزء

عنى أول عدد صحيح.

$$(0.25)_{10} \rightarrow (0.2)_8$$

$$0.25 \times 8 = 2.0$$

$$(0.25)_{10} \rightarrow (0.4)_{16}$$

$$0.25 \times 16 = 4.0$$

2] From any other system to Decimal: -

Rule -  $(0.154)_{10} = 1 \times 10^{-1} + 5 \times 10^{-2} + 4 \times 10^{-3}$   
 $= 0.1 + 0.05 + 0.004.$

$$\Rightarrow (0.01)_2 \longrightarrow (0.25)_{10}$$

$$0 \times 2^{-1} + 1 \times 2^{-2} = 0 + 0.25$$

$$\Rightarrow (0.2)_8 \longrightarrow (0.25)_{10}$$

$$0.2 \Rightarrow 2 \times 8^{-1} = 0.25$$

$$\Rightarrow (0.4)_{16} \longrightarrow (0.25)_{10}$$

$$4 \times 16^{-1} = 0.25$$



$$(0.2)_8 \rightarrow (0.01)_2$$

octal to Binary

$$000.010$$

$$(48.875)_{10} \rightarrow (\quad)_2$$

$$\begin{array}{l} \hookrightarrow 48/2 \rightarrow 24 \quad R=0 \\ 24/2 \rightarrow 12 \quad R=0 \\ 12/2 \rightarrow 6 \quad R=0 \\ 6/2 \rightarrow 3 \quad R=0 \\ 3/2 \rightarrow 1 \quad R=1 \\ 1/2 \rightarrow 0 \quad R=1 \end{array}$$

$$110000.111$$

$$0.875 \times 2 \quad R=1.75$$

$$0.75 \times 2 \quad R=1.5$$

$$0.5 \times 2 \quad R=1.0$$

# Operations on Binary numbers :-

=> addition and subtraction

المجموع والفرق

$$(7)_{10} + (1)_{10} \rightarrow$$

$$\left. \begin{array}{l} 7/2 = 3 \quad R=1 \\ 3/2 = 1 \quad R=1 \\ 1/2 = 0 \quad R=1 \end{array} \right\} \begin{array}{l} 1/2 = 0 \quad R=1 \end{array}$$

$$\begin{array}{r} \phantom{000}111 \\ 0111 \\ + 0001 \\ \hline 1000 \end{array}$$

الإجابة ↪

$$(7)_{10} - (1)_{10} = (00000111)_{10} + (-1)_{10}$$

$$(1)_{10} \rightarrow (00000001)_2 \rightarrow \begin{array}{r} 1111 \quad 1110 \\ \phantom{1111} \quad 1 \\ \hline \end{array} \quad 1^s \text{ comp}$$

$$\begin{array}{r} 1111 \quad 1111 \\ \phantom{1111} \quad 1 \\ \hline \end{array} \quad 2^s \text{ comp}$$

المجموع الإجمالي ↪

$$\begin{array}{r} 1111 \quad 1110 \\ 0000 \quad 0111 \\ + 1111 \quad 1111 \\ \hline \end{array}$$

over flow bit

drop the over flow

$$100000111 \rightarrow 00000110 \leftarrow \text{الإجابة}$$



28/2 → 14	R=0
14/2 → 7	R=0
7/2 → 3	R=1
3/2 → 1	R=1
1/2 → 0	R=1

$$(1A)_{16} - (28)_{10}$$

$$(0001\overset{8}{1}0\overset{4}{1}0)_{2} + (-28)_{10}$$

$$(28)_{10} \rightarrow (00011100)_{2} \rightarrow 111000\overset{1}{1}1 \quad 1^3 \text{ comp}$$

$$11100100 \quad 2^s \text{ comp}$$

$$\begin{array}{r} 0001\ 1010 \\ 1110\ 0100 \\ \hline 1111\ 1110 \end{array}$$

الجواب ←

$$(26)_{10} - (28)_{10} = -2$$

التحقق ←

$$\begin{array}{r} 1111\ 1110 \\ 0000\ 0001 \\ \hline 1111\ 1111 \end{array}$$

الجواب

بقالب

بمع ①

$$\checkmark \text{ يعنى } \leftarrow 0000\ 0010$$

$$(32)_8 - (01111110)_2 \Rightarrow$$

$$(32)_8 \rightarrow (011010)_2$$

0 1 1 0 1 0

$$(00011010)_2 + (-01111110)_2$$

$$(01111110)_2 \xrightarrow{1's \text{ Complement}} (10000001)$$

$$\begin{array}{r} 10000001 \\ + 1 \\ \hline 10000010 \end{array} \quad 2's \text{ comp}$$

$$\begin{array}{r} 00011010 \\ 10000010 \\ \hline 10011100 \end{array} +$$

الجواب النهائي

$$(32)_8 - (176)_8 = (-144)_8$$

للتأكد -

$$\begin{array}{r} 10011100 \\ 01100011 \\ \hline 01100100 \end{array} \begin{array}{l} \text{الجواب} \\ \text{يقطع} \\ + \\ + \end{array}$$

$$\begin{array}{r} 01100100 \\ \hline 144 \end{array} \rightarrow 2's \text{ comp}$$

1 4 4 ✓



$$(37)_{10} - (39)_{10} \rightarrow (\quad)_2$$

$$\begin{array}{l} 37/2 \rightarrow 18 \quad R=1 \\ 18/2 \rightarrow 9 \quad R=0 \\ 9/2 \rightarrow 4 \quad R=1 \\ 4/2 \rightarrow 2 \quad R=0 \\ 2/2 \rightarrow 1 \quad R=0 \\ 1/2 \rightarrow 0 \quad R=1 \\ (00100101)_2 \end{array}$$

$$(39)_{10} \rightarrow (\quad)_2$$

$$\begin{array}{l} 39/2 = 19 \rightarrow R=1 \\ 19/2 = 9 \quad R=1 \\ 9/2 = 4 \quad R=1 \\ 4/2 = 2 \quad R=0 \\ 2/2 = 1 \quad R=0 \\ 1/2 = 0 \quad R=1 \end{array}$$

$$(00100111) \rightarrow (11011000) \quad 1^3 \text{ com}$$

$$\underline{11011001} \quad 2^3 \text{ comp}$$

$$\begin{array}{r} 00100101 \\ 11011001 \\ \hline (11111110) \end{array} +$$

الجواب

$$(37)_{10} - (39)_{10} = (-2)_{10}$$

التحقق

$$\underline{11111110}$$

الجواب

$$00000001$$

نقل

$$1 +$$

$$\underline{00000010}$$

$2^3 \text{ comp}$

$$(FD)_{16} - (35)_8 \rightarrow$$

$$(11111101)_{16} + (-35)_8$$

$$(35)_8 \rightarrow (00011101)_2 \rightarrow 11100010 \quad 1's \text{ comp}$$

$$11100011 \quad 2's \text{ comp}$$

$$\begin{array}{r}
 11111101 \\
 11111101 \\
 \hline
 11100011 \\
 \hline
 11110000
 \end{array}$$

over flow bit X ←

1100000 ← The answer



# Data Representation: (تمثيل البيانات) :-

⇒ من أشكال البيانات

- \* Integers الأعداد الصحيحة
- \* Characters الحروف
- \* Fractions الأعداد الحقيقية الكسرية

## Integers

⇒ We use two bytes (16 bits) to represent an integers.

Example:- Represent  $(17)_{10}$  in memory :-

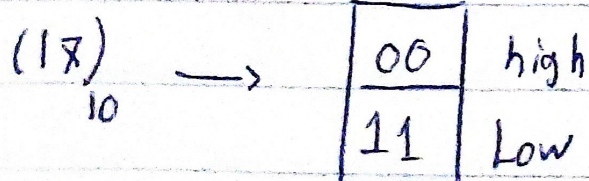
- تحول من النظام العشري إلى الثنائي
- يكمل لـ 16 منزلة (بت) عشيا استخدم Two bytes.
- تحول الرقم إلى Hex عن طريق Table.

$$\begin{aligned}
 17/2 &= 8 \quad R=1 \\
 8/2 &= 4 \quad R=0 \\
 4/2 &= 2 \quad R=0 \\
 2/2 &= 1 \quad R=0 \\
 1/2 &= 0 \quad R=1
 \end{aligned}$$

$$(10001)_2 \quad \text{①}$$

$$\underbrace{00000000}_0 \quad \underbrace{00010001}_1 \quad \text{②}$$

③







Represent (-33) in memory?

$$(33)_{10} \rightarrow (0000\ 0000\ 0010\ 0001)_2 \rightarrow \overline{1111\ 1111\ 1101\ 1110}$$

$1^{\text{comp}}$   
 $1+$

$$\overbrace{1111}^F \ \overbrace{1101}^D \ \overbrace{1111}^F \rightarrow \begin{array}{|c|c|} \hline DF & \text{Low} \\ \hline FF & \text{high} \\ \hline \end{array}$$

characters (حروف)

⇒ we use 1 byte (8 bits) to represent characters (ASCII)

$8 \text{ bits} = 2^8 = 256$

(65)<sub>10</sub> → ( ) in memory.

□ نحولها لـ نظام ثنائي

- 65/2 = 32 R=1
- 32/2 = 16 R=0
- 16/2 = 8 R=0
- 8/2 = 4 R=0
- 4/2 = 2 R=0
- 2/2 = 1 R=0
- 1/2 = 0 R=1

(01000001)

صفحة صفر عشان  
أعلى اليمين زوجي  
والم

Parity bit

even parity

odd parity

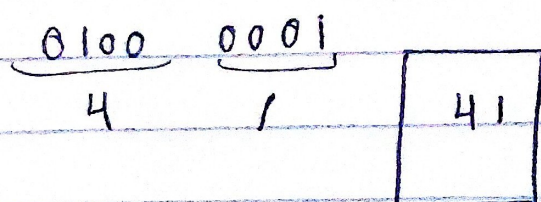
بتخلو عدد الواحدات زوجي

بتخلو عدد الواحدات فردي

□ بيتل parity bit

- \* even Parity: makes the number of ones even
- \* odd , , , , , , , odd.

□ تحويل Hex إلى table.





Represent NOOR in memory :-

$N \rightarrow ( \quad 01001110 )$   
 $O \rightarrow ( \quad 01101111 )$   
 $R \rightarrow ( \quad 01100100 )$

4E
6F
72

4      14  
 6      15  
 7      2

Using the even parity to represent the character R in the computer memory :-  
 (Hint R=82 in ASCII):-

$(82)_{10} \rightarrow ( \quad 1010010 )$   
 8 4 2 1  
 1 0 1 0 0 1 0  
 0 2

in memory,

02
----

$82/2 = 41 \quad R=0$   
 $41/2 = 20 \quad R=1$   
 $20/2 = 10 \quad R=0$   
 $10/2 = 5 \quad R=0$   
 $5/2 = 2 \quad R=1$   
 $2/2 = 1 \quad R=0$   
 $1/2 = 0 \quad R=1$

(1010010)

بنايت

**Fractions** :- We use 4 bytes to represent fractions (Montissa representation) :-

⇒ Ex:- Represent  $(48.875)_{10}$  in memory

□ تحول من النظام العشري إلى الثنائي (العدد الصحيح لجان والكسري لجان).

$$\begin{aligned}
 48/2 &= 24 & R=0 \\
 24/2 &= 12 & R=0 \\
 12/2 &= 6 & R=0 \\
 6/2 &= 3 & R=0 \\
 3/2 &= 1 & R=1 \\
 1/2 &= 0 & R=1
 \end{aligned}$$

$$\begin{aligned}
 0.875 \times 2 &= 1.75 \\
 0.75 \times 2 &= 1.5 \\
 0.5 \times 2 &= 1.0
 \end{aligned}$$

0.111

(110000)

$$(48.875)_{10} \longrightarrow (110000.111)_2$$

(النقطة العائمة) Floating point

← لا يتم تخزينه على طريقة (scientific method) ←



Exo - Use the odd parity to represent the word Dello  
in the computer memory :-

Hint:- D = 68  
e = 101  
l = 108  
l = 108  
o = 111

8 4 2 1

$68/2 = 34$ R=0	$101/2 = 50$ R=1	$108/2 = 54$ R=0
$34/2 = 17$ R=0	$50/2 = 25$ R=0	$54/2 = 27$ R=0
$17/2 = 8$ R=1	$25/2 = 12$ R=1	$27/2 = 13$ R=1
$8/2 = 4$ R=0	$12/2 = 6$ R=0	$13/2 = 6$ R=1
$4/2 = 2$ R=0	$6/2 = 3$ R=0	$6/2 = 3$ R=0
$2/2 = 1$ R=0	$3/2 = 1$ R=1	$3/2 = 1$ R=0
$1/2 = 0$ R=1	$1/2 = 0$ R=1	$1/2 = 0$ R=1

11000100  
12=C 4

11100101  
E 5

11101100  
E C

$111/2 = 55$  R=1  
 $55/2 = 27$  R=1  
 $27/2 = 13$  R=1  
 $13/2 = 6$  R=1  
 $6/2 = 3$  R=0  
 $3/2 = 1$  R=1  
 $1/2 = 0$  R=1

C4
E5
EC
EC
EF

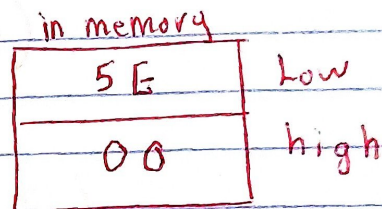
11101111  
E F



⇒ Represent the following integer in memory using 2-bytes?  
(94)

2 bytes ⇒ 16 bits

$94/2 = 47$      $R=0$   
 $47/2 = 23$      $R=1$   
 $23/2 = 11$      $R=1$   
 $11/2 = 5$        $R=1$   
 $5/2 = 2$         $R=1$   
 $2/2 = 1$         $R=0$   
 $1/2 = 0$         $R=1$



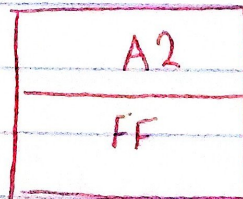
$0000\ 0000\ 0101\ 1110$   
<sup>8 4 2</sup>  
5 E



Represent the following integer in memory using 2-bytes?

(-94)

$(94) \rightarrow (0000\ 0000\ 0101\ 1110) \rightarrow 1111\ 1111\ 1010\ 0001$     1's comp  
1 +  
 $1111\ 1111\ 1010\ 0001$     2's comp  
F    F    A    1





## ⇒ Floating Point Representation

تمثيل النقطة العائمة

$$\text{Ex:- } 54.3.1 = 54.31 \times 10^0$$

$$= 5.431 \times 10^2 \quad ] \Rightarrow$$

$$= 0.5431 \times 10^3$$

كلمة صح بس لا تكون

على طريقة

Scientific method

(لا تكون بسا رقم على شكل العائمة).

□ لا تكون على طريقة (scientific method)

□ بجمع العدد ١٢٧ القوة

□ تحول الى نظام ثنائي

□ تحول كل واحد Hex



Ex: show the memory representation of the number  $(43.625)_{10}$  using 32 bit floating point representation.

II] تحويل الرقم من نظام عشري إلى ثنائي

$43/2 = 21$	$R=1$	}	$0.625 \times 2 = 1.25$
$21/2 = 10$	$R=1$		$0.25 \times 2 = 0.5$
$10/2 = 5$	$R=0$		$0.5 \times 2 = 1.0$
$5/2 = 2$	$R=1$		
$2/2 = 1$	$R=0$		
$1/2 = 0$	$R=1$		

101

101011

$(43.625)_{10} = (101011.101)_2$

2] scientific notation      استخدام  
 الرقم في وسط، الأقواس رقم واحد فقط

$101011.101 = 1.01011101 \times 2^5$

1bit sign field	Exponent Field	Mantissa Field
0 <small>0 في bit 43</small>	Rule = $X + 127$ <small>Exponent (الأس)</small> $= 5 + 127 = 132 = (10000100)$ <small>4 2</small>	

الرقم على جوانب الأقواس  
 ويكون أولها 1، غير 0

010111010000000000000000

2 E 8 0 0 0

Memory

00
80
2E
42



# Numbering system:-

حل أسئلة على

[A] Convert the following:-

$$\textcircled{1} (00011110)_2 \rightarrow (30)_{10}$$

$$0 \times 2^9 + 0 \times 2^8 + 0 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 =$$

$$0 + 0 + 16 + 8 + 4 + 2 = 30$$

$$\textcircled{2} (01101001)_2 \rightarrow (105)_{10}$$

$$0 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 =$$

$$0 + 64 + 32 + 0 + 8 + 1 = 105$$

$$\textcircled{3} (25)_{10} \rightarrow (11001)_2$$

$$25/2 = 12 \quad R=1$$

$$12/2 = 6 \quad R=0$$

$$6/2 = 3 \quad R=0$$

$$3/2 = 1 \quad R=1$$

$$1/2 = 0 \quad R=1$$

$$\textcircled{4} (547)_{10} \rightarrow (100010011000011)_2$$

$$547/2 = 273 \quad R=1$$

$$273/2 = 136 \quad R=1$$

$$136/2 = 68 \quad R=0$$

$$68/2 = 34 \quad R=0$$

$$34/2 = 17 \quad R=0$$

$$17/2 = 8 \quad R=1$$

$$8/2 = 4 \quad R=0$$

$$4/2 = 2 \quad R=0$$

$$2/2 = 1 \quad R=0$$

$$1/2 = 0 \quad R=1$$

$$\textcircled{5} (26.75)_{10} \rightarrow (11010.11)_2$$

$$26/2 = 13 \quad R=0$$

$$13/2 = 6 \quad R=1$$

$$6/2 = 3 \quad R=0$$

$$3/2 = 1 \quad R=1$$

$$1/2 = 0 \quad R=1$$

$$0.75 \times 2 = 1.5$$

$$0.5 \times 2 = 1.0$$

$$\textcircled{6} (0.2)_{10} \rightarrow (0.\overline{0011})_2$$

$$0.2 \times 2 = 0.4$$

$$0.4 \times 2 = 0.8$$

$$0.8 \times 2 = 1.6$$

$$0.6 \times 2 = 1.2$$

$$0.2 \times 2 = 0.4$$

$$\textcircled{7} (-32)_{10} \rightarrow ( )_2 \text{ use 2's complement and 8 bits.}$$

$$32/2 = 16 \quad R=0$$

$$16/2 = 8 \quad R=0$$

$$8/2 = 4 \quad R=0$$

$$4/2 = 2 \quad R=0$$

$$2/2 = 1 \quad R=0$$

$$1/2 = 0 \quad R=1$$

$$(00100000) \rightarrow (11011111) \text{ 1's Comp}$$

$$\begin{array}{r} 11011111 \\ + 1 \\ \hline 11100000 \end{array}$$

←  
2's Comp

$$\textcircled{8} (72)_{16} \rightarrow (114)_{10}$$

$$7 \times 16^1 + 2 \times 16^0 = 112 + 2 = 114$$

$$\textcircled{9} (72)_{8} \rightarrow (58)_{10}$$

$$7 \times 8^1 + 2 \times 8^0 = 56 + 2 = 58$$



(B2.F)  $\rightarrow$  ( )

$$B \times 16^1 + 2 \times 16^0 = 11 \times 16 + 2$$

$$= 178$$

$$F = 15$$

$$(0.15) = 1 \times 16^{-1} + 5 \times 16^{-2} = 0.0820313$$

(B) Solve the following using 8 bits and 2's Complement:-

$$\square (01111111)_2 - (76)_{10} =$$

$$(01111111)_2 + (10110100)_{10} = ( \quad )$$

$$76/2 = 38 \quad R=0$$

$$38/2 = 19 \quad R=0$$

$$19/2 = 9 \quad R=1$$

$$9/2 = 4 \quad R=1$$

$$4/2 = 2 \quad R=0$$

$$2/2 = 1 \quad R=0$$

$$1/2 = 0 \quad R=1$$

$$(01001100) \rightarrow 10110011 \quad 1's \text{ comp}$$

$$\underline{10110100} \quad 2's \text{ comp}$$

$$\begin{array}{r} 11111 \\ 01111111 \\ 10110100 \\ \hline \times \boxed{1}00110011 \end{array}$$

Q Represent  $(-25.5)_{10}$  in memory

$$\begin{array}{l} 25/2 = 12 \quad R = 1 \\ 12/2 = 6 \quad R = 0 \\ 6/2 = 3 \quad R = 0 \\ 3/2 = 1 \quad R = 1 \\ 1/2 = 0 \quad R = 1 \end{array}$$



$$0.5 \times 2 = 1.0$$

(11001.1)

Q  $1.10011 \times 2^4$

Q  $x + 12x = 131$

$$131/2 = 65 \quad R = 1$$

$$65/2 = 32 \quad R = 1$$

$$32/2 = 16 \quad R = 0$$

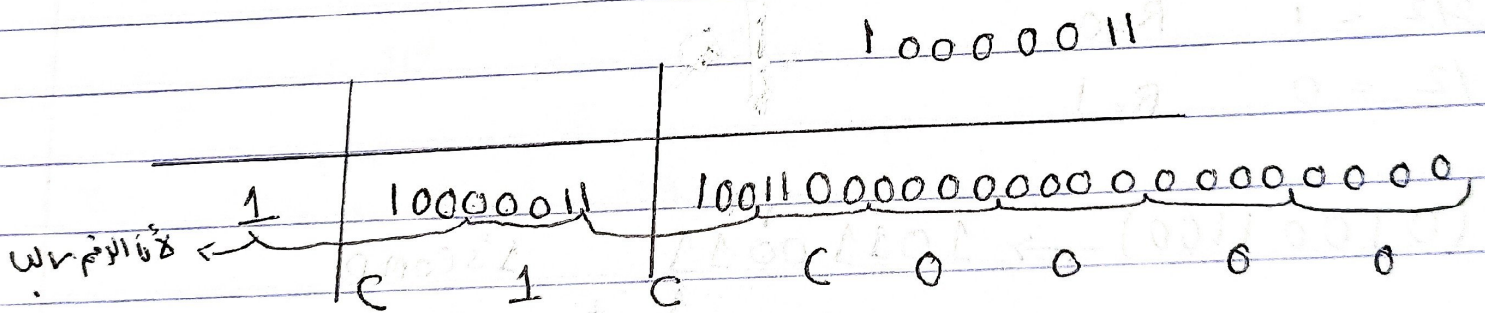
$$16/2 = 8 \quad R = 0$$

$$8/2 = 4 \quad R = 0$$

$$4/2 = 2 \quad R = 0$$

$$2/2 = 1 \quad R = 0$$

$$1/2 = 0 \quad R = 1$$



Memory :-

00	Low
00	
CC	
C1	high



حل الاسايمنت :-

using 8bit pattern and two's comp, Find the answers

$$A) (35)_{16} - (36)_7 = ( \quad )_{10}$$

$$(35)_{16} + (-36)_x$$

$$(36)_x \rightarrow (27)_{10} \rightarrow (00011011)_2$$

$$3 \times 7^1 + 6 \times 7^0 = 21 + 6 = 27$$

$$27/2 = 13 \text{ R}=1$$

$$13/2 = 6 \text{ R}=1$$

$$6/2 = 3 \text{ R}=0$$

$$3/2 = 1 \text{ R}=1$$

$$1/2 = 0 \text{ R}=1$$

00011011

$$(35)_{16} \rightarrow (00110101)_2 \checkmark$$

$$(-36)_x \rightarrow (00011011)_2 \rightarrow (11100100) \text{ 1's comp}$$

$$11100101 \text{ 2's comp}$$

$$\begin{array}{r} 1111 \\ 00110101 \\ 11100101 \end{array} +$$

$$\hline 100011010$$

$$100011010 \rightarrow$$

the answer  $\Rightarrow$  00011010

X  
overflowbit  
detect

$$(53)_{10} - (27)_{10} = (26)_{10}$$

الاجابة

$$\checkmark (26)_{10} = \leftarrow$$

$$B) (132)_8 - (58)_{16} = ( \quad )_9 = ( \quad )_4$$

$$(132)_8 + (-58)_{16} =$$

$$(132)_8 \rightarrow (001011010)_2$$

$$(58)_{16} \rightarrow (01011000)_2 \rightarrow \begin{array}{r} 10100111 \quad 1^3 \text{ comp} \\ \underline{\quad \quad \quad 1} + \\ 10101000 \quad 2^3 \text{ comp} \end{array}$$

$$\begin{array}{r} 001011010 \\ + \\ 010101000 \\ \hline 100000010 \end{array}$$

overflow  
bit x  
بغضو

$$(00000010)_2 \rightarrow ( \quad )_9 = ( \quad )_4$$

$$(132)_8 \rightarrow (1 \times 8^2 + 3 \times 8^1 + 2 \times 8^0) = (90)_{10}$$

$$(58)_{16} \rightarrow (5 \times 16^1 + 8 \times 16^0) = (88)_{10}$$

$$(90)_{10} - (88)_{10} = (2)_{10} = (00000010)_2 \quad \checkmark$$

$$(00000010)_2 \rightarrow (2)_{10} \rightarrow (2)_{9}$$

$$2/9 = 0 \quad R=2 \quad (2)_{4}$$

$$2/4 = 0 \quad R=2$$



3/ Use the 32-bit floating point representation to represent the following  
 A)  $(-27.875)_{10}$   
 B)  $(13.4)_8$

A)  $(-27.875)_{10}$

$27/2 = 13 \quad R=1$

$13/2 = 6 \quad R=1$

$6/2 = 3 \quad R=0$

$3/2 = 1 \quad R=1$

$1/2 = 0 \quad R=1$

$0.875 \times 2 = 1.75$

$0.75 \times 2 = 1.5$

$0.5 \times 2 = 1.0$

111

11011

11011.111

$\Rightarrow 1.1011111 \times 2^4$

1	10000011	8	10111110000000000000000000000000
C	I	D	F 0 0 0 0

$4 + 127 = (131)_{10}$

$131/2 = 65 \quad R=1$

$65/2 = 32 \quad R=1$

$32/2 = 16 \quad R=0$

$16/2 = 8 \quad R=0$

$8/2 = 4 \quad R=0$

$4/2 = 2 \quad R=0$

$2/2 = 1 \quad R=0$

$1/2 = 0 \quad R=1$

00	low order byte
00	
DF	
CI	high order byte

10000011

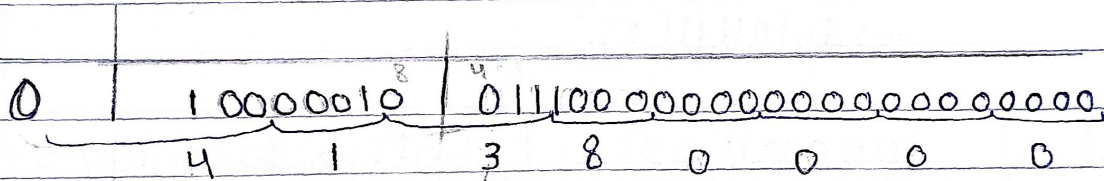
(13.4)<sub>8</sub> → ( )<sub>2</sub>

التحويل من نظام ثنائي إلى ثنائي نراري أن كل رقم عبارة عن ثلاث منازل

(13.4)<sub>8</sub> → (001 011 . 100)<sub>2</sub>

نكتبه بالطريقة العلمية بحيث نترك الفاصلة إلى أن يصبح على يسارها رقم واحد

001011.100 → 001.011100 × 2<sup>3</sup>



128 + 3 = 130

00
00
38
41

130/2 = 65 R=0

65/2 = 32 R=1

32/2 = 16 R=0

16/2 = 8 R=0

8/2 = 4 R=0

4/2 = 2 R=0

2/2 = 1 R=0

1/2 = 0 R=1

10000010



The value below represents a float value in the computer memory using 32bit floating point representation.  
 Find out the decimal value for this representation  
 (show the solution steps).

00	Low
00	
01	
01	high

C1 91 00 00

12

8421

11000001 10010001 000000000000

2<sup>126</sup>

$$(10000011)_2 \rightarrow (131)_{10}$$

$$1 \times 2^8 + 0 \times 2^6 + 0 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 1 + 2 + 128 = 131$$

$$131 - 127 = 4 \quad \text{القوة}$$

$$(-1.0010001 \times 2^4)$$

↓

$$( )_{10} \leftarrow (-10010.001)_2$$

$$2^1 + 2^4 + 2^{-3} = (18.125)_{10}$$

10





Represent the following word in memory  
(8-bit ASCII chars using even parity) cat

$$C = (67)_{10} \rightarrow (1000011)_2$$

$$a = (97)_{10} \rightarrow (1100001)_2$$

$$t = (116)_{10} \rightarrow (1110100)_2$$

$$C := (67)_{10} \rightarrow ( \quad \quad \quad )_2$$

$$67/2 = 33 \quad R=1$$

$$33/2 = 16 \quad R=1$$

$$16/2 = 8 \quad R=0$$

$$8/2 = 4 \quad R=0$$

$$4/2 = 2 \quad R=0$$

$$2/2 = 1 \quad R=0$$

$$1/2 = 0 \quad R=1$$

$$\begin{array}{c} \text{84} \quad \text{21} \\ (11000011) \\ \text{C} \quad \text{3} \end{array}$$

$$97/2 = 48 \quad R=1$$

$$48/2 = 24 \quad R=0$$

$$24/2 = 12 \quad R=0$$

$$12/2 = 6 \quad R=0$$

$$6/2 = 3 \quad R=0$$

$$3/2 = 1 \quad R=1$$

$$1/2 = 0 \quad R=1$$

$$\begin{array}{c} (11100001) \\ \text{E} \quad \text{1} \end{array}$$

$$t := (116)_{10} \rightarrow ( \quad \quad \quad )_2$$

$$116/2 = 58 \quad R=0$$

$$58/2 = 29 \quad R=0$$

$$29/2 = 14 \quad R=1$$

$$14/2 = 7 \quad R=0$$

$$7/2 = 3 \quad R=1$$

$$3/2 = 1 \quad R=1$$

$$1/2 = 0 \quad R=1$$

$$\begin{array}{c} \text{42} \quad \text{1} \\ 0110100 \\ \text{t} \quad \text{4} \end{array}$$

in memory

C	C3
a	E1
t	t4