(أنظمة العد) Numbering systems.

① Decimal system.   النظام العشري
   └→ 10 digits (0 →9)   ١١,...;أ,...
   └→ The base is 10   القاهرة ١٠

② Binary system.   النظام الثنائي (لغة الكمبيوتر).
   └→ 2 digits (0,1)
   └→ The base is 2

③ Octal system   نظام الثماني
   └→ 8 digits (0 → 7)
   └→ The base is 8

④ Hexadecimal system   النظام السادس عشر
   └→ 16 digits (0 →9 , A →F)
   └→ The base is 16

_____

1010 :-

4 digits
4 bits
nibble
$\frac{1}{2}$ byte.

_____

* 4 bits form a NIBBLE
* 8 bits form a byte
* 1 digits form a bit
* 2 bytes form a word
   form a word

$\Rightarrow$ Converting from decimal to any other system :-

$$(\qquad)_{10} \longrightarrow (\qquad)_{2,8,16}$$

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① from decimal to Binary :-

① $(22)_{10} = (\qquad)_{2}$

		سؤال
$22/2 \longrightarrow 11$	The Reminder of $0 \longrightarrow LSB$
$11/2 \longrightarrow 5$	R of 1
$5/2 \longrightarrow 2$	R of 1
$2/2 \longrightarrow 1$	R of $= 0$
$1/2 \longrightarrow 0$	$R = 1 \longrightarrow MSB$

$(22)_{10} \longrightarrow (1\ 0\ 1\ 1\ 0)_2$ الرقم ≠ بلغة الحاسوب ،

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② $(13)_{10} \longrightarrow (\qquad)_{2}$

$13/2 \longrightarrow 6 \qquad R = 1$
$6/2 \longrightarrow 3 \qquad R = 0$
$3/2 \longrightarrow 1 \qquad R = 1$
$1/2 \longrightarrow 0 \qquad R = 1$

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

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③ $(220)_{10} = (\qquad)_{2}$

$220/2 \longrightarrow 110 \quad R = 0$
$110/2 \longrightarrow 55 \qquad R = 0$
$55/2 \longrightarrow 27 \qquad R = 1 \qquad (11011100)_2$
$27/2 \longrightarrow 13 \qquad R = 1$
$13/2 \longrightarrow 6 \qquad R = 1$
$6/2 \longrightarrow 3 \qquad R = 0$
$3/2 \longrightarrow 1 \qquad R = 1$
$1/2 \longrightarrow 0 \qquad R = 1$

[4] $(21)_{10} \longrightarrow (\quad)_2$

$21/2 \longrightarrow 10 \quad R=1$
$10/2 \longrightarrow 5 \quad R=0$
$5/2 \longrightarrow 2 \quad R=1$
$2/2 \longrightarrow 1 \quad R=0$
$1/2 \longrightarrow 0 \quad R=1$

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

[5] $(15)_{10} \longrightarrow (1111)_2$

$15/2 \longrightarrow 7 \quad R=1$
$7/2 \longrightarrow 3 \quad R=1$
$3/2 \longrightarrow 1 \quad R=1$
$1/2 \longrightarrow 0 \quad R=1$

From Decimal to Octal :-

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

[1] $(39)_{10} \longrightarrow (47)_8$

$39/8 \longrightarrow 4 \quad R=7$
$4/8 \longrightarrow 0 \quad R=4$

طريقة : $\dfrac{39}{8} = 4.875$
الحل

$0.875 \times 8 = 7$

$\dfrac{4}{8} = 0.5$
$0.5 \times 8 = 4$

From Decimal to Hexadecimal :-

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

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

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

Result ↗

مثال: $\dfrac{39}{16} = 2.4375$

$0.4375 \times 16 = 7$

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

$0.125 \times 16 = 2.$

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

$$29/2 \longrightarrow 14 \qquad R = 1$$
$$14/2 \longrightarrow 7 \qquad R = 0$$
$$7/2 \longrightarrow 3 \qquad R = 1$$
$$3/2 \longrightarrow 1 \qquad R = 1$$
$$1/2 \longrightarrow 0 \qquad R = 1$$

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

$$29/8 \longrightarrow 3 \qquad R = 5$$
$$3/8 \longrightarrow 0 \qquad R = 3$$

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

$$29/16 \longrightarrow 1 \qquad R = 13 \curvearrowright D$$
$$1/16 \longrightarrow 0 \qquad R = 1$$

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

$$29/5 = 5 \longrightarrow R = 4$$
$$5/5 = 1 \longrightarrow R = 0$$
$$1/5 = 0 \longrightarrow R = 1$$

Converting from any other system to decimal :-

$\{Rule\} \Rightarrow (453)_{10} = 4 \times 10^2 + 5 \times 10^1 + 3 \times 10^0 = 400 + 50 + 3 = 45$

$\Rightarrow$ { Binary to Decimal :- }

$(10110)_2 \longrightarrow (\quad 22 \quad)_{10}$
$1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 18 + 0 + 4 + 2 + 0 = 22$

$(1010)_2 \longrightarrow (\quad 10 \quad)_{10}$
$1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 8 + 2 = 10$

$(0010)_2 \longrightarrow (\quad 2 \quad)_{10}$
$0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 0 + 0 + 2 + 0 = 2$

$(101)_2 \longrightarrow (\quad 5 \quad)_{10}$

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

$\Rightarrow$ { Octal to Decimal : }

$(\quad 47 \quad) \longrightarrow (\quad 39 \quad)_{10}$
$4 \times 8^1 + 7 \times 8^0 = 32 + 7 = 39$

$\Rightarrow$ { Hexadecimal to dicimal }

$(\quad 27 \quad)_{16} \longrightarrow (\quad 39 \quad)_{10}$
$2 \times 16^1 + 7 \times 16^0 = 32 + 7 = 39$

$$\Rightarrow (\overset{4\ 3\ 2\ \ 1\ 0}{1\ 1\ 1\ 0\ 1})_2 \longrightarrow (\qquad)_{10}$$

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

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

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

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

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

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

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

$\Rightarrow$ Convert from Binary to other system:-

{Binary to Octal}:-

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

⟸ الطريقة الاولى (الطويلة) بحول من Binary إلى Decimal ثم إلى ثماني :-

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

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

$298 / 8 \longrightarrow 37 \quad R = 2$
$37 / 8 \longrightarrow 4 \quad R = 5$
$4 / 8 \longrightarrow 0 \quad R = 4$

⟸ الطريقة الثانية (الأقصر) بقسم لنظام ثلاثيات

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

Binary to Hexadecimal :-

$1001,0101\ b = (\,95\,)_h$

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

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

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

$011 \quad 101$

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

$(\ 111\,101\ 111\ 101\ 111\ )_2 \longrightarrow (75757\ )_8$

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

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

Binary to any other system:-

$$(11101)_2 \longrightarrow (\qquad)_5$$

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

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

$$29/5 \longrightarrow 5 \qquad R = 4$$
$$5/5 \longrightarrow 1 \qquad R = 0$$
$$1/5 \longrightarrow 0 \qquad R = 1$$

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

$$35/2 \longrightarrow 17 \qquad R=1$$
$$17/2 \longrightarrow 8 \qquad R=1$$
$$8/2 \longrightarrow 4 \qquad R=0$$
$$4/2 \longrightarrow 2 \qquad R=0$$
$$2/2 \longrightarrow 1 \qquad R=0$$
$$1/2 \longrightarrow 0 \qquad R=1$$

2 $(1110111)_2 \longrightarrow (119)$
$$1\times2^6+1\times2^5+1\times2^4+0\times2^3+1\times2^2+1\times2^1+1\times2^0 = 64+32+16+0+4+2+1 = 119$$

3 $(1DF)_{16} \longrightarrow (0001\ 1101\ 1111)_2$

4 $(375)_8 \longrightarrow (\qquad)$
$$3\times8^2+7\times8^1+5\times8^0 = 192+56+5 = 253$$

5 $(1213111321)_4 \longrightarrow (1001\ 11\ 01\ 01\ 01\ 11\ 10\ 01)_2$

لما أنو في النظام الثماني نستخدم الثلاثيات
$$\begin{array}{cc} 1 & 01 \\ 2 & 10 \\ 3 & 11 \end{array}$$
" " السادس عشر " الرباعيات

النظام الرباعي يستخدم الثنائيات

6 $(F1F5)_{16} \longrightarrow (\qquad)_8$
$$15\times16^3+1\times16^2+15\times16^1+5\times16^0 = (61941)_{10}$$

$$61941/8 \longrightarrow 7742 \qquad R=5$$
$$7742/8 \longrightarrow 967 \qquad R=6 \qquad (170765)_8$$
$$967/8 \longrightarrow 120 \qquad R=7$$
$$120/8 \longrightarrow 15 \qquad R=0$$
$$15/8 \longrightarrow 1 \qquad R=7$$
$$1/8 \longrightarrow 0 \qquad R=1$$

7 $(AB)_{16} \longrightarrow (10101011)_2$

10   11

$\underset{8\ 4\ 2\ 1}{1010}$ 1011

8 $(23)_4 \longrightarrow (\qquad)_8$

$(23)_4 \longrightarrow (11)_{10} \longrightarrow (13)_8$

$2 \times 4^1 + 3 \times 4^0 = 2 \ast 8 + 3 = 11$

$11/8 \longrightarrow 1 \qquad R = 3$
$1/8 \longrightarrow 0 \qquad R = 1$

9 $(35)_7 \longrightarrow (\qquad)_8$

$(35)_7 \longrightarrow (26)_{10} \longrightarrow (32)_8$

$3 \times 7^1 + 5 \times 7^0 = 21 + 5 = 26$

$26/8 \longrightarrow 3 \qquad R = 2$
$3/8 \longrightarrow 0 \qquad R = 3$

10 $(72E)_{16} \longrightarrow (\qquad)_8$

$(72E)_{16} \longrightarrow (011100101110)_2 \longrightarrow (3456)_8$

14

$\underset{\underset{1\ 1\ 1\ 0}{8\ 4\ 2\ 1}}{0111 \quad 0010 \quad 1110}$

{Signed numbers :}- الأرقام السالبة

⇐ عملية الطرح عبارة عن عملية جمع لرقم سالب .

هناك ثلاث طرق لتمثيل الأرقام السالبة
signed magnitude ⇐ ①
ones Complement ⇐ ②
two's Complement ⇐ ③

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② Signed magnitude :-

① يضيف رقم زيادة وهذا الرقم يسمى   sign bit
② → 0   اذا الرقم موجب (P)
③ → 1   اذا الرقم سالب (N)

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

$6/2 \longrightarrow 3$ $R = 0$
$3/2 \longrightarrow 1$ $R = 1$
$1/2 \longrightarrow 0$ $R = 1$

                                    → sign bit .
+ positive 6 ⟶ = 0110
- Negative 6 ⟶   1110

المشكلة التي رح نواجها هي عدم معرفة اذا كان هذا signbit تمثل bit
او الرقم بنفسه 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

(بتغيّر البت (نقلب) / 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 إذا الرقم موجب بحول (2)

[4] " " " negative (-) " the positive value of x in bin

[5] Reverse each bit

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

المطلوب   → Decimal

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

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

يبقى 3 أصفار على اليسار، حتى يكونوا   4 bits

$1 \rightarrow 0001$

الرقم 1 موجب ما بدي أعمل بنقل   1 comp

$-1 \rightarrow 000\underline{1} \xrightarrow[قلب]{} 1110 \quad$ 1's comp.

$5 \rightarrow 0\underline{1}01$
    من عندي

$5/2 \rightarrow 2 \quad R=1$
$2/2 \rightarrow 1 \quad R=0$
        $R=1$

$-5 \rightarrow 0\underline{1}0\underline{1} \rightarrow 1010 \quad$ 1's comp

Two's complement :-

⇒ adding 1 to 1's comp.

⇒ اذا الرقم موجب بس بحول لـ نظام ثنائي

⇒ اذا الرقم سالب ، بكتب العدد الموجبة وبحولها لنظام ثنائي

⇒ بعكس 0 → 1   أو   1 → 0

⇒ يزيد 1 على الرقم

Exampels:

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

⇒ $(1)_{10} \rightarrow (0001)_2$

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

$$1110 +$$
$$1$$
$$\overline{1111}$$

$= 11112$'s complement .

⇒ $(5)_{10} \rightarrow (0101)_2$

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

$$1 +$$
$$\overline{1011}$$ 2's complement.

Perform the following subtraction using two's complement:-

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

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

7/2 → 3 R=1
3/2 → 1 R=1
1/2 → 0 R=1

$$(1)_{10} \rightarrow (0001) \rightarrow (1110)\ 1's\ complement$$
$$\underline{1\ +}$$
$$1111\ \ 2's\ complement$$

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

$$0\overset{1\ 1\ 1}{1}11\ +$$
$$\underline{1\ 1\ 1\ 1}$$
$$[1]0110$$

over flow bit

بنخذ 2's comp B

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

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

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

001 110

$$(B1)_{16} = (1011\,0001) = 0100\,1110 \quad 1's\,comp$$
$$\underline{\qquad\qquad\qquad 1\ +}$$
$$0100\,1111 \quad 2's\,complement.$$

$$\begin{array}{r}
\overset{1\,1}{0000\,1110}\ \ + \\
0100\,1111\ \ \\
\hline
0\,1011101
\end{array}$$

$$(14)_{10} - (177)_{10} = {}^{-}(163)_{10} \qquad \quad الحظة -:$$

to check take complement and add 1

$$\begin{array}{r}
1010\,0010 \\
1\ + \\
\hline
1010\,0011 \rightarrow = 163
\end{array}$$

الجواب (+

موجب

$1 \leftarrow 0$
$0 \leftarrow 1$

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

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

$(7)_{10} \longrightarrow (\quad 0000\ 0111\ )_2$

$\begin{array}{l} 0\ 1101\ 001 \\ \underline{1\ 0010\ 110} \quad \text{1's comp} \\ \qquad\qquad\ \underline{1} \quad +\ \text{2's comp} \\ \underline{1\ 0010\ 111} \end{array}$

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

$(7)_{10} + (1001\ 0\ 111)$

$\begin{array}{r} \overset{1\ 1\ 1}{0\ 000\ 0\ 111} \\ \underline{1\ 0\ 0\ 1\ 0\ 1\ 1\ 1}\ ^+ \\ 1\ 0\ 0\ 1\ 1\ 1\ 1\ 0 \end{array}$

الإجابة

8^n ²

{converting fractions}

① From Decimal to other system :-

(Rule) Meltiply the number by the traget base
and take in right order (من فوق لتحت)

Ex:- ⟹ $(0.25)_{10}$ ⟶ $(0.01)_2$

$0.25 \times 2 = \boxed{0}.5$
$0.5 \times 2 = \boxed{1}.0$

بضرب في (2) لما ما
يصير العدد من
يمين أصبح لعدد صحيح.

$(0.25)_{10}$ ⟶ $(0.2)_8$

$0.25 \times 8 = 2.0$

$(0.25)_{10}$ ⟶ $(0.4)_{16}$

$0.25 \times 16 = 4.0$

2 From any other system to Decimal :-

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

$= 0.1 + 0.05 + 0.004$

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

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

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

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

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

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

$(\underbrace{0 \cdot 2}_{8}) \longrightarrow (\qquad 0.01)_{2}$ octal to Binary

$0 0 0 . 0 1 0$

$(4 8 . 8 7 5) \underset{10}{} \longrightarrow (\qquad)_{2}$

$\hookrightarrow$

$48/2 \rightarrow 24 \qquad R = 0$

$24/2 \rightarrow 12 \qquad R = 0$

$12/2 \rightarrow 6 \qquad R = 0 \qquad 110000 . 111$

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

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

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

$0.875 \times 2 \qquad R = 1 \quad 75$

$0.75 \times 2 \qquad R = 1 \quad 5$

$0.5 \times 2 \qquad R = 1 \quad 0$

Operations on Binary numbers :-

=> addition and subtraction   المحاضرة :-

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

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

$$\begin{array}{r}
111 \\
0111 \\
\text{الإجابة} \quad 0001 + \\
\hline
\hookrightarrow 1000
\end{array}$$

$(7)_{10} - (1)_{10} = (0000\ 0111)_{10} + (-1)_{10}$

$(1)_{10} \rightarrow (0000\ 0001)_2 \rightarrow 1111\ 1110 \quad 1's\ comp$
$\phantom{(1)_{10} \rightarrow (0000\ 0001)_2 \rightarrow 1111\ 1111}\ 1 +$
$\text{نعكس الأرقام ونضيف}\ \underline{1111\ 1111} \quad 2's\ comp$

$$\begin{array}{r}
1111\ 110 \\
0000\ 0111 \\
1111\ 1111 + \\
\hline
10000\ 0110
\end{array}$$

over flow
bit
drop the over flow

$0000\ 0110 \Leftarrow \text{الإجابة}$

$$28/2 \rightarrow 14 \qquad R=0$$
$$14/2 \rightarrow 7 \qquad R=0$$
$$7/2 \rightarrow 3 \qquad R=1$$
$$3/2 \rightarrow 1 \qquad R=1$$
$$1/2 \rightarrow 0 \qquad R=1$$

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

$$(0001\ \overset{8\ 4\ 2\ 1}{1010})_2 + (-28)_{10}$$

$$(28)_{10} \rightarrow (00011100)_2 \longrightarrow 11100011 \quad 1\text{'s comp}$$
$$\underline{\qquad\qquad 1 \quad +}$$
$$11100100 \quad 2\text{'s comp}$$

$$\begin{array}{r} 0001\ 1010 \\ 1110\ 0100 \ + \\ \hline 1111\ 1110 \end{array} \quad \Leftarrow \text{الجواب} =$$

$$(26)_{10} \div (28)_{10} = -2 \quad \Leftarrow \boxed{\text{التحقق}}$$

$$\begin{array}{r} 1111\ 1110 \quad \text{الجواب} \\ 0000\ 0001 \quad \text{نقلبه} \\ \underline{\qquad 1 \ +} \\ 0000\ 0010 \end{array}$$

نفس الرقم ✓   بحجم ①

$$(32)_8 - (0 0 1 1 1 1 1 1 0)_2 \Rightarrow$$

$$(32)_8 \rightarrow (0 1 1 0 1 0)_2$$

$0 \underline{1 1} \ 0 \underline{1 0}$

$$(0 0 0 1 \ 1 0 1 0)_2 + (-0 1 1 1 1 1 1 0)_2$$

$$(0 1 1 1 \ 1 1 1 0)_2 \curvearrowright (1 0 0 0 \ 0 0 0 1) \quad 1's \text{ complement}$$

$$\frac{+ \quad 1}{1 0 0 0 \ 0 0 1 0} \quad 2's \text{ comp}$$

$$\begin{array}{r} 0 0 0 1 \ 1 0 1 0 \\ 1 0 0 0 \ 0 0 1 0 \ + \\ \hline 1 \ 0 \ 0 1 1 1 0 0 \end{array}$$ الجواب النهائي

$$(32)_8 - (1 7 6)_8 = (-1 4 4)_8$$ للتأكد:

$$\begin{array}{r} 1 0 0 1 1 1 0 0 \quad \text{الجواب} \\ 0 1 1 0 0 0 1 1 \quad \text{نقلب} \\ \hline + \quad 1 \quad + 1 \\ \hline 0 1 1 0 0 \ 1 0 0 \rightarrow 2's \text{comp} \end{array}$$

$\underbrace{0 1 1 0 0}_{1 \quad 4} \ \underbrace{1 0 0}_{4} \checkmark$

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

$37/2 \rightarrow 18 \quad R=1$
$18/2 \longrightarrow 9 \quad R=0$
$9/2 \longrightarrow 4 \quad R=1$
$4/2 \longrightarrow 2 \quad R=0$
$2/2 \longrightarrow 1 \quad R=0$
$1/2 \longrightarrow 0 \quad R=1$
$(00100101)_2$

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

$39/2 = 19 \rightarrow R= 1$
$19/2 = 9 \quad R=1$
$9/2 = 4 \quad R=1$
$4/2 = 2 \quad R=0$
$2/2 = 1 \quad R=0$
$1/2 = 0 \quad R=1$

$(00100111) \rightarrow (11011000) \quad 1's \text{ com}$

$\underline{ 1} \quad +$

$\underline{11011001} \quad 2's \text{ comp}$

00100101
$\underline{11011001} \quad +$
(11111110) \qquad الجواب

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

11111110 \qquad الجواب
0000001 \qquad نقلب
$\underline{ 1} \quad +$
00000010 \qquad $2's \text{ comp}$

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

$$(1111\ 1101) + (-35)_8$$

$$(35)_8 \rightarrow (00011101)_2 \rightarrow \begin{array}{l} 11100010 \quad 1\text{'s comp} \\ \underline{\quad\quad\quad\ 1} + \\ 11100011 \quad 2\text{'s comp} \end{array}$$

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

over flow
bit   X $\longleftarrow$ 1 1 1 1 0 0 0 0 0

$$1110000 \quad \bigg\} \quad \text{The answer}$$

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 ..

① بحول من النظام العشري إلى الثنائي.
② يكمل لـ 16 منزلة (بت) عشان نستخدم two bytes.
③ بحول الرقم لـ Hex عن طريق table.

$$17/2 = 8 \quad R=1$$
$$8/2 = 4 \quad R=0$$
$$4/2 = 2 \quad R=0$$
$$2/2 = 1 \quad R=0$$
$$1/2 = 0 \quad R=1$$

$(10001)_2$ ①

0 0 0 0 0 0 0 0   0 0 0 1 0 0 0 1   ②
     0   0   1   1

③

$(17)_{10}$ ⟶

00	high
11	Low

Represnt 33 in memory :-

33/2 = 16   R = 1
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

$$(\underbrace{0000000}_{0} \underbrace{0}_{0} \underbrace{0010}_{2} \underbrace{0001}_{1})_2$$

$(33)_{10} \longrightarrow$

21	Low
00	high

Represnt (-17) in memory :-

17/2 = 8   R = 1
8/2 = 4   R = 0
4/2 = 2   R = 0
2/2 = 1   R = 0
1/2 = 0   R = 1

$(0000000000010001) \longrightarrow (1111111111101110)$ 1's complement

$$\underset{1+}{\qquad\qquad}$$

$$(\underbrace{1111}_{F} \underbrace{1111}_{F} \underbrace{1110}_{E} \underbrace{1111}_{F})$$ 2's comp

$(-17) \longrightarrow$

EF
FF

Represnt (-33) in memory ?

$(33)_{10} \rightarrow$ (0000 0000 0010 0001)$_2$ $\rightarrow$ 1111 1111 1101 1110   1's comp

$\underline{\hspace{8cm}}$ 1+

$\underbrace{1111}_{F} \; \underbrace{1101}_{D} \; \underbrace{1111}_{F})$ $\rightarrow$

DF	Low
FF	high

$\boxed{\text{characters} \quad (\text{حروف})}$

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

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

$(65)_{10} \longrightarrow (\qquad)$ in memory.

لذا نحولها لأ نظام ثنائي

$$65/2 = 32 \quad R = 1$$
$$32/2 = 16 \quad R = 0$$
$$16/2 = 8 \quad R = 0$$
$$8/2 = 4 \quad R = 0$$
$$4/2 = 28 \quad R = 0$$
$$2/2 = 1 \quad R = 0$$
$$1/2 = 0 \quad R = 1$$

$(0,1000001)$

خانة صفر عشان أخلي الاثمان زوجي نحن ٨

$\boxed{\text{Parity bits}}$

$\boxed{\text{even parity}}$ $\boxed{\text{odd parity}}$

بتخلي عدد الواحدات زوجي   بتخلي عدد الواحدات فردي

٢ بنحل parity bit

* even parity ; makes the number of ones even
* odd   "   ;   "   "   "   "   " odd.

٣ بنحول الى Hex من table.

$\underline{0100} \quad \underline{0001}$
4   1 $\boxed{41}$

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Represent Noor in memory :-

$N \longrightarrow ($ $0100\ 1110_{(E428)}$) | 4E |
$O \longrightarrow ($ $0110\ 1111$) | 6F |
$r \longrightarrow ($ $0111\ 0010$) | 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):-

$(82)_{10} \longrightarrow ($ ①$1101\ 0010$)$_2$ | D2 | in memory.
                       D   2

$82/2 = 41$ R=0 $\longrightarrow$ parity bit.
$41/2 = 20$ R=1
$20/2 = 10$ R=0
$10/2 = 5$ R=0
$5/2 = 2$ R=1
$2/2 = 1$ R=0
$1/2 = 0$ R=1

$(1010010$)

{Fractions} :- we use 4 byets to represent fractions

۳۲ بت

(Montissa representation):-

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

II حول من النظام العشري إلى الثنائي (العدد الصحيح لحال والكسري لحال).

48/2 = 24 R=0	0.875 × 2 = 1.75
24/2 = 12 R=0	0.75 × 2 = 1.5
12/2 = 6 R=0	0.5 × 2 = 1.0
6/2 = 3 R=0	
3/2 = 1 R=1	0.111
1/2 = 0 R=1	

(110000)

$(48.875)_{10}$ ——> $(110000.111)_2$

floating point (النقطة العائمة)

=> لازم P تكون على طريقة ← (scientific method)

Ex:- 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=1
1/2 = 0 R=1	1/2 = 0 R=1	1/2 = 0 R=1

1100 0100
12=C   4

1110 0101
E   5

1110 1100
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

1110 1111
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   in memory
    1/2 = 0   R = 1   ┌─────────┬──────┐
                           │   5 E   │ Low │
                           ├─────────┼──────┤
                           │   0 0   │ high │
         8 4 2   └─────────┴──────┘
0000 0000 0101 1110
      5   E

←────────────────────

═══════════════════════

Represent the following integer in memory using 2 - bytes?

(-94)

(94) → (0000 0000 0101 1110) → 1111 1111 1010 0001   1's comp
                                                    1   +
                              1111 1111 1010 0010   2's comp
                               F   F   A   2

                           ┌──────────┐
                           │   A2   │
                           ├──────────┤
                           │   FF   │
                           └──────────┘

Floating Point Representation

تمثيل النقطة العائمة

$Ex:-$ $54.3.1 = 54.31 \times 10$

$\qquad = 5.431 \times 10^2$] $\Longrightarrow$

$\qquad = 0.5431 \times 10^3$

١ علامة صح بين X أو تكون
على طريقة
Scientific method
(لا أنه يكون بس رقم على شمال الفاصلة) .

٢ X أنه تكون على طريقة (scientific method)

٣ بجمع العدد ١٢٧ للقوة

٤ يحول الى نظام٢ ثنائي

٥ يحول كلو لـ Hex

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

1⃣ بحول الرقم من نظام عشري إلى ثنائي .

$43/2 = 21$ $R=1$	$0.625 \times 2 = \boxed{1}.25$
$21/2 = 10$ $R=1$	$0.25 \times 2 = \boxed{0}.5$
$10/2 = 5$ $R=0$	$0.5 \times 2 = \boxed{1}.0$
$5/2 = 2$ $R=1$	
$2/2 = 1$ $R=0$	101
$1/2 = 0$ $R=1$	

101011

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

2⃣ استخدام scintific notation
x أي على يسار العلامة رقم واحد فقط

$$101011.101 = 1.01011101 \times 2^5$$

↗ كل أساس يمثل

1bit sign field	Exponent Field	Mantissa field.
0 موجب ✓ لأن الرقم 43 موجب	Rule $= x + 127$ ↳ Exponent (العدة) $= 5 + 127 = 132 = (\underset{4}{1000}\,\underset{2}{0100})$	

بما أن
الأرقام موجبة على اليسار
وعلامة الأرقام على اليمين

$\underbrace{0}\,\underbrace{1010\,1110}\,\underbrace{1000\,0000}\,\underbrace{0000\,0000}\,\underbrace{0000\,0000}$
$2 \qquad E \qquad B \qquad 0 \qquad 0 \qquad 0$

Memory

00
80
2E
42

Numbering System :-

حل أسئلة على

[A] convert the following :-

① $(00001110)_2 \longrightarrow (\quad 30 \quad)_{10}$

$0\times2^7 + 0\times2^6 + 0\times2^5 + 1\times2^4 + 1\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0 =$

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

② $(01101001) \longrightarrow (\quad 105 \quad)_{10}$

$0\times2^7 + 1\times2^6 + 1\times2^5 + 0\times2^4 + 1\times2^3 + 0\times2^2 + 0\times2^1 + 1\times2^0 =$

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

③ $(25)_{10} \longrightarrow (\quad 11001 \quad)_2$

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

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

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

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

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

④ $(547)_{10} \longrightarrow (\quad 100010011 \quad)_2$

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

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

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

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

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

$17/2 = \quad R = 1$

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

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

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

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

⑤ $(26.75)_{10} \longrightarrow (\quad 11010.11 \quad)_2$

$26/2 = 13 \quad R = 0 \qquad\qquad 0.75 \times 2 = 1.5$

$13/2 = 6 \quad R = 1 \qquad\qquad 0.5 \times 2 = 1.0$

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

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

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

⑥ $(0.2)_{10} \longrightarrow (\quad 0.\overline{0011}\quad)_2$

$0.2 \times 2 = 0.4$
$0.4 \times 2 = 0.8$
$0.8 \times 2 = 1.6$
$0.6 \times 2 = 1.2$
$0.2 \times 2 = 0.4$

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

$32/2 = 16 \quad R = 0$
$16/2 = 8 \quad R = 0$
$8/2 = 4 \quad R = 0$
$4/2 = 2 \quad R = 0$
$2/2 = 1 \quad R = 0$
$1/2 = 0 \quad R = 1$

$(00100000) \longrightarrow (11011111)$ 1's comp
$$\underline{\qquad\qquad 1 \qquad +}$$
$$11100000 \quad \overset{\curvearrowleft}{\text{2's}}$$

⑧ $(72)_{16} \longrightarrow (\quad 114\quad)_{10}$

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

⑨ $(72)_8 \longrightarrow (\quad 58\quad)_{10}$

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

$(B2.F)_{16} \longrightarrow (\qquad)_{10}$

$B \times 16^1 + 2 \times 16^0 = 11 \times 16 + 2$
$\qquad = 178$

$F = 15$

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

B) Solve the following using 8 bits and 2's complement:

① $(01111111)_2 - (76)_{10} =$

$(01111111)_2 + (10110100 \quad) = (\qquad)$

$76/2 = 38 \quad R = 0$
$38/2 = 19 \quad R = 0$
$19/2 = 9 \quad R = 1$
$9/2 = 4 \quad R = 1$
$4/2 = 2 \quad R = 0$
$2/2 = 1 \quad R = 0$
$1/2 = 0 \quad R = 1$

$(01001100) \longrightarrow 10110011 \qquad$ 1's comp
$$\begin{array}{r} 1 \, + \\ \hline 10110100 \end{array} \qquad \text{2's comp}$$

$$\begin{array}{r} \overset{11111}{01111111} \\ 10110100 \, + \\ \hline x \boxed{1}00110011 \end{array}$$

© Represnt $(-25.5)_{10}$ in memory

(1) 25/2 = 12   R= 1
    12/2 = 6   R= 0
    6/2 = 3   R= 0
    3/2 = 1   R= 1
    1/2 = 0   R= 1

$0.5 \times 2 = \boxed{1}.0$

(11001. 1)

(2) 1.10011×2^4

(3) $x + 127 = 131$

131/2 = 65   R= 1
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

1 0 0 0 0 0 1 1

وربطها ← 1 | 10000011 | 10011 00000000 00 000 00000
          C   1   C   C   C   O   0   0   0
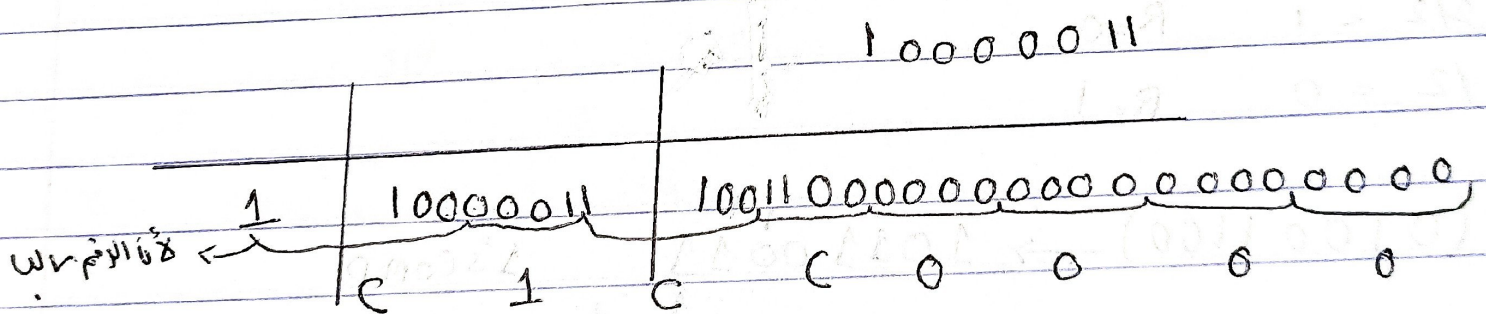
Memory:-

0 0	Low
0 0	
C C	
C 1	high

using 8 bit pattern and two comp, Find the answers

A) $(35)_{16} - (36)_{7} = ($ $)_{10}$

$(35)_{16} + (-36)_{7}$

$(36)_{7} \rightarrow (27)_{10} \longrightarrow (00011011)_{2}$

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

$27/2 = 13$ R=1
$13/2 = 6$ R=1
$6/2 = 3$ R=0
$3/2 = 1$ R=1
$1/2 = 0$ R=1
00011011

$(35)_{16} \rightarrow (0011\ 0101)_{2}$ ✓

$(-36)_{7} \rightarrow (00011011)_{2} \rightarrow (11100100)$ 1's comp
$1 +$
11100101 2's comp

```
      1  1      1    1
0 0 1 1 0 1 0 1
1 1 1 0 0 1 0 1   +
1 0 0 0 1 1 0 1 0 →
```

X
overflewbit
deleat

the answer → 0 0 0 11010

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

$(26)_{10} = $

8 4 2 1

B) $(132)_8 - (58)_{16} = ($ $)_a = ($ $)_4$

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

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

$(58)_{16} \longrightarrow (01011000)_2 \longrightarrow 10100111$ 1's comp

$\underline{\qquad\quad 1}$ +

10101000 2's comp.

001011010
$01010100 0$ +

overflow bit X — $1,000000010$
بنحذفها

$(0000\ 0010)_2 \longrightarrow ($ $)_a = ($ $)_4$

$(132)_8 \longrightarrow (1\times8^2 + 3\times8^1 + 2\times8^0) = (90)_{10}$

$(58)_{16} \longrightarrow (5\times16^1 + 8\times16^0) = (88)_{10}$

$(90)_{10} - (88)_{10} = (2)_{10} = (0000\ 0010)_2$ ✓

$(0000\ 0010)_2 \longrightarrow ($ 2 $)_{10} \longrightarrow ($ 2 $)_a$

$2/9 = 0$ R=2 $($ 2 $)_4$

$2/4 = 0$ R=2

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

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

$27/2 = 13 \quad R=1$ $0.875 \times 2 = 1.75$
$13/2 = 6 \quad R=1$ $0.75 \times 2 = 1.5$
$6/2 = 3 \quad R=0$ $0.5 \times 2 = 1.0$
$3/2 = 1 \quad R=1$
$1/2 = 0 \quad R=1$ 111

11011

11011.111

$\Rightarrow 1.1011111 \times 2^4$

1	10000011	1011111000000000000000000
	C 1	D F 0 0 0 0

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

$131/2 = 65 \quad R=1$
$65/2 = 32 \quad R=1$
$32/2 = 16 \quad R=0$
$16/2 = 8 \quad R=0$
$8/2 = 4 \quad R=0$
$4/2 = 2 \quad R=0$
$2/2 = 1 \quad R=0$
$1/2 = 0 \quad R=1$

0 0	Low order byte
0 0	
DF	
C1	high order byte

$$(13.4)_8 \rightarrow (\quad)_2$$

⇐ للتحويل من نظام ثماني الى ثنائي نراعي أن كل رقم عبارة عن ثلاث منازل

$$(13.4)_8 \longrightarrow (\underset{1}{001}\ 011\ .\ 1\ \underset{2}{00})$$

⇐ نكتبه بالطريقة العلمية بحيث نحرك الفاصلة الى أن يصبح على يسارها رقم واحد ⊡

$$001011.100 \longrightarrow 001.011100 \times 2^3$$

$$0\ |\ \underset{4\quad 1}{10000010}\ |\ \underset{3\quad 8\quad 0\quad 0\quad 0\quad 0}{011100\ 0000000000000000\ 0000}$$
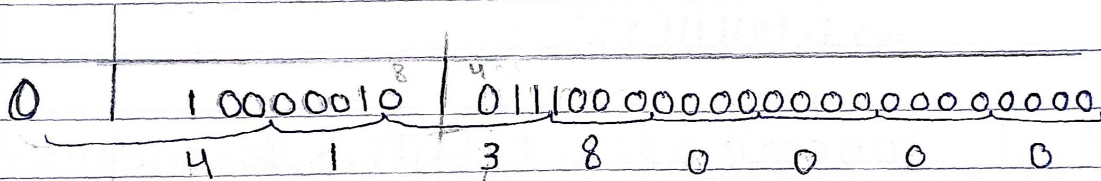
$$128 + 3 = 130$$

$$130/2 = 65 \quad R = 0$$
$$65/2 = 32 \quad R = 1$$
$$32/2 = 16 \quad R = 0$$
$$16/2 = 8 \quad R = 0$$
$$8/2 = 4 \quad R = 0$$
$$4/2 = 2 \quad R = 0$$
$$2/2 = 1 \quad R = 0$$
$$1/2 = 0 \quad R = 1$$

$$10000010$$

00
00
38
41

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

00	Low
00	
91	
C1	high

12

C1   91   00   00   8 4 2 1

1 1000001   1,001 0001 0000 0000 0000

قيمة الاشارة

$(10000011)_2 \longrightarrow (\quad 131 \quad)_{10}$

$\quad\quad 8\quad 6\quad 5\quad 4\quad 3\quad 2\quad 1\quad 0$
$1\times2 + 0\times2 + 0\times2 + 0\times2 + 0\times2 + 0\times2 + 1\times2 + 1\times2 = 1+2+128 = 131$

131 - 127 = 4   القوة

$(-1.001 0001 \times 2^4)$

$(\quad\quad)_{10} \longleftarrow (-10010.001)_2$

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

Represent the following two integers(2 bytes each using 2's comp)
in computer memory (Hex representation) 34, -21

$(34)_{10} \rightarrow (\qquad)_2$

34/2 = 17 R = 0
17/2 = 8 R = 1
8/2 = 4 R = 0
4/2 = 2 R = 0
2/2 = 1 R = 0
1/2 = 0 R = 1

0000000000100010
  0   0   2   2

2	2
0	0

$\dfrac{(-21)}{10}$

21/2 = 10 R = 1
10/2 = 5 R = 0
5/2 = 2 R = 1
2/2 = 1 R = 0
1/2 = 0 R = 1

0000000000010101) → (1111111111101010) 1's comp
                                              +

                          1111111111101011 2's comp

                           F   F   E   B

E B
F F

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

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

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

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

$$C:- (67)_{10} \rightarrow (\qquad)_2$$

67/2 = 33 R=1	97/2 = 48 R=1
33/2 = 16 R=1	48/2 = 24 R=0
16/2 = 8 R=0	24/2 = 12 R=0
8/2 = 4 R=0	12/2 = 6 R=0
4/2 = 2 R=0	6/2 = 3 R=0
2/2 = 1 R=0	3/2 = 1 R=1
1/2 = 0 R=1	1/2 = 0 R=1

$$(\overset{84}{11000}0\overset{21}{11})$$
  C   3

$$(\underline{1110000 1})$$
   E   1

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

116/2 = 58 R=0
58/2 = 29 R=0
29/2 = 14 R=1
14/2 = 7   R=0
7/2 = 3   R=1
3/2 = 1   R=1
1/2 = 0   R=1

in memory

C	C3
a	E1
t	74

0 1 1 1 0 1 0 0