

→ Q4: in sheet 1:

$$a) 0|11101 - 111101$$

→ direct
 → 1's Comp.
 → 2's Comp.

$$= \overline{1}$$

* direct:

$$\begin{array}{r}
 0|11101 \\
 - 111101 \\
 \hline
 0|11101 \\
 \hline
 -100000
 \end{array}$$

Decimal

* 1's Comp.

$$\begin{array}{r}
 0|11101 \\
 + 000010 \\
 \hline
 0|11111
 \end{array}$$

1's Comp. of
 (111101)
 (000010)

↳ the result = -1's Comp. of (01111)

$$\boxed{-100000}$$

1's Comp.

↳ 9's comp.

$\times \underline{2^{\text{nd}} \text{ Comp.}}$

$$\begin{array}{r} 011101 \\ -111101 \\ \hline 000011 \end{array}$$

$$\begin{array}{r} 011101 \\ + 000011 \\ \hline 100000 \end{array}$$

→ * the result = $\underline{2^{\text{nd}} \text{ Comp. of}}$
 (100000)
 $\underline{-} 100000$

$2^{\text{nd}} \text{ Comp.}$

→ $1^{\text{st}} \text{ Comp.}$

(2)

Q4: b)

$$11010 \cdot 11001 - 01101 \cdot 11100$$

$2 \rightarrow (1_0)$

* direct:

$$\begin{array}{r} \frac{1}{0} \quad \frac{2}{0} \quad \frac{2}{0} \\ + \frac{1}{0} \quad \frac{2}{0} \quad \frac{2}{0} \\ \hline 01101 \cdot 11100 \\ - 01101 \cdot 11100 \\ \hline 01100 \cdot 11101 \end{array}$$

* 1's Comp

$$\begin{array}{r} 11010 \cdot 11001 \\ + 10010 \cdot 00011 \\ \hline 01100 \cdot 11100 \\ \text{carry} \dots \dots \rightarrow 1+ \\ \hline 01100 \cdot 11101 \end{array}$$

$1^{\text{'}}\text{s Comp}$
 $(01101 \cdot 11100)$
 $\overbrace{10010 \cdot 00011}$

(3)

2's Comp.

$$11010 \cdot 11001 - 01101 \cdot \underbrace{1100}_{(10010 \cdot 00100)}$$

1's Comp.

$$\begin{array}{r} 11010 \cdot 11001 \\ + 10010 \cdot 00100 \leftarrow 2's \text{ Comp.} \\ \hline 01100 \cdot 1101 \end{array}$$

→ discard
first

— — —

* 9's Comp. → 1's Comp.

* 10's Comp. → 9's Comp.

Q5)

$$27.750 - 13.625$$

using 9's Comp.
10's Comp.

*9's Comp.

$$\begin{array}{r}
 10^3 \\
 + 27.750 \\
 + 86.374 \\
 \hline
 141.124
 \end{array}$$

↓
1+ ← 9's comp.

$$\left. \begin{array}{r}
 .9.9 \quad .9.9.9 \\
 13.625 \\
 (86.374) \\
 \hline
 9's comp.
 \end{array} \right\} 9's \text{ comp.}$$

$$\left. \begin{array}{r}
 \text{direct} \\
 27.780 \\
 - 13.625 \\
 \hline
 14.125
 \end{array} \right\}$$

(5)

$$27.750 - \underline{13.625} \\ 10's comp.$$

* 10's comp.

$$\begin{array}{r} 27.750 \\ + 86.375 \\ \hline \cancel{1}4.125 \end{array}$$

$$\begin{array}{r} -9-9-9-10 \\ 13.625 \\ -86.375 \\ \hline 10's Comp. \end{array}$$

$$\begin{array}{r} Ex. \\ \hookrightarrow 71.2300 \\ -10 \end{array}$$

$$28.7700$$

$$\rightarrow 71.2300$$

$$9's \text{ comp.} =$$

$$\rightarrow 28.7699$$

(1)

$$\hline 28.7700$$

10's comp.

(6)

$$\begin{array}{r} \text{Calculate:} \\ 13.625 \xrightarrow{\quad} 27.750 \\ = \xrightarrow{\quad} -14.125 \end{array}$$

*9's Comp.

$$\begin{array}{r} 13.625 \\ + 72.249 \\ \hline 85.874 \end{array}$$

$$\begin{array}{r} 9's \text{ Comp.} \\ -27.750 \\ \hline 72.249 \end{array}$$

→ The result =

$$\begin{array}{r} -9's \text{ Comp. of } (85.874) \\ -14.125 \end{array}$$

$$\begin{array}{r} -9 -9 -9 -10 \\ 27.750 \\ \hline 10's \text{ Comp.} \end{array}$$

*10's Comp.

$$\begin{array}{r} 13.625 \\ + 72.250 \\ \hline 85.875 \end{array}$$

$$\begin{array}{r} -9 -9 -9 -10 \\ 27.750 \\ \hline 72.250 \end{array}$$

$$\begin{array}{r} \text{The result} = -10's \text{ Comp. of } (85.875) \\ -14.125 \end{array}$$

(7)

* Signed Numbers:

$$(\dots)_2 \rightarrow (?)_{10}$$

$$(\dots)_{10} \rightarrow (?)_2$$

→ unsigned

→ signed magnitude.

→ 1's Comp.

→ 2's Comp.

→ Excess-notation.

$$(1001.1\bar{1})_2 \rightarrow (?)_{10}$$

-unsigned } $(9.75)_{10}$

-signed magnitude

$\boxed{1}001.\bar{1}^{2^{-2}}$ $1 \rightarrow -$
 $(-1.75)_{10}$ $0 \rightarrow +$

-1's comp.

$\boxed{0}01.11$
 $= -1's \text{ comp. of } (001.11)$
 $\quad \quad \quad -1^1 0.00$
 $\quad \quad \quad (-6)_{10}$

2's comp

$\boxed{-}001.11$
 $= -2's \text{ comp. of } (001.11)$
 $\quad \quad \quad -110.01$
 $\quad \quad \quad (-6.25)_{10}$

(9)

$$(0111 \cdot 10)_{\frac{1}{2}} \rightarrow (?)_{10}$$

unsigned: $(7.5)_{10}$

signed:

$$\begin{array}{r} 0 \downarrow 111.10 \\ (+ 7.5)_{10} \end{array}$$

1's comp.

$$\begin{array}{r} 0 \downarrow 111.10 \\ (+ 7.5)_{10} \end{array}$$

2's comp.

$$\begin{array}{r} 0 \downarrow 111.10 \\ (+ 7.5)_{10} \end{array}$$

(10)

Q7

$$(-12)_{10} \rightarrow (?)_2$$

5 bits.
 n

* Unsign

$$[0, 2^n - 1] = [0, 31]$$

(-12) in 5 bits.

$$(01100)_2 \quad 2 \div \boxed{12}$$

16.8421
0.1100

* signed
magnitudes

$$\left[\frac{5}{7} \times -1 \right] = \left[\frac{-5}{7} \right]$$

$(-12) \rightarrow (?)$, in 5 bits.

1106

$\begin{pmatrix} 1 & 1 & 0 & 0 \end{pmatrix}_2$ in signal
space

- ↛ |
+ ↛ 0

$$1's \text{ Comp. } (-12)_{10} \rightarrow (12)$$

in 5 bits.

$$\left. \begin{array}{l} 1's \text{ Comp.} \\ \{ \end{array} \right\} \left[\mp \left(2^{n-1} - 1 \right) \right] = [\mp 15]$$

$$-12$$

$$1's \text{ Comp. } (0 \mid 1 \ 0 \ 0)$$

$$(1 \ 0 \ 0 \mid 1)$$

$_2$ in 1's Comp.

$$2's \text{ Comp. } \left[- \left(2^{n-1} \right), + \left(2^{n-1} - 1 \right) \right]$$

$$[-16, +15]$$

$$-12$$

$$2's \text{ Comp. } \downarrow (0 \mid 1 \ 1 \ 0 \ 0)$$

$$(1 \ 0 \ 1 \ 0 \ 0)$$

$_2$ in 2's Comp.

(12)

(+) 12 in 5 bits

unsign \rightarrow

0 | 1 | 0 0

Signed \rightarrow

0 | 1 | 0 0

1's comp. \rightarrow $(0\ 1\ 1\ \cancel{0}\ 0)_2$ in 1's comp.

2's comp. \rightarrow $(0\ 1\ 1\ 0\ 0)$

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(13)

Exam - notation

$$(-)_{10} \rightarrow (?)_2 \text{ in Exam}$$

( b in Exam  $\rightarrow (?)_{10}$ )



$$\overbrace{(-12)}_{10} \xrightarrow{\text{Exam}} \text{Exam - 16}$$

$$[-16, +15]$$

$$-12 + 16 \Rightarrow 4$$

$$(00100)_2 \text{ in Exam}$$

|    |
|----|
| 16 |
|----|

5 bits  
16 . 8 . 4 . 2 . 1



(14)

$(1101)_2$  in EKm<sub>8</sub>  $\rightarrow (?)_{10}$   
(4 bits)

$$\begin{array}{r} \overset{8\ 4\ 2\ 1}{\underline{1\ 1\ 0\ 1}} - 1000 \\ 13 - 8 \Rightarrow (+5)_{10} \end{array}$$

(2 intex)  
not  
 $-8$   $\downarrow$   $(?)_{10}$   
not



(15)

# \* Subtraction using signed 2's

Complement:

a)  $\rightarrow +5 + 2$

in 5 bits

b)  $\rightarrow +5 - 2$

c)  $\rightarrow -5 + 2$

d)  $\rightarrow -5 - 2$

e)  $\rightarrow -5 - (+2)$

f)  $\rightarrow -5 + (-2)$

g)  $\rightarrow -5 - (-2)$

a) +5 +2 in 5 bits.

2's Comp.

$$\begin{array}{r} +5 \rightarrow 00101 \\ +2 \rightarrow 00010 \\ \hline +7 \rightarrow 00111 \end{array}$$



$$\begin{array}{r} 16 \ 3 \ 4 \ 2 \ 1 \\ 0 \ 0 \ 1 \ 0 \ 1 \\ 0 \ 0 \ 0 \ 1 \ 0 \end{array}$$



b) +5 -2

$$\begin{array}{r} +5 \rightarrow +00101 \rightarrow 00101 \\ -2 \rightarrow -00010 \rightarrow 11110 \\ \hline +3 \rightarrow 00011 \end{array}$$

$$\begin{array}{r} 05 \rightarrow -00101 \rightarrow 11011 \\ +2 \rightarrow +00010 \rightarrow 00010 \\ \hline 03 \rightarrow 11101 \end{array}$$

∴ the result = -2's Comp.

of (11101)

- 00010 ←

(17)

d)

$$\begin{array}{r}
 -5 \\
 -2 \\
 \hline
 -7
 \end{array}
 \rightarrow
 \begin{array}{r}
 00101 \\
 00010 \\
 \hline
 \text{X}11001
 \end{array}$$

the result = -2's Comp.

~~OF(11001)~~

c)  $-5 - (+2)$

$$\begin{array}{r}
 -5 \\
 -2 \\
 \hline
 -7
 \end{array}$$

f)  $-5 + (-2)$

$$\begin{array}{r}
 -5 \\
 -2 \\
 \hline
 -7
 \end{array}$$

$$\begin{array}{r}
 -5 \\
 +2 \\
 \hline
 -3
 \end{array}$$

(c)

$\overset{?}{2}$  bits

$$0 \rightarrow 00$$

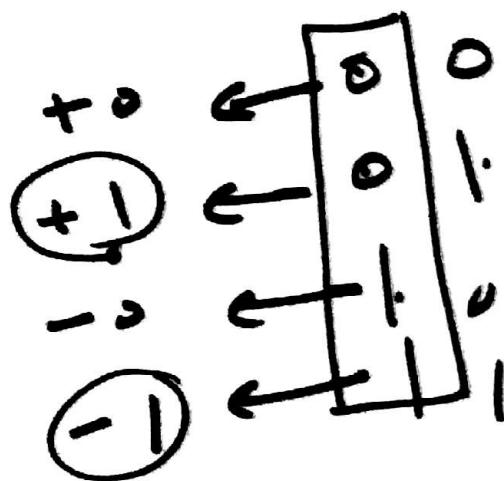
$$\left[0, 2^n - 1\right]$$

$$1 \rightarrow 01$$

$$\left[0, 3\right]$$

$$2 \rightarrow 10$$

$$3 \rightarrow 11$$



$$\left[-(2^{n-1})\right]$$

$$2-1$$

$$\left[\mp 1\right]$$