

## 1d - Number System (2s comp to Decimal).

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$$10001 \rightarrow -15$$

(signed no.)

### Method 1

Weight of MSB is in (-)ve.

$$\begin{array}{l} \textcircled{i} \quad 0101 \rightarrow 2^0 \\ \quad \downarrow \\ \quad -2^3 \end{array} \Rightarrow -0.2^3 + 1.2^2 + 0.2^1 + 1.2^0$$
$$\Rightarrow 0 + 4 + 0 + 1 = 5$$

$$\begin{array}{l} \textcircled{ii} \quad 1011 \Rightarrow -1.2^3 + 0.2^2 + 1.2^1 + 1.2^0 \\ \quad \downarrow \quad \quad \downarrow \\ \quad -2^3 \quad 2^0 \Rightarrow -8 + 0 + 2 + 1 \\ \\ \Rightarrow -5 \end{array}$$

$$\begin{array}{l} \textcircled{iii} \quad 10001 = -1.2^4 + 1.2^0 \\ \quad \quad \quad = -16 + 1 \\ \quad \quad \quad = -15 \quad \underline{\text{-Ans.}} \end{array}$$

### Method 2

$\textcircled{i}$  If no. is (+)ve, convert to decimal normally

$\textcircled{ii}$  If no. is negative, convert to decimal. Put in a minus sign

~ means sign.

eg:  $1101 \xrightarrow[\text{comp}]{2's} \begin{array}{r} 0010 \\ + 1 \\ \hline 0011 \end{array} \rightarrow 3 \xrightarrow[\text{minus}]{\text{add}} -3.$

Copying Unsigned Numbers to higher bit representation:

(i) Copying Unsigned Number (zero extension):

$0101$  4bit  $\rightarrow$  6 bit

Use case: Short  $x = 5;$       Short is 16 bit  
              int  $y = x;$       Int is 32 bit.

$0101 \rightarrow$   $00000101$

$\therefore$  the no. is unsigned, always fill with 0.

Q:  $1010$  unsigned to 8 bits

Ans)  $00001010$

## ② Signed Number Copying (sign extension)

Signed bit 0 or 1 needs to be copied.

Q Copy 10010110 to 9-bits

Ans)

1 1 0 0 1 0 1 1 0

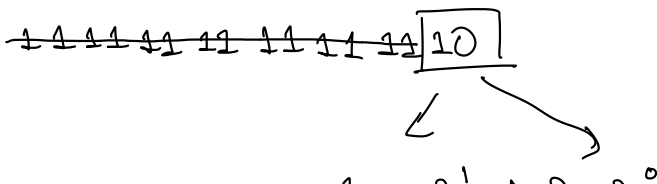


Adding 0 would make MSB +ve,  
but original no. is -ve.

By adding 1, the no. remains unchanged.

| 4-bit | 8-bit     | 16-bit                 | Decimal |
|-------|-----------|------------------------|---------|
| 0111  | 0000 0111 | 00 00 00 00 00 00 0111 | +7      |
| 1110  | 1111 1110 | 1111 11 11 11 11 11 10 | -2      |

Convert 16-bit to decimal: All 1's except left most one can be ignored.



$$+2 + 0 + 2$$

$$= -2$$

Sign extension is a step in converting a signed integer from one size to another.

Min & Max no. in Unsigned form with k bits

let  $k = 4$ .

$$\underline{1} \quad \underline{1} \quad \underline{1} \quad \underline{1} \longrightarrow \text{max} = 15$$

$$\text{min} = 0$$

If Signed

$$\underline{1} \quad \underline{1} \quad \underline{1} \quad \underline{1} \longrightarrow \text{min} = -7$$

$$\underline{0} \quad \underline{1} \quad \underline{1} \quad \underline{1} \longrightarrow \text{max} = 7$$

Homework

1. 1.b. have 7 bits to represent integer

then what will be the 2's complement signed no. we can represent.

Ans) largest unsigned: 1 1 1 1 1 1 1

largest 2's comp signed: 0 1 1 1 1 1 1

(2's comp, so the MSB matters)

Q Complete the following table

| Decimal | 2's complement    |                 |
|---------|-------------------|-----------------|
| -256    | 1 0 0 0 0 0 0 0   |                 |
| -154    | 1 0 1 1 0 1 1 0   |                 |
| -107    | 1 0 0 1 0 1 1     | 1 0 0 1 0 1 0 1 |
| 135     | 0 1 0 0 0 0 1 1 1 |                 |