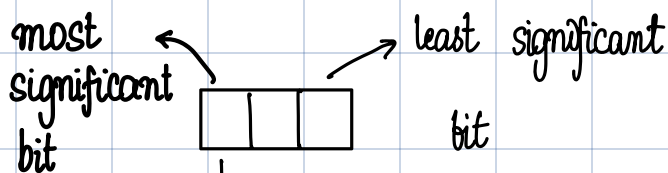


# Binary Number System

$$\begin{array}{r} 110 \\ - 010 \\ \hline 100 \end{array}$$

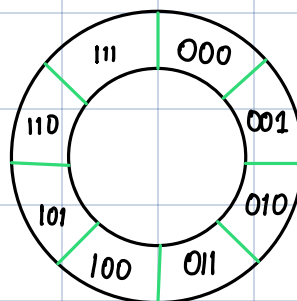
borrow from 4<sup>th</sup> bit → inconsistent result

$$\begin{array}{r} 111 \\ - 110 \\ \hline 111 \\ - 111 \\ \hline 000 \end{array}$$



can be used as sign bit

$$\begin{bmatrix} 0 \rightarrow +ve \\ 1 \rightarrow -ve \end{bmatrix}$$



## \* Signed number representation

| Binary | Decimal |
|--------|---------|
| 000    | + 0     |
| 001    | + 1     |
| 101    | - 1     |
| ⋮      | ⋮       |

$\frac{n \text{ bits}}{\text{(no sign bit)}}$   
↓  
0 to  $2^n - 1$

$\frac{n \text{ bits}}{\text{(1 sign bit)}}$   
 $-2^{n-1} + 1 \leftarrow 0 \rightarrow 2^{n-1} - 1$

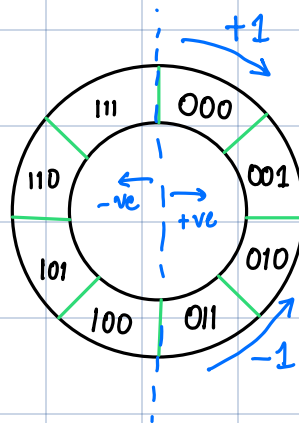
|   |   |   |   |
|---|---|---|---|
| 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 |

$$\left. \begin{array}{r} 6 \\ -7 \end{array} \right\}$$

$$\begin{array}{r} 0110 \\ -0111 \\ \hline \end{array}$$

$$\begin{array}{r} \downarrow \\ - \left[ \begin{array}{cccc} 0 & 1 & 1 & 1 \\ -0 & 1 & 1 & 0 \end{array} \right] \\ \hline 1001 \end{array}$$

\* 2's complement system



→ Increase in count in CW

→ Decrease in count in CCW

$$\begin{array}{r} 010 \quad (2)_{10} \\ -011 \quad (3)_{10} \\ \hline \end{array}$$

| Binary | Decimal |
|--------|---------|
| 000    | +0      |
| 001    | 1       |
| 010    | 2       |
| 011    | 3       |
| 100    | -4      |
| 101    | -3      |
| 110    | -2      |
| 111    | -1      |

$$\begin{aligned} 715 - 897 \\ = 715 + (-897) + \cancel{Z} - \cancel{Z} \quad \text{subtraction is easy} \\ = 715 + (-897 + \cancel{Z}) - \cancel{Z} \end{aligned}$$

Choose  $Z = 1000$

$$-897 + Z = 103$$

$$715 - 897$$

$$= 818 - 1000$$

$$= -(1000 - 818)$$