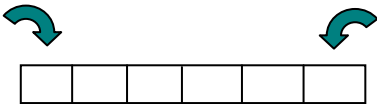


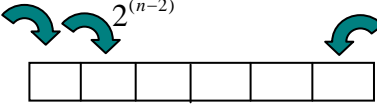
## EE200 DIGITAL LOGIC CIRCUIT DESIGN

The material covered in this class will be as follows:

- Signed binary numbers
- Addition and Subtraction of Signed binary numbers.

### Signed Binary Numbers:

Unsigned binary numbers  $\rightarrow 2^{(n-1)}$    
n bit binary number  $\rightarrow$

Signed binary numbers  $\rightarrow$  Sign bit 

The sign bit is 0 for " + " and 1 for " - ".

Three types of signed numbers are used

Examples using 8 bits

1. Signed magnitude representation 

+9	$\rightarrow$	00001001
-9	$\rightarrow$	10001001
2. Signed 1's complement representation 

+9	$\rightarrow$	00001001
-9	$\rightarrow$	11110110
3. Signed 2's complement representation 

+9	$\rightarrow$	00001001
-9	$\rightarrow$	11110111

## Addition of signed binary numbers:

1. In signed magnitude representation follow the rules of ordinary arithmetic. If the signs are the same, add the magnitudes and give the sum the same sign. If different signs, subtract and give the result the sign of the big number.
2. In complement representation, add the two numbers including the sign bit. Any carry out from the sign bit is ignored. No comparison or subtraction is needed.

### Examples:

Add  $(-6) + (+13)$  using signed 2's complement form with 8 bits. Repeat for  $(+6) + (-13)$

**Answer →**  $(+6) \equiv 00000110$  and  $(+13) \equiv 00001101$   
 $\therefore (-6) \equiv 11111010$  and  $(-13) \equiv 11110011$  .

$$\begin{array}{r} -6 \rightarrow 11111010 \\ +13 \rightarrow 00001101 \\ \hline 100000111 \end{array} \rightarrow \text{Answer is } +7$$

Carry  
out

Sign bit

Also,  $\begin{array}{r} +6 \rightarrow 00000110 \\ -13 \rightarrow 11110011 \\ \hline 11111001 \end{array} \rightarrow \text{Answer is } -7$

Sign bit

## Arithmetic Subtraction:

Take the 2's complement of the subtrahend, including the sign bit, and add it to the minuend. A carry out is discarded.

$$(\pm A) - (\pm B) = (\pm A) + (\mp B)$$

### Example:

Perform the subtraction  $(-6) - (-13)$  using signed 2's complement representation with 8 bits.

$$\begin{array}{rcl} (-6) & 11111010 & \rightarrow (-6) \quad 11111010 \\ -(-13) & 11110011 & \rightarrow +(+13) \quad 00001101 \\ \hline & 100000111 & \rightarrow \text{Answer is } +7 \end{array}$$

