BINARY, SIGNED AND UNSIGNED NUMBER

- What about negative numbers in binary?
  - There are 2 methods for representing a negative number
  1. Sign and magnitude
     - Reserve the most significant bit(MSB) for sign
     - 0 for positive and 1 for negative
     - $(0101)_2 = (5)_{10}$
     - $(1101)_2 = (-5)_{10}$

Signed denary number to be represented	Sign and magnitude representation	Two's complement representation
+7	0111	0111
+6	0110	0110
+5	0101	0101
+4	0100	0100
+3	0011	0011
+2	0010	0010
+1	0001	0001
+0	0000	0000
−0	1000	Not represented
−1	1001	1111
−2	1010	1110
−3	1011	1101
−4	1100	1100
−5	1101	1011
−6	1110	1010
−7	1111	1001
−8	Not represented	1000

SIGN AND MAGNITUDE SYSTEM

- Write these number in binary with sign and magnitude system
- 4-bit
  - 10
  - -5
- 8-bit
  - 65
  - -20

BINARY, TWO'S COMPLEMENT

2. Two's complement

- There are 2 methods to convert normal binary to Two's complement
- Method 1
  1. One's complement
     - Invert each bit; 0 => 1 and 1 => 0
  2. Two's complement
     - Add 1 to the least significant digit (LSD)

Example, covert 5 to -5 by using two's complement

BINARY, TWO'S COMPLEMENT

- Convert these number to negative value using 1st method
- 4-bit
  - 10
  - 6
- 8-bit
  - 20
  - 10
- Extra question
  - What would happen if we use two's complement with -20

BINARY, TWO'S COMPLEMENT

- Two's complement
- Method 2
  1. Consider the most significant digit is negative
  2. Multiple each place value with 0 or 1; Put 1 into the place values that can make to total of result equals to the target

Example, covert 5 to -5 by using two's complement

-128	64	32	16	8	4	2	1

BINARY, TWO'S COMPLEMENT

- Convert these number to negative value using 2nd method
- 4-bit
  - 10
  - 6
- 8-bit
  - 20
  - 10

BINARY TWO'S COMPLEMENT

- Subtraction?
  - Computer processors don't have a circuit for subtraction
  - 28 – 5 : computers cannot do the calculation
  - 28 + (-5) : computers can do the calcucation
  - Use of two's complement

Worked example

Add 28 and –5.

This is more difficult. The result should be 23.

The two's complement representation of –5 is

5	0	0	0	0	0	1	0	1
Flip	1	1	1	1	1	0	1	0
Add 1	1	1	1	1	1	0	1	1

Adding binary 28 to binary –5 gives

0	0	0	1	1	1	0	0
1	1	1	1	1	0	1	1
0	**0**	**0**	**1**	**0**	**1**	**1**	**1**

The result is 00010111, which is the binary equivalent of 23.

BINARY TWO'S COMPLEMENT

- Show working for -5 + 10, using 4-bit binary