EARNEST ACADEMY

SUBJECT: DIGITAL COMPUTER PRINCIPLES

FACULTY NAME: JYOTHSNA S MOHAN

BINARY MULTIPLICATION

Rules for Binary multiplication

Case	A x B	Multiplication
1	0 x 0	0
2	0 x 1	0
3	1 x 0	0
4	1 x 1	1

Example:

0011010 x 001100 = 100111000

```
     0 0 1 1 0 1 0   = 26₁₀
   x 0 0 0 1 1 0 0   = 12₁₀
   ---------------
     0 0 0 0 0 0 0
   0 0 0 0 0 0 0
 0 0 1 1 0 1 0
0 0 1 1 0 1 0
   ---------------
0 1 0 0 1 1 1 0 0 0  = 312₁₀
```

Q. Multiply 1011.101, 101.01

```
                1    0    1    1    1    0    1 *
                     1    0    1    0    1
-------------------------------------------------------
                     1    0    1    1    1    0    1
                0    0    0    0    0    0    0
           1    0    1    1    1    0    1
      0    0    0    0    0    0    0
 1    0    1    1    1    0    1
---------------------------------------------------------------
 1    1    1    1    0    1 .  0    0    0    0    1
```

Q. When two 4-bit binary number $A= a_3\, a_2\, a_1\, a_0$, $B = b_3\, b_2\, b_1\, b_0$ are multiplied, the digit c_1 of the product C is given by [GATE 1991]

$$
\begin{array}{cccc}
a_3 & a_2 & a_1 & a_0\, * \\
b_3 & b_2 & b_1 & b_0
\end{array}
$$

.... $a_1\, b_0$ $a_0\, b_0$

.... $a_0\, b_1$

....

$c_6\quad c_5\quad c_4\quad c_3\quad c_2\quad c_1\quad c_0$

Ans: $c_1 = a_1\, b_0 + a_0\, b_1$

BINARY DIVISION

Rules for binary division

DIVIDEND	DIVISOR	RESULT
0	0	Not allowed
0	1	0
1	0	Not allowed
1	1	1

101010 / 000110 = 000111

```
              1 1 1        = 7₁₀
         ______________
000110 ) 1 0 1 0 1 0       = 42₁₀
        -1 1 0             = 6₁₀
        ______
         1 0 0 1
        -1 1 0
        ______
           1 1 0
          -1 1 0
          ______
               0
```

Q. If $(11001101)_2$ is divided by $(110)_2$ the remainder is :

a) 101 b) 11 c) 0 d) 1

Ans : d)

Q. If $(11001101)_2$ is divided by $(110)_2$ the Quotient is :

a) 11011 b) 1111 c) 100010 d) 100001

Ans : c)

REPRESENTATION OF SIGNED NUMBERS

- 2 ways of representing signed numbers

  a) Sign magnitude form

  b) Complement form

     i) 1's complement form

     ii) 2's complement form

SIGNED MAGNITUDE FORM

- In the signed magnitude method number is divided into two parts:

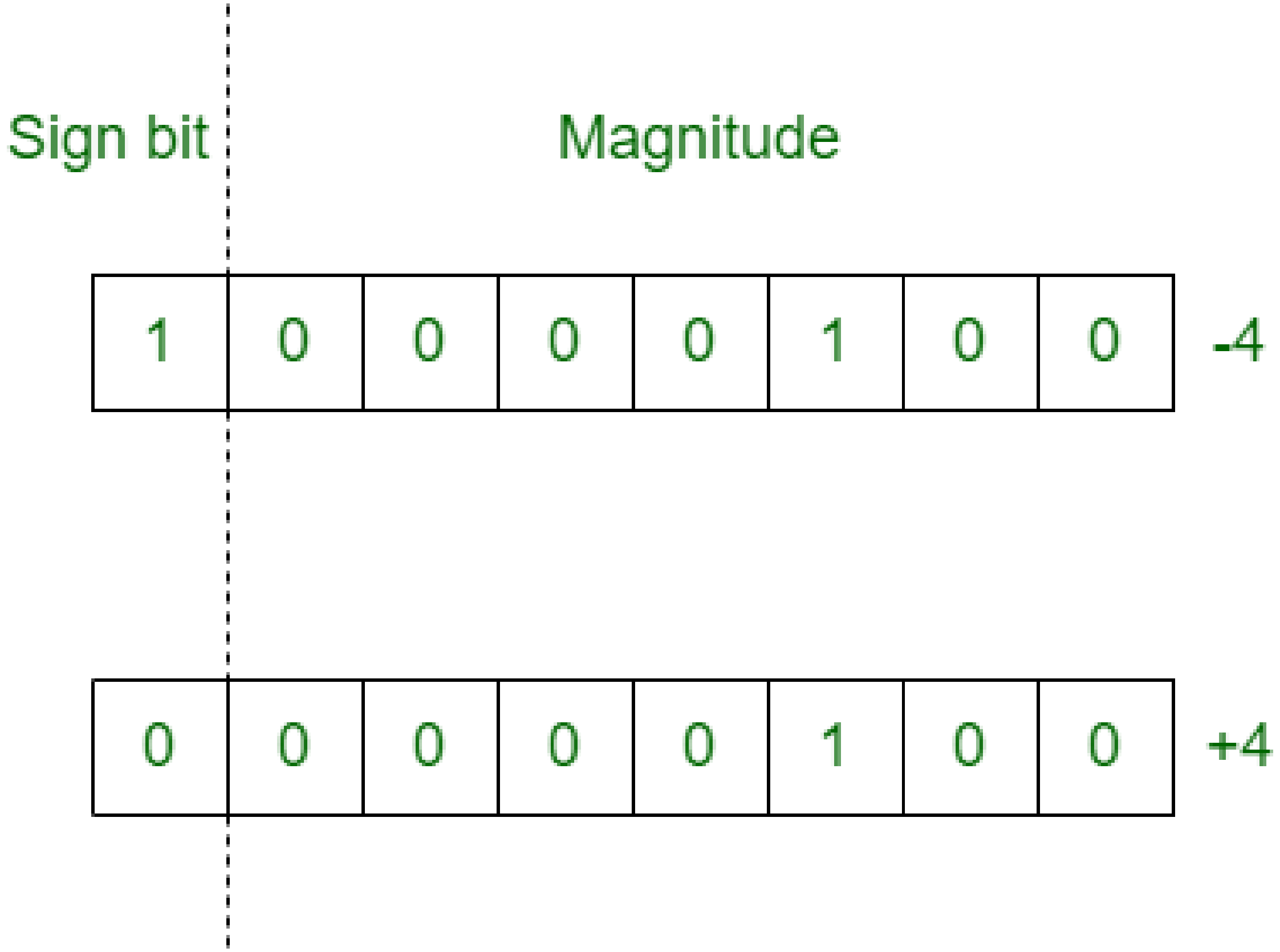
  1) Sign bit

     MSB =1 for negative number

     MSB = 0 for positive number

  2) Magnitude

     Represented with the binary form of the number.


Sign bit
Magnitude
1 0 0 0 0 1 0 0
-4
0 0 0 0 0 1 0 0
+4

- Only difference between +ve & -ve number is the sign bit

- To negate sign-magnitude numbers, simply toggle the sign bit.

- Two representations for the number zero.

  10000000

  00000000

Q) The decimal values of the given 8-bit sign-magnitude number 10000011 is

Ans:

Q) -15 in 8-bit sign-magnitude form is……………..

Ans:

Q) The decimal values of the given 8-bit sign-magnitude number 10000011 is

Ans: -3

Q) -15 in 8-bit sign-magnitude form is…………….

Ans: 10001111

FINDING 1'S COMPLEMENT OF A BINARY

- Invert the given number.

  1→ 0

  0 → 1

Q . Find the 1's complement of 10010001

Binary →	1	0	0	1	0	0	0	1
1's complement →	0	1	1	0	1	1	1	0

FINDING 2’S COMPLEMENT

Method1:

Add 1 to the LSB of 1’s complement

Q: Find 2’s complement of the binary 10110010

Binary→	1	0	1	1	0	0	1	0
1’s →	0	1	0	0	1	1	0	1+
								1
2’s →	0	1	0	0	1	1	1	0

Method 2:

1. Start at the least significant bit(LSB) copy all the zeros, until the first 1 is reached

2. Copy that 1

3. Flip all the remaining bits

Q: Find 2’s complement of the binary 10110010

Binary →	1	0	1	1	0	0	1	0
2’s Complement →	0	1	0	0	1	1	1	0

Q. The 2’s complement of a binary number is 101001 is

a) 010101 b) 01110 c) 100101 d) 010111

Ans: d

Q. Which of the following 4 bit number equals its 2’s complement

a. 0101

b. 1000

c. 1010

d. No number exists

Ans: b

- To convert from a 1's or 2's complement back to binary form , use the same procedure

2's Complement →	0	1	0	0	1	1	1	0
Binary →	1	0	1	1	0	0	1	0

1'S COMPLEMENT FORM

EARNEST ACADEMY

- +ve numbers in 1's complemented form : Same as +ve numbers in sign magnitude form
- -ve numbers in 1's complemented form :1's complement of the corresponding +ve numbers

–ve = 1's(+ve)

+25 = 0 0 0 1 1 0 0 1

-25 = 1 1 1 0 0 1 1 0

2'S COMPLEMENT FORM

- +ve numbers in 2's complemented form : Same as +ve numbers in sign magnitude form & 1's complemented form
- -ve numbers in 2's complemented form : 2's complement of the corresponding +ve numbers

–ve = 2's(+ve)

+25 = 0 0 0 1 1 0 0 1

-25 = 1 1 1 0 0 1 1 1

- Represent +51 , -51 in

  Sign magnitude

  1’s complemented form

  1’s complemented form

Binary : 1 1 0 0 1 1

+51	
Sign magnitude	0 0 1 1 0 0 1 1
1's	
2's	

-51								
Binary	0	0	1	1	0	0	1	1
Sign magnitude	1	0	1	1	0	0	1	1
1's	1	1	0	0	1	1	0	0
2's	1	1	0	0	1	1	0	1

Y

Q. The 2’s complement representation of the decimal value is -15 is

a) 1111 b) 11111 c) 111111 d) 10001

Ans: d

DECIMAL VALUE OF SIGNED NUMBERS

- Decimal value of +ve & -ve numbers in sign magnitude form = Sum of the weights of all 1's in the magnitude bit positions
- Sign determined by the sign bit given.

Sign magnitude form	0	0	1	1	0	0	1	1
Weights			32	16			2	1
Decimal	**+51**							

Sign magnitude form	1	0	1	1	0	0	1	1
Weights			32	16			2	1
Decimal	**-51**							

DECIMAL VALUE OF 1'S COMPLEMENTED NUMBERS

- +ve numbers = Sum of the weights of all 1's in the magnitude bit positions

-ve numbers = -ve value to the weight of sign bit + sum of the weights of all 1's in the magnitude bit positions +1

Q. Determine the decimal value of the signed number expressed in 1's complement

a). 00010111

b). 11101000

a)

1's	0	0	0	1	0	1	1	1
weights				16		4	2	1

Ans: 23

b)

1's	1	1	1	0	1	0	0	0	
weights	-128	64	32		8				+1

Ans: -23

DECIMAL VALUE OF 2'S COMPLEMENTED NUMBERS

- +ve numbers & -ve numbers = Sum of the weights of all 1's in the magnitude bit positions with weight of sign bit of –ve number –ve .

Q. Determine the decimal values of the signed number in 2's complement form

a) 01010110

b) 10101010

a) 01010110

2's	0	1	0	1	0	1	1	0
weights		64		16		4	2	

Ans: + 86

b) 10101010

2's	1	0	1	0	1	0	1	0
Weights	-128		32		8		2	

Ans: - 86

Q. A 4 bit 2's complement representation of a decimal number is 1000. The number is

a) 8   b) 0   c) -7   d) -8

Ans: d

- 2’s Complement form is priffered.

One representation for 0

Simply requires summation of weights for both +ve & -ve

Q. Zero has 2 representations in

a) sign magnitude b) 1's complement c) 2's complement d) None of these

Ans: a & b

2's complemented

-2^{n-1} to $(2^{n-1} - 1)$

Sign magnitude &

1's complemented

$-2^{n-1}+1$ to $(2^{n-1} - 1)$

Q : The range of integers that can be represented by an n bit 2's complement number system is

a) -2^{n-1} to $(2^{n-1} - 1)$

b) $-(2^{n-1} - 1)$ to $(2^{n-1} - 1)$

c) -2^{n-1} to 2^{n-1}

d) $-(2^{n-1} + 1)$ to $(2^{n-1} + 1)$

Ans: a)

Q. The smallest integer that can be represented by an 8 bit number in 2's complement form is

a) -256 b) -128 c) -127 d) 0

Ans: b) -128