Tutorial Problems 1

1. Find the two's complement representation for the following numbers, assuming that they are represented as a 16-bit number.

   Write the value in both binary and hexadecimal.

   a) −93

   b) 1034

Steps:

- First convert the magnitude number into binary.
- If number is positive, stop, else proceed to next step.
- Compute the 1's complement by inverting the bits.
- Add 1 to the 1's complement to obtain the 2's complement number.

a) 93 = 1 0 1 1 1 0 1 B

Can be converted by hand using **repeated division** by 2 and keeping track of the remainders.

2 ∟ 93
2 ∟ 46 Remainder 1 (**Least Significant bit**)
2 ∟ 23 Remainder 0
2 ∟ 11 Remainder 1
2 ∟ 5 Remainder 1
2 ∟ 2 Remainder 1
2 ∟ 1 Remainder 0
0 Remainder 1

In 16-bit format, 93 can be represented as

0 0 0 0 0 0 0 0 0 1 0 1 1 1 0 1 B

0 0 0 0 0 0 0 0 0 1 0 1 1 1 0 1 B (93)

Invert the bits to get the 1's complement:

1 1 1 1 1 1 1 1 1 0 1 0 0 0 1 0 B

Add 1 to obtain the 2's complement.

1 1 1 1 1 1 1 1 1 0 1 0 0 0 1 0 B

+ 1 B

1 1 1 1 1 1 1 1 1 0 1 0 0 0 1 1 B

(2's complement representation of −93 in Binary)

F F A 3

or **0xFFA3** in 16-bit **hexadecimal** format

b) 1034 = 1 0 0 0 0 0 0 0 1 0 1 0 B

In 16-bit format

0 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 B

0 4 0 A

or **0x040A** in 16-bit hexadecimal format

2. Using the smallest data size possible, either a byte, a halfword (16 bits), or a word (32 bits), convert the following values into two's complement representations:

    a) −18,304

    b) −20

2. Two's complement integer ranges

Byte : −128 to 127

Halfword : −32,768 to 32,767

Word: −2,147,483,648 to 2,147,483,647

a) −18,304 can be represented using Halfword or 16 bits

Halfword : −32,768 to 32,767

In 16-bit format, 18304 can be represented by

0 1 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 B

1 0 1 1 1 0 0 0 1 0 0 0 0 0 0 0 0 B

(converted to 2's complement form)

Byte : **−128 to 127**

b) -20 can be represented by a byte or 8 bits
In 8-bit format, 20 can be represented by

0 0 0 1 0 1 0 0 B
1 1 1 0 1 1 0 0 B (2's complement form)

6. Convert the following numbers into binary numbers

a) Decimal number: 8.625

b) Hexadecimal number : A1.E8

6. Have to **separate the number into two parts**, the whole number part and the fractional part.

a) 8.625 = 8 + **0.625**

- Convert the whole number part using repeated division by 2.

  8 decimal = 1 0 0 0 Binary

- Convert the **fractional part** using repeated multiplication by 2.

  0.625 × 2 = 1.25 ; 1

  0.25 × 2 = 0.5 ; 0

  0.5 × 2 = 1.0 ; 1

  Hence the binary number equivalent of 8.625 will be **1 0 0 0. 1 0 1**

b) Hexadecimal to binary conversion is simple even for float numbers

A	1	.	E	8
1010	0001	.	1110	1000

Hence answer is 10100001.11101 Binary