Tutorial Problems 1

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

Write the value in both binary and hexadecimal.

- a) -93
- b) 1034

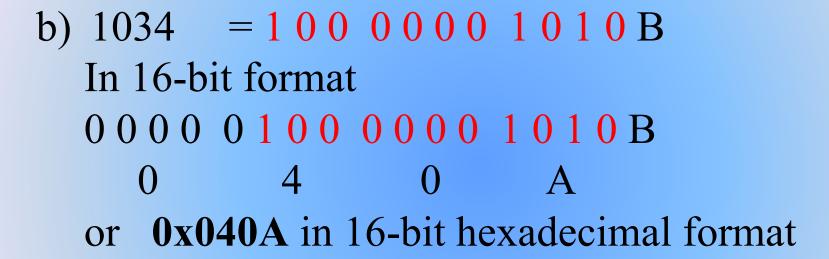
Steps:

- 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.

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a) 93 = 1011101B
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
      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

0000000001011101B(93) Invert the bits to get the 1's complement: 11111111110100010B Add 1 to obtain the 2's complement. 11111111110100010B 11111111110100011B (2's complement representation of -93 in Binary) or 0xFFA3 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 <u>1 0 0 0 0 0 0 0</u> B

1011 1000 1000 0000 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 <u>1 0 0</u> 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

- 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.
 - $8 \text{ decimal} = 1 \ 0 \ 0 \ 0 \text{ Binary}$
 - Convert the **fractional part** using repeated multiplication by 2.

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0.625 \times 2 = 1.25; 1
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$$0.25 \times 2 = 0.5$$
; 0

$$0.5 \times 2 = 1.0$$
;

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