Assignment 1 for COMP 2280

Due: 11:30 PM on Friday February 16th, 2021

Total Marks: 32

- You can use this Word document to complete the assignment, use another word processing program, or do the work on paper and scan it.
- It is the Student's responsibility to ensure your work is legible and readable for the markers.
- Handin your assignments and work as a **single PDF document.**
    a. If you do your work on paper, you must scan it, and add the images to the word document before exporting as a pdf.
    b. Including the original Word document and/or scans is optional but can be useful if issues arise.
- If the markers are required to go through multiple files to find all of your work, you will lose points.
- Do the conversions by hand, show your work, and do not skip steps, answers without work get a zero.
- Remember, you CAN use the Base Conversion Table provided on UMLearn!

Written Questions

1. (2 marks) Convert each of the following **signed magnitude** three hexadecimal digit (12 bits) hexadecimal numbers to decimal.
    - Do the conversions by hand and show your work and **don't skip steps.**
    - You can either convert Hex->Decimal or Hex->Binary->Decimal, whichever clearly shows the work required.
    - Be sure to mention if the number is positive or negative, and how can you tell.

a) $0x6EA_{16}$

$6EA_{16} = ??_{10}$
6 = 0110, sign is 0, so it's a **positive** number
E = 1101 = 14
A = 1010 = 10
= (6*16*16) + (14*16) + 10
= 1536 + 224 + 10
$= 1{,}770_{10}$

They can also do the binary version.

b) $0xCAB_{16}$

$CAB_{16} = ??_{10}$
C = 1100, sign is 1, so it's a **negative** number
1100 becomes 0100 aka 4
A = 1010 = 10
B = 1011 = 11
= -((4*16*16) + (10*16) + 11)

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= -(1024 + 160 + 11)
= **-1195**$_{10}$
Note: If they do 2s complement they would get -853

They can also do the binary version.

2. (2 marks) Convert each of the following **One's Complement** three hexadecimal digit (12 bits) numbers to decimal.
   - Do the conversions by hand and show your work and **don't skip steps.**
   - You can either convert Hex->Decimal or Hex->Binary->Decimal, whichever clearly shows the work required.
   - Be sure to mention if the number is positive or negative, and how can you tell.

a) 0xDA5$_{16}$

DA5$_{16}$ = ??$_{10}$
D = 1101, sign is 1, so it's a **negative** number
A =1010 = 10
5 = 0101 = 5
DA5 = 1101 1010 0101
Invert: 0010 0101 1010 == 25A
2 = 0010 = 2
5 = 0101 = 5
A = 1010 = 10
= (2*16*16) + (5*16) + 10
= 512 + 80 + 10
= 602$_{10}$
remember it's negative.
= **-602$_{10}$**

They can also do the binary version.

b) 0x6CD$_{16}$

6CD$_{16}$ = ??$_{10}$
6 = 0110, sign is 0, so it's a **positive** number
C = 1100 = 12
D = 1101 = 13
= ((6*16*16) + (12*16) + 13)
= (1536 + 192 + 13)
= **1741$_{10}$**

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They can also do the binary version.

3. (4 marks) Convert each of the following **2's complement** three hexadecimal digit (12 bits) numbers to decimal.
   - Do the conversions by hand and show your work and **don't skip steps.**
   - You can either convert Hex->Decimal or Hex->Binary->Decimal, whichever clearly shows the work required.
   - Be sure to mention if the number is positive or negative, and how can you tell.

a) $0x1357_{16}$

$x1357_{16} = ??_{10}$
1 = 0001, sign is 0, so **positive** number
= (1*16*16*16) + (3*16*16) + (5*16) + 7
= 4 096 + 768 + 80 + 7
$= 4\ 951_{10}$

They can also do the binary version.

b) $0xCAED_{16}$

$CAED_{16} = ??_{10}$
C = 1100, sign is 1, so **negative** number
1100 1010 1110 1101
0011 0101 0001 0010 flip the bits (1's comp)
+1 add 1
0011 0101 0001 0011 2's complement
= -0x3513
$= -0x3513_{16} = -(3 \times 16^3 + 5 \times 16^2 + 1 \times 16 + 3)$
= -(3(4096) + 5(256) + 1(16) + 3)
= -(12,288 + 1,280 + 16 + 3)
$= 13,587_{10}$
Remember it's negative so:
= -13,587

They can also do the binary version.

4. (4 marks) Write the following decimal numbers in 8-bit **2s complement** representation.
   - Show your answers in both binary and hex.
   - Do the conversions by hand using the repeated division method from the notes
   - Show your work and **don't skip steps.**

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a) -111_{10}

111/2 = 55r1 => Bit 0
55/2 = 27r1
27/2 = 13r1
13/2 = 6r1
6/2 = 3r0
3/2 = 1r1
1/2 = 0r1
110 1111
Add a 0 to get 8 bits:
111 == 0110 1111
Remember it was negative:
0110 1111
1001 0000 1s complement
+ 1 add one
1001 0001
1001 = 9
0001 = 1
-111_{10} == 1001 0001_2 == $0x91_{16}$
Need both Binary and Hexadecimal answer

b) 123_{10}

123/2 = 61r1 => Bit 0
61/2 = 30r1
30/2 = 15r0
15/2 = 7r1
7/2 = 3r1
3/2 = 1r1
1/2 = 0r1
Add a 0 to get 8 bits
0111 1011
It was positive so no conversion needed
0111 = 7
1011 = 11 == B
123_{10} == 0111 1011_2 == $0x7B_{16}$

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5. (4 marks) Add the 4-bit and 8-bit **2's complement** numbers given below to give an 8-bit **2's complement** result.
   - Show your answers in binary and hexadecimal.
   - Indicate an overflow if it occurs.
   - Write the carry-out bit of the msb (most significant bit) in parenthesis.

   (a) 1110 + 1010 1011

   1110 + 1010 1011 (sign extend 1110 to get 1111 1110)

   1111 1110
   +1010 1011
   (1) 1010 1001_2 ==(-2)+(-85) == -87_{10} == $0xA9_{16}$

   (b) 0110 + 0111 1110

   0110 + 0111 1110 (sign extend 0110 to get 0000 0110)

   0000 0110
   +0111 1110
   (1) 0000 0100_2 6+(126) == -124_{10} == $0x84_{16}$

   OVERFLOW!

6. (6 marks) Give the 32-bit IEEE floating point representation for the following two base 10 numbers.
   - Do the conversions by hand and **show your work and don't skip steps**.
   - Give the final answers in binary and hex.

   a) 84.875_{10}

   84/2 = 42r0
   42/2 = 21r0
   21/2 = 10r1
   10/2 = 5r0
   5/2 = 2r1
   2/2 = 1r0
   1/2 = 0r1

   84_{10} = 101 0100 $_2$

   0.875*2 = 1.75
   0.75*2 = 1.5
   0.5*2 = 1.0
   $0.9375_{10} = 0.111_2$

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$84.875 = 1010100.111 = 1.010100111 * 2^6$
exponent = $127 + 6 = 133_{10} = 128 + 5 = 1000\ 0101_2$
Positive => sign bit is 0

Plug them into their spots

0	1	0	0	0	0	1	0	1	0	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0100 0010 1010 1001 1100 0000 0000 0000= 0x42A9C000

84.875_{10} is represented by $0x42A9\ C000_{16}$

b) -77.3125_{10}

77/2 = 38r1
38/2 = 19r0
19/2 = 9r1
9/2 = 4r1
4/2 = 2r0
2/2 = 1r0
1/2 = 0r1

$77_{10} == 100\ 1101_2$

0.3125*2 = 0.625
0.625*2 =1.25
0.25*2 = 0.5
0.5*2 = 1.0

$0.3125_{10} = 0.0101_2$

$77.3125 = 1001101.0101 = 1.0011010101 * 2^6$
exponent = $127 + 6 = 133_{10} = 128 + 4 + 1 = 1000\ 0101_2$
Negative => sign bit is 1

Plug them into their spots

1	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

1100 0010 1001 1010 1010 0000 0000 0000= 0xC29A A000

-77.3125_{10} is represented by $0xC29A\ A000_{16}$

7. (6 marks) Give the decimal equivalent of the following 32-bit numbers (given in hexadecimal notation) considered as being IEEE floating point numbers. Do the computations by hand and show your work.
   a) $0xC1B1\ 8000_{16}$

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C1B1 C000= 1100 0001 1011 0001 1000 0000 0000 0000

The Sign bit is 1, the number is Negative

The exponent is 1000 0011, 131 => 131 -127 = 4

$-1.01100011*2^4 = -10110.0011$

$= -(16+4+2 + 1/8 + 1/16)$

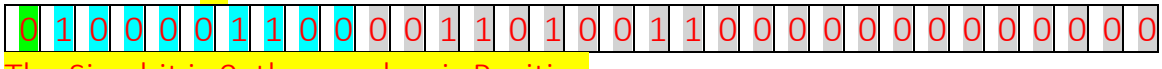
$= -(22 + 0.125 + 0.0625)$

$= - 22.1875_{10}$

$0xC1B1\ 8000_{16}$ represents -22.1875_{10}

b) $0x431A\ 6000_{16}$

0x431A 6000= 0100 0011 0001 1010 0110 0000 0000 0000



The Sign bit is 0, the number is Positive

The exponent is 1000 0110, 134 => 134 -127 = 7

$1.0011\ 0100\ 11*2^7 = 1001\ 1010.011$

$= (128 + 16 + 8 + 2 + 1/4 + 1/8)$

$= (128 + 16 + 8 + 2 + 0.25 + 0.125)$

$= (154+ 0.25 + 0.125)$

$= 154.375_{10}$

$0x431A\ 6000_{16}$ represents 154.375_{10}

8. (4 marks) Compute the following using 8-bit binary values by hand and show your work. Give the results as 8-bit binary values.

a) (NOT (1000 0110)) AND (1101 1011)

NOT 1000 0110

0111 1001

AND 1101 1011

0101 1001

b) (0101 0101) OR (NOT (1101 0110))

NOT 1101 0110

0010 1001

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OR 0101 0101
0111 1101