Université d'Ottawa
Faculté de génie

École de science informatique
et de génie électrique

uOttawa

L'Université canadienne
Canada's university

University of Ottawa
Faculty of Engineering

School of Electrical Engineering
and Computer Science

COURSE: CEG2136
Computer Architecture I

Assignment 2

Q1. In a signed binary system of 8 bits (**N=8**):

a) Find the 2's complement **representation** of the following signed numbers :

$(+63)_{10} = (00111111)_2$

63/2	remainder		
31	1	lsb	2^0
15	1		2^1
7	1		2^2
3	1		2^3
1	1		2^4
0	1		2^5

	Sign	2^6	2^5	2^4	2^3	2^2	2^1	2^0
+63=	0	0	1	1	1	1	1	1

Or observe that 63 = 32+16+8+4+2+1

$(-115)_{10} = (10001101)_2$

115/2	remainder		
57	1	lsb	2^0
28	1		2^1
14	0		2^2
7	0		2^3
3	1		2^4
1	1		2^5
0	1	msb	2^6

	Sign	2^6	2^5	2^4	2^3	2^2	2^1	2^0
+115=	0	1	1	1	0	0	1	1

-115 = 2's complement of (01110011) = 10001101

b) Find the 2's complement of the following signed numbers and give your results in decimal, too: $(-63)_{10}$ and $(+115)_{10}$

The 2's complement **representation** of $(-63)_{10} = (11000001)_2$

=> **Do the 2's complement of $(-63)_{10}$** as required in the question

= 2's complement of $(11000001)_2$ = $(\mathbf{00111111})_2$ = which is the 2's complement representation of $(\mathbf{+63})_{10}$ (which in fact is the result that we expected)

The 2's complement representation of $(+115)_{10} = (01110011)$

=> **Do the 2's complement of $(+115)_{10}$** = 2's complement of (01110011) = $(\mathbf{10001101})_2$ = 2's complement representation of $(\mathbf{-115})_{10}$

c) Perform the following arithmetic operations using the signed-2's complement representation and provide your results in decimal (including intermediary steps), as well:

1) Say A = $\mathbf{(+115)_{10}}$ and $\mathbf{B = (-63)_{10}}$

$\mathbf{S = A + B = (+115)_{10} + (-63)_{10}}$

	CY8	CY7	CY6	CY5	CY4	CY3	CY2	CY1	CY0	Base 10
CY:	1	1	0	0	0	0	1	1	0	
A +		0	1	1	1	0	0	1	1	115_{10}+
B		1	1	0	0	0	0	0	1	-63_{10}
S=A+B		0	0	1	1	0	1	0	0	52_{10}

(2's complement representation)

$CY_8 = CY_7 = 1$ => NO overflow

2) Say $\mathbf{C=(-115)_{10}}$ and $\mathbf{D=(-63)_{10}}$

$\mathbf{X = C - D = (-115)_{10} - (-63)_{10} = (-115)_{10} + [-(-63)]_{10} = (-115)_{10} + (+63)_{10}}$

	CY8	CY7	CY6	CY5	CY4	CY3	CY2	CY1	CY0	Base 10
CY:	0	0	1	1	1	1	1	1	0	
C+		1	0	0	0	1	1	0	1	-115_{10}
- D		0	0	1	1	1	1	1	1	63_{10}
X=C-D		1	1	0	0	1	1	0	0	-52_{10}

(2's complement representation)

As the msb of X = C-D is 1 => X is a negative number (X = –y) with a magnitude y=-(-y) = -(X) = 2's complement of (X) = 2's complement of (11001100) = 00110100 = 52_{10}

=> $X = -y = -52_{10}$

$CY_8 = CY_7 = 0$ => NO overflow

Q2. a) Identify the decimal number which is represented next with 32-bit in the IEEE 754 standard: (1 10001011 **11101**000000000000000000) = $(?)_{10}$

Sign = 1 : => negative ; C = 139, hence Exp = C-127 = 12

1.M = 1.**11101** (where M = mantissa)

$-1.\mathbf{11101} * 2^{12} = -1111010000000 = (-7808)_{10}$

b) Represent (221.390625) in the IEEE 754 standard with 32 bits.

$(221.390625)_{10} = (11011101.011001)_2 = (1.\mathbf{1011101011001}) \times 2^7$

Sign = 0 ; Exp = 7; C = 127 + 7 = 134 = $(10000110)_2$

M = **1011101011001**

$(221.390625)_{10}$ = (0 10000110 **1011101011001**0000000000 $)_{IEEE754}$

3.1.

$(101110)_2 = 32+8+4+2 = 46$

$(1110101)_2 = 64+32+16+4+1 = 117$

$(110110100)_2 = 256+128+32+16+4 = 436$

3.3.

$(1231)_{10} = 1024+128+64+15 = 2^{10}+2^7+2^6+2^3+2^2+2+1 = (10011001111)_2$

$(673)_{10} = 512+128+32+1 = 2^9+2^7+2^5+1 = (1010100001)_2$

$(1998)_{10} = 1024+512+256+128+64+8+4+2$
$= 2^{10}+2^9+2^8+2^7+2^6+2^3+2^2+2^1 = (11111001110)_2$

3.4

$(7562)_{10} = (16612)_8$

$(1938)_{10} = (792)_{16}$

$(175)_{10} = (10101111)_2$

3.5

$(F3A7C2)_{16} = (1111\ 0011\ 1010\ 0111\ 1100\ 0010)_2$
$= (74723702)_8$

3.8

$(295)_{10} = 256+32+7 = (100100111)_2$

(a) 0000 0000 0000 0001 0010 0111

(b) 0000 0000 0000 0010 1001 0101

(c) 10110010 00111001 00110101

3.10. Decode the following ASCII code:

1001010	1001111	1001000	1001110	0100000	1000100	1001111	1000101
4A	4F	48	4E	20	44	4F	45
J	O	H	N		D	O	E

3.13

	10101110;	10000001	10000000	00000001	00000000.
1's compl	01010001	01111110	01111111;	11111110	11111111
2's compl	01010010	01111111	10000000	11111111	00000000

3.16

$+42 = 0101010$
$-42 = 1010110$

$+13 = 0001101$
$-13 = 1110011$

$$\begin{array}{rr} (+42) & 0101010 \\ (-13) & 1110011 \\ \hline (+29) & 0011101 \end{array}$$

$$\begin{array}{rr} (-42) & 1010110 \\ (+13) & 0001101 \\ \hline (-29) & 1100011 \end{array}$$

Q3.
An 8-bit register contains the binary value 00011100.
What is the BCD representation of this number?

		2^6	2^5	2^4	2^3	2^2	2^1	2^0	
Binary:	**0**	0	0	1	1	1	0	0	Decimal 16+8+4 = $(2\ \ 8)_{10}$
									BCD: 010 1000