Last Name: RAMOS *First Name: Anthony*

Computer Science

C.Sc. 342

Quiz No.1

March 1, 2021

Please write your Last Name on every page:

NO CORRECTIONS ARE ALLOWED IN ANSWER CELLS!!!!!

You may use the back page for computations.

Please answer all questions. **Not all questions are of equal difficulty. Please review the entire quiz first and then budget your time carefully.**

Please hand write and sign statements affirming that you will not cheat:

"I will neither give nor receive unauthorized assistance on this exam. I will use only one computing device to perform this test"

Please hand write and sign here:

I will neither give nor receive unauthorized assistance on this exam. I will only use one computing device to perform this test.

Anthony Ramos

1. For **each 8 BIT** binary pattern shown in the table below please write corresponding values of the following interpretations: **UNSIGNED INT, SIGNED INT, UNSIGNED Fixed Point, SIGNED Fixed Point.**
Each correctly answered column is **2.5** points. ***FIXED POINT IS LOCATED TWO POSITIONS FROM THE RIGHT!*** **MOST SIGNIFICANT BIT IS 7. LEAST SIGNIFICANT BIT IS 0.**

76543210	Unsigned Int	Signed Int	Unsigned Fixed Point	Signed Fixed Point
1000 0000	128	-128	32	-32
1000 0011	131	-125	32.75	-31.25
1000 0001	129	-127	32.25	-31.75
0100 0001	65	+65	16.25	+16.25
0111 1111	127	+127	31.75	+31.75
1111 1111	255	-1	63.75	-0.25
1111 1100	252	-4	63	-1
0000 0000	0	0	0	0
0111 1110	126	+126	31.5	+31.5
1000 1110	142	-114	35.5	-28.5
0001 0011	19	+19	$4+\frac{3}{4}=\frac{16+3}{4}$	$+4+\frac{3}{4}=+\frac{19}{4}$

See "Workspace" for fixed point calculations

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2. [10 points] What is the most negative number (largest absolute value negative) that can be represented using 16 bit signed integer representation? Please circle around over all the correct ones: -32768, -65536, -16384, -32767, NONE

$$-32768, -65536, -16384, -32767, NONE$$

Explanation: $-2^{16-1} = -2^{10} \times 2^5 = -1024 \times 32 = -32768$

3. [10 points]Please subtract two number in Hex. Then convert each operand to binary and perform the same operation in binary, then repeat BASE 10. The signed integers are represented using two's complement.

	0x0E	+14	0b0000 1110
-			
	0xFF	-1	0b1111 1111
+			0b0000 0001

Hex: 0x0F Dec: +15 Binary: 0b0000 1111

4. [20 points]

Determine the **MINIMAL** number of **bit**s required to represent ***-127.75*** *using:*

4.1. (5 points) ASCII Code: 56-Bits

Each character is represented by 8-Bits of information in ASCII. Because there are 7 characters in "-127.75" (that includes the minus sign and decimal point), it requires 7x8 = 56 Bits.

4.2. (5 points) Binary Fixed Point representation: 10-Bits

We need at least 8 bits to represent -127 plus an additional 2 bits to represent 0.75. In total, we need 10-bits.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	0	0	0	0	0	0	0	0	1

$$-2^7 + \frac{1}{4} = -128 + 0.25 = -127.75$$

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4.3 (5 points) Take the result from the previous answer and shift the fixed point by 2 positions to the right and write the resulting signed decimal value.

2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	0	0	0	0	0	0	0	0	1	0	0

Since we are shifting two positions to the right, we are multiplying the previous result by 2^2

$$2^2 \times \left(-2^7 + \frac{1}{4}\right) = -2^9 + 1 = -512 + 1 = -511$$

4.4 (5 points) Please write down the signed rational number stored in the 9-bit word below:

2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}
1	0	0	0	0	0	0	0	1

This represents the number 1.00000001_2. To convert this into a decimal sum up the necessary terms:

$$(1 \times 2^0) + (1 \times 2^{-8}) = 1 + \frac{1}{256} = \frac{257}{256}$$

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5. [10 points] Please determine if single precision floating point representation given below is ***NAN,or +Infinity,-Infinity, or a valid number*** floating point : The top row shows the bit index. ***PLEASE JUSTIFY your ANSWER and SHOW your*** work! Just the final result will not count as a correct answer.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This is a valid number whose value is given as follows:

The sign bit is 0, the exponent field (30 to 23) contains the value 129, and the fraction field contains $(1 \times 2^{-1}) + (1 \times 2^{-2}) = 0.75$. Hence, we use the following equation:

$$(-1)^s \times (1 + F) \times 2^{E-Bias}$$

Where $s = 0, F = 0.75, E = 129, Bias = 127$

$$(-1)^0 \times (1 + 0.75) \times 2^{129-127} = 1.75 \times 2^2 = 7.0$$

6. [10 points] Please determine the decimal value (scientific notation) of the single precision floating point representation given below: The top row shows the bit index. ***PLEASE SHOW your*** work! Just the final result will not count as correct answer. ***If it represents NAN, or Infinity, or zero please state this and justify.***

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The sign bit is 1, the exponent field (30 to 23) contains the value 133, and the fraction field contains $(1 \times 2^{-1}) + \cdots + (1 \times 2^{-8}) = 0.99609375$. Hence, we use the following equation:

$$(-1)^s \times (1 + F) \times 2^{E-Bias}$$

Where $s = 0, F = 0.75, E = 133, Bias = 127$

$$(-1)^1 \times (1 + 0.99609375) \times 2^{133-127} = -1.99609375 \times 2^6 = -127.75$$

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7. [5 points] Please determine the decimal value (scientific notation) of the single precision floating point representation given below: The top row shows the bit index. ***PLEASE SHOW your*** work! Just the final result will not count as correct answer. ***If it represents NAN, or Infinity, or zero please state this and justify.***

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Since every value is 0, the decimal value is simply 0.

8. [5 points] Please determine the decimal value (scientific notation) of the single precision floating point representation given below: The top row shows the bit index. ***PLEASE SHOW your*** work! Just the final result will not count as correct answer. ***If it represents NAN, or Infinity, or zero please state this and justify.***

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Since every value the sign bit and exponent field are all 1's, it is NaN. Recall, NaN has the form:

s 11111111 1xxx xxxx xxxx xxxx xxxx xxxx

where *s* is the sign-bit and in our case is 1.

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10. ***In EACH Questions 10.1-10.4 you are given SIGNED Integers stored in 32 BIT Registers. (Not 33-BIT Register). Please write decimal, and binary operands and the results. For each question you have to write the result and*** **overflow or No overflow. You may override '0' with '1'.**

10.1 – (5 points) What is the result (hexadecimal, decimal, and binary) of the following addition:

0x0000000E	+14	0b0000 0000 0000 0000 0000 0000 0000 1110
+		
0xFFFFFFFF	-1	0b1111 1111 1111 1111 1111 1111 1111 1111

Hex: 0x0000000D Dec:+13 Binary: 0b0000 0000 0000 0000 0000 0000 0000 1101

Overflow? NO

10.2 - (5 points) What is the result (hexadecimal, decimal, and binary) of the following Subtraction:

0x7FFFFFFF	2147483647	0b0111 1111 1111 1111 1111 1111 1111 1111
-		
0xFFFFFFFF	-1	0b1111 1111 1111 1111 1111 1111 1111 1111
+		0b0000 0000 0000 0000 0000 0000 0000 0001

Hex: 0x80000000 Dec: -2147483648 Binary: 0b1000 0000 0000 0000 0000 0000 0000 0000

Overflow? YES, we expected +2147483648. This overflow occurs because the maximum value represented in a 32-bit WORD is +2147483647 or $+2^{31} - 1$.

10.3 - (5 points) What is the result (hexadecimal, decimal, and binary) of the following subtraction:

0x80000000	-2147483648	0b1000 0000 0000 0000 0000 0000 0000 0000
-		
0xFFFFFFFF	-1	0b1111 1111 1111 1111 1111 1111 1111 1111
+		0b0000 0000 0000 0000 0000 0000 0000 0001

Hex: 0x80000001 Dec: -2147483647 Binary: 0b1000 0000 0000 0000 0000 0000 0000 0001

Overflow? NO

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10.4 - (5 points) What is the result (hexadecimal, decimal, and binary) of the following addition:

0x7FFFFFFF	2147483647	0b0111 1111 1111 1111 1111 1111 1111 1111
+		
0xFFFFFFFF	-1	0b1111 1111 1111 1111 1111 1111 1111 1111

Hex: 0x7FFFFFFE Dec: +2147483646 Binary: 0b0111 1111 1111 1111 1111 1111 1111 1110

Overflow? NO

Workspace for Question 1

The fixed point is the boundary between the yellow and green

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	0	0	0	0	0	0	0

Unsigned Fixed Point: $(1 \times 2^5) = 32$

Signed Fixed Point: $-(1 \times 2^5) = -32$

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	0	0	0	0	0	1	1

Unsigned Fixed Point: $(1 \times 2^5) + (1 \times 2^{-1}) + (1 \times 2^{-2}) = 32 + \frac{1}{2} + \frac{1}{4} = 32.75$

Signed Fixed Point: $-(1 \times 2^5) + (1 \times 2^{-1}) + (1 \times 2^{-2}) = -32 + \frac{1}{2} + \frac{1}{4} = -31.25$

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	0	0	0	0	0	0	1

Unsigned Fixed Point: $(1 \times 2^5) + (1 \times 2^{-1}) = 32 + \frac{1}{4} = 32.25$

Signed Fixed Point: : $-(1 \times 2^5) + (1 \times 2^{-1}) = -32 + \frac{1}{4} = -31.75$

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
0	1	0	0	0	0	0	1

Unsigned Fixed Point: $(1 \times 2^4) + (1 \times 2^{-2}) = 16 + \frac{1}{4} = 16.25$

Signed Fixed Point: Same as unsigned

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
0	1	1	1	1	1	1	1

Unsigned Fixed Point: $(1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2}) = 16 + 8 + 4 + 2 + 1 + \frac{1}{2} + \frac{1}{4} = 31.75$

Signed Fixed Point: Same as unsigned

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	1	1	1	1	1	1	1

Unsigned Fixed Point: $(1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2}) = 32 + 16 + 8 + 4 + 2 + 1 + \frac{1}{2} + \frac{1}{4} = 63.75$

Signed Fixed Point: $-(1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2}) = -32 + 16 + 8 + 4 + 2 + 1 + \frac{1}{2} + \frac{1}{4} = -0.25$

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	1	1	1	1	1	0	0

Unsigned Fixed Point: $(1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 32 + 16 + 8 + 4 + 2 + 1 = 63$

Signed Fixed Point: $-(1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = -32 + 16 + 8 + 4 + 2 + 1 = -1$

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
0	1	1	1	1	1	1	0

Unsigned Fixed Point: $(1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) = 16 + 8 + 4 + 2 + 1 + \frac{1}{2} = 31.5$

Signed Fixed Point: Same as unsigned

2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
1	0	0	0	1	1	1	0

Unsigned Fixed Point: $(1 \times 2^5) + (1 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) = 32 + 2 + 1 + \frac{1}{2} = 35.5$

Signed Fixed Point: $-(1 \times 2^5) + (1 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) = -32 + 2 + 1 + \frac{1}{2} = -28.5$