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COM S 321 - Problem Set 3
10/17/19

3.3

5ED4 = $\mathbf{101111011010100_2}$

Hexadecimal is an attractive numbering system because each individual hex value can be represented by using 4 binary digits. Most machines also use multiples of 4 to represent bits, so this is also attractive.

3.9

A = $151_{10} \rightarrow 10010111_2 \rightarrow 01101001_2$ (two's) $\rightarrow -105_{10}$
B = $214_{10} \rightarrow 11010110_2 \rightarrow 00101010_2$ (two's) $\rightarrow -42_{10}$
A + B = –105 + (–42) = –105 – 42 = **–147**

3.10

A = $151_{10} \rightarrow 10010111_2 \rightarrow 01101001_2$ (two's) $\rightarrow -105_{10}$
B = $214_{10} \rightarrow 11010110_2 \rightarrow 00101010_2$ (two's) $\rightarrow -42_{10}$
A – B = –105 – (–42) = –105 + 42 = **–63**

3.13

$62_{16} = 0001\ 0010_2$
$12_{16} = 0110\ 0010_2$

Iteration	Step	Multiplier	Multiplicand	Product
0	Initial Values	0001 0010	0000 0000 0110 0010	0000 0000 0000 0000
1	1: 0 ⇒ No Operation	0001 0010	0000 0000 0110 0010	0000 0000 0000 0000
	2: Shift Left Multiplicand	0001 0010	**0000 0000 1100 0100**	0000 0000 0000 0000
	3: Shift Right Multiplier	**0000 1001**	0000 0000 1100 0100	0000 0000 0000 0000

2	1a: 1 ⇒ Prod = Prod + Mcand	0000 1001	0000 0000 1100 0100	**0000 0000 1100 0100**
	2: Shift Left Multiplicand	0000 1001	**0000 0001 1000 1000**	0000 0000 1100 0100
	3: Shift Right Multiplier	**0000 0100**	0000 0001 1000 1000	0000 0000 1100 0100
3	1: 0 ⇒ No Operation	0000 0100	0000 0001 1000 1000	**0000 0000 1100 0100**
	2: Shift Left Multiplicand	0000 0100	**0000 0011 0001 0000**	0000 0000 1100 0100
	3: Shift Right Multiplier	**0000 0010**	0000 0011 0001 0000	0000 0000 1100 0100
4	1: 0 ⇒ No Operation	0000 0010	0000 0011 0001 0000	**0000 0000 1100 0100**
	2: Shift Left Multiplicand	0000 0010	**0000 0110 0010 0000**	0000 0000 1100 0100
	3: Shift Right Multiplier	**0000 0001**	0000 0110 0010 0000	0000 0000 1100 0100
5	1a: 1 ⇒ Prod = Prod + Mcand	0000 0001	0000 0110 0010 0000	**0000 0110 1110 0100**
	2: Shift Left Multiplicand	0000 0001	**0000 1100 0100 0000**	0000 0110 1110 0100
	3: Shift Right Multiplier	**0000 0000**	0000 1100 0100 0000	0000 0110 1110 0100

The result is: $\mathbf{0000\ 0110\ 1110\ 0100_2 = 6E4_{16}}$

3.17

$33_{16} = 0011\ 0011_2$
$55_{16} = 0101\ 0101_2$

Iteration	Step	Multiplier	Multiplicand	Product
0	Initial Values	0011 0011	0000 0101 0101	0000 0000 0000
1	1: 0 ⇒ No Operation	0011 0011	0000 0101 0101	0000 0000 0000
	2: Shift Left Multiplicand	0011 0011	**0000 1010 1010**	0000 0000 0000
	3: Shift Right Multiplier	**1001 1001**	0000 1010 1010	0000 0000 0000
2	1a: 1 ⇒ Prod = Prod + Mcand	1001 1001	0000 1010 1010	**0000 1010 1010**
	2: Shift Left Multiplicand	1001 1001	**0001 0101 0100**	0000 1010 1010

	3: Shift Right Multiplier	**1100 1100**	0001 0101 0100	0000 1010 1010
3	1: 0 ⇒ No Operation	1100 1100	0001 0101 0100	**0000 1010 1010**
	2: Shift Left Multiplicand	1100 1100	**0010 1010 1000**	0000 1010 1010
	3: Shift Right Multiplier	**0110 0110**	0010 1010 1000	0000 1010 1010
4	1: 0 ⇒ No Operation	0110 0110	0010 1010 1000	**0000 1010 1010**
	2: Shift Left Multiplicand	0110 0110	**0101 0101 0000**	0000 1010 1010
	3: Shift Right Multiplier	**0011 0011**	0101 0101 0000	0000 1010 1010
5	1: 0 ⇒ No Operation	0011 0011	0101 0101 0000	**0000 1010 1010**
	2: Shift Left Multiplicand	0011 0011	**1010 1010 0000**	0000 1010 1010
	3: Shift Right Multiplier	**0000 0000**	1010 1010 0000	0000 1010 1010

The result is: $\mathbf{0000\ 1010\ 1010_2 = AA_{16}}$

3.23

$63.25 \times 10^0 = 111111.01 \times 2^0$

Normalize $\Rightarrow$ 1.1111101×2^5

Sign is positive

Exponent $\Rightarrow$ 127 + 5 = 132

$\Rightarrow$ 0 1000 0100 1111 1010 0000 0000 0000 0000

IEEE 754 Format ⇒ 0 10000100 11111010000000000000000

3.27

-1.5625×10^{-1}

$\Rightarrow -0.15625$

$\Rightarrow -0.15625 \ - \ 0.125 \ = \ 0.03125$

$\Rightarrow -1.5625_{10} = 0.00101_2 = \ 1.01 \times 2^{-3}$

Exponent $\Rightarrow$ 01100

Mantissa $\Rightarrow$ 0100000000

Result ⇒ 1 01100 0100000000

3.29

$26.125 \rightarrow 11010.001_2 \rightarrow 1.1010001 * 2^4$
$0.4150390625 \rightarrow 0.0110101001_2 \rightarrow 1.10101001 * 2^{-2}$

$\Rightarrow$ 0 10011 0001010001
$\Rightarrow$ 0 01101 0010101001

$\Rightarrow 1.1010001 \times 2^4 + 1.10101001 \times 2^{-2} \Rightarrow 1.1010001 \times 2^4 + 0.00000110101001 \times 2^4$
10-bit $\Rightarrow 1.1010100010 \times 2^4$
16-bit ⇒ 0 1010100010 10011

3.30

$A = -8.0546875 \times 10^0 \Rightarrow 1000.000111 \Rightarrow -1.000000111 \times 2^3$
$B = -1.79931640625 \times 10^{-1} \Rightarrow 0.001011100001 \Rightarrow -1.011100001 \times 2^{-3}$
$1.000000111 \times 1.011100010 \Rightarrow$ **$101110110000010111 0_2 \Rightarrow 383022_{10}$**

3.42

Adding -¼ to itself 4 times: -¼ + -¼ + -¼ + -¼ = −1
Multiplication: -¼ * 4 = −1

They hold the same result

3.43

⅓ ⇒ 0.33333333333... ⇒ 0.0101010101010101010101010101010101...
Mantissa is 17-bits long ⇒ 0.0101010101010101
Exponent is 6-bits long ⇒ 000001

Result ⇒ 0 00101010101010101 000001

Extra Credit

Most of the time, I like to get pretty creative in the kitchen and experiment with different kinds of food. Other times, I like to keep it simple. Here's my recipe for my special buttered toast:

Steps:

1. Be lazy
2. Grab a piece of toast
3. Put toast in the toaster
4. Toast the toast until golden brown and delicious
5. Grab a knife (not too sharp) and your favorite stick of butter from the fridge
6. Spread butter on the toast after it is done from the microwave
7. Pat yourself on the back and enjoy