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Assignment 2.

1. a).

i) $0.00111111111 \rightarrow 1.111111 \times 2^{-3}$

$-3 = E - 127$ $\quad -3 + 127 = E = 124$

124/2 = 62	0	
62/2 = 31	0	
31/2 = 15	1	
15/2 = 7	1	
7/2 = 3	1	
3/2 = 1	1	
1/2 = 0	1	

$E = 01111100_2$ 8 bits

Frac = .11111100000000000000000 (23 bits)

$= 0\,|\,01111100\,|\,11111000000000000000000_2$: binary

$0x \quad 3 \quad E \quad 7 \quad E \quad 0 \quad 0 \quad 0 \quad 0$: Hex

ii) 3 → binary = 00000011 (8 bits)

0.141601562 5 × 2 = 0.283203125	0
× 2 = 0.5664062 5	0
× 2 = 1.132812 5	1
× 2 = 0.26562 5	0
× 2 = 0.53125	0
× 2 = 1.0625	1
× 2 = 0.125	0
× 2 = 0.25	0
× 2 = 0.5	0 ✓
× 2 = 1	1

$= 1.001001001 \times 2^{-2}$

$= 0\,|\,10000001\,|\,00100100100100100100000$

$0x \quad 4 \quad 0 \quad 4 \quad 9 \quad 1 \quad 0 \quad 0 \quad 0$

iii) sign bit = 1

exp = seen below

frac:

0.9	x2 =	1.8	1
repeat.	x2 =	1.6	1
	x2 =	1.2	1
	x2 =	0.4	0
	x2 =	0.8	0
	x2 =	1.6	1

S = 0

m = ↘

Exp = 1

= 00000000.11001 = 1.1101×2^{1} = Exp.

0x B F 6 6 6 6 6 6

1 01111110 11001100110011001100 = 0x BF666666.

bias Exp -1 = E - 127 = 126

iiii)

0.3	x2 =	0.6
0.6	x2 =	1.2
0.2	x2 =	0.4
0.4	x2 =	0.8
0.8	x2 =	1.6
0.6	x2 =	1.2

= $0.01001100\overline{1100} \times 2^{2}$

S = 0

E = 2 ≈ 129 = 10000001

m = 00111001100

= 0 10000001 00111001100110011001101 round up.

0x 409CE73B

b) 0x4AEA4C1A = 0100 | 1010 | 1110 | 1010 | 0100 | 1100 | 0001 | 1010

= 0 | 10010101 | 11010100100110000001010

10010101 = 149 = $2^7 + 2^4 + 2^2 + 2^0$ = 128 + 16 + 4 + 1

149 - 127 = 22 = E ∴ = 10010101|11010100100110000001010 = num

= 7,677,453

c) i) 1.0011111, all ones = round up. = 1.00100

ii) 1.1001001 round down (drop bits) = 1.1001

iii) 1.01111100 exactly half and left is 1 = 1.1000 round up

iiii) 1.0110100 exactly half and left is 0 = 1.0110 round down.

2.

$[E = e - 3]$ $\quad V = 2^E \cdot M$

e = unsigned number having bit rep $e_{k-1} \cdots e_1 e_0$

		exponent			fraction		Value		
Description	Bit Representation	exp	E	2^E	frac	M	$M 2^E$	V	Decimal
zero	0 000 00	0	-2	1/4	0/4	0/4	0/16 →		0
smalest pos den	0 000 01	0	-2	1/4	1/4	1/4	1/16 →		0.0625
	0 000 10	0	-2	1/4	2/4	2/4	2/16 →		0.125
lrgest pos den	0 000 11	0	-2	1/4	3/4	3/4	3/16 →		0.1875
smalest pos Nor	0 001 00	1	-2	1/4	0/4	4/4	4/16 →		0.25
	0 001 01	1	-2	1/4	1/4	5/4	5/16 →		0.3125
	0 001 10	1	-2	1/4	2/4	6/4	6/16 →		0.375
	0 001 11	1	-2	1/4	3/4	7/4	7/16 →		0.4375
	0 010 00	2	-1	1/2	0/4	4/4	4/8 →		0.5
	0 010 01	2	-1	1/2	1/4	5/4	5/8 →		0.625
	0 010 10	2	-1	1/2	2/4	6/4	6/8 →		0.75
	0 010 11	2	-1	1/2	3/4	7/4	7/8 →		0.875
one	0 011 00	3	0	1	0/4	4/4	4/4 →		1
	0 011 01	3	0	1	1/4	5/4	5/4 →		1.25
	0 011 10	3	0	1	2/4	6/4	6/4 →		1.5
	0 011 11	3	0	1	3/4	7/4	7/4 →		1.75
	0 100 00	4	1	2	0/4	4/4	8/4 →		2.0
	0 100 01	4	1	2	1/4	5/4	10/4 →		2.5
	0 100 10	4	1	2	2/4	6/4	12/4 →		3.0
	0 100 11	4	1	2	3/4	7/4	14/4 →		3.5
	0 101 00	5	2	4	0/4	4/4	16/4 →		4
	0 101 01	5	2	4	1/4	5/4	20/4 →		5
	0 101 10	5	2	4	2/4	6/4	24/4 →		6
	0 101 11	5	2	4	3/4	7/4	28/4 →		7
	0 110 00	6	3	8	0/4	4/4	32/4 →		8
	0 110 01	6	3	8	1/4	5/4	40/4 →		10
	0 110 10	6	3	8	2/4	6/4	48/4 →		12
lrg pos norm	0 110 11	6	3	8	3/4	7/4	56/4 →		14

a) Bias? $= 2^{k-1} - 1 = 2^2 - 1 = [3]$

b) they are 1/16 apart.

=

c) they are also 1/16 apart. $= 0.0625 \simeq 2^{-4}$

d) they are 1/8 apart $= 0.125 \simeq 2^{-3}$

e) they are 1/4 apart. $= 0.25 \simeq 2^{-2}$

f)

i) based on the above id guess 2^{-1}

ii) 2^0

iii) 2^1

g. ± 14 = normalized number range

h. On the chart it is $(-2 \leftrightarrow 3)$

i. lets try $0.0626 \times 2 = 0.1252$ | once normalized

$\times 2 = 0.2504$ | the mantissa would

$\times 2 = 0.5008$ | look like 1.000....

$\times 2 = 1.0016$ | which we cannot

$0.0016 \times 2 = 0.0032$ | accurately represent in

$\times 2 = 0.0064$ | our 6 bit

$\times 2 = 0.0128$ | IEEE.

$\times 2 = 0.0256$

$\times 2 = 0.0512$

and so on.

j lets try $15/2 = 7 \; 1$

$7/2 = 3 \; 1 \quad = 1111.00$

$3/2 = 1 \; 1$

$1/2 = 0 \; 1 \quad = 1.11100 \times 2^{3} \quad 3 = E - 3 = 6$

= | 0 | 110 | 11 | 0 | exactly half and left is 1 = round up

= | 0 | 111 | 00 | this is now a special case and overflows to infinity

K. In the chart the value of the fraction for the largest possitive normalized number is [1/4]