1.3. What is the 16-bit FP number representation of −5.375 in hex with 1-bit sign, 4-bit biased exponent, and 11-bit fraction, where bias offset = 7?

Step 1: Convert decimal to binary

First convert the whole #: 5

$$\begin{array}{r} 2 \\ 2\overline{)5} \\ \underline{4} \\ 1 \end{array} \longrightarrow \boxed{1}$$

$5_{10} = 101_2$

$$\begin{array}{r} 1 \\ 2\overline{)2} \\ \underline{2} \\ 0 \end{array} \longrightarrow 0$$

$$\begin{array}{r} 0 \\ 2\overline{)1} \\ \underline{0} \\ 1 \end{array} \longrightarrow \boxed{1}$$

*Remember: Write binary number starting from last division digit calculation to the first division digit calculation

Now convert the fraction portion: .375

$0.375 \times 2 = 0.75 = \boxed{0} + .75$

$0.75 \times 2 = 1.5 = 1 + .5$

$0.50 \times 2 = 1.0 = \boxed{1} + 0$

$0.0 \times 2 = 0.0 \rightarrow$ End

$0.375_{10} = .011_2$

$5.375_{10} = 101.011_2$

Step 2: Convert Binary to Scientific Notation

$5.375_{10} = 101.011_2$

$101.011_2 \Rightarrow 1.01011 \times 2^2 \leftarrow$ # of decimal places moved to the left

Step 3: Calculate Biased Exponent:

Unbiased Exponent $= 1.01011 \times 2^{\boxed{2}}$

$$\boxed{\text{Biased Exponent} = \text{Unbiased Exponent} + \text{Biased offset}}$$

Biased offset $= 7$

$$\begin{aligned} \text{Biased Exponent} &= \underline{2} + \underline{7} \\ &= 9_{10} \\ &= 1001_2 \end{aligned}$$

Step 4: Fusion of Floating Point

$$\underset{\text{sign bit}}{1}.\underbrace{01011}_{\text{Mantissa}} \times 2^9 = 1.01011 \times 2^{\underbrace{1001_2}_{\text{Biased Exponent}}}$$

1	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0
C				A				C				0			

0xCAC0

1.4. What is the real number equivalent to FP number 0x3400 with 1-bit sign, 4-bit biased exponent, 11-bit fraction, and bias offset = 7?

Step 1: Convert Hex to 16-bit binary

3 = 0011
4 = 0100
0 = 0000
0 = 0000

0x3400 => $[0011\ 0100\ 0000\ 0000]_2$

sign bit = 0
mantissa = 10000000000
exponent = 0110

Step 2: Calculate Unbiased Exponent:

Biased Exponent = 0110_2 = 6

$$\boxed{\text{Biased Exponent} = \text{Unbiased Exponent} + \text{Biased Offset}}$$

Unbiased Exponent = Biased Exponent − Biased offset
= 6 − 7
= −1

Step 3: Convert Mantissa to Decimal

~~Mantissa = $1100\ 0000\ 0000_2 \times 2^{-1}$~~

Mantissa = 100 0000 0000
$= 1 \times 2^{-1}$
$= 0.5$

Step 4: Find the real number equivalent using the equation:

$$\boxed{\text{Real \#} = (-1)^S \times (1 + m) \times 2^E}$$

S: Sign Bit
m: Mantissa
E: Unbiased Exponent

$= (-1)^0 \times (1 + 0.5) \times 2^{-1}$

$= 1.5 \times 2^{-1}$

$= 0.75$

1.5. What is the real number equivalent to FP number 0x3400 with 1-bit sign, 4-bit biased exponent, 11-bit fraction, and bias offset = 8?

Step 1: Convert Hex to 16-bit Binary

3 = 0011

4 = 0100

0 = 0000

0 = 0000

0x3400 => $[0011\ 0100\ 0000\ 0000]_2$

Step 2: Calculate Unbiased Exponent

Biased Exponent = $0110_2 = 6$

Unbiased Exponent = Biased Exponent − Biased offset

= 6 − 8

= −2

Step 3: Convert Mantissa to Decimal

Mantissa = 100 0000 0000

$= 1 \times 2^{-1}$

= 0.5

Step 4: Find the real number equivalent using the equation:

$$\text{Real \#} = (-1)^S \times (1 + m) \times 2^E$$

$$= (-1)^0 \times (1 + 0.5) \times 2^{-2}$$

$$= 0.375$$

1.14. What is a Von Neumann architecture bottleneck?

The performance of CPUs has increased at a faster rate than that of memory. Therefore, the Von Neumann architecture presents a communication bottleneck between a faster CPU and a slower memory.