Virginia Tech
ECE 4500: Fundamentals of Computer Systems

Floating-Point Representation Examples

EXAMPLE QUESTION 1

Suppose four bytes of memory contain the following values.

Offset	*Contents (Hex)*	*Contents (Binary)*
0	00	0000 0000
1	00	0000 0000
2	C0	1100 0000
3	3F	0011 1111

Assume that the four bytes represent a floating-point number using IEEE 754 single-precision representation. Also, assume that the most significant byte is at offset 3. What is the represented value in decimal?

Answer

Since offset 3 contains the most significant byte, the stored value is:

$$(3F\ C0\ 00\ 00)_{16} = (0011\ 1111\ 1100\ 0000\ 0000\ 0000\ 0000\ 0000)_2$$

The bits correspond to the sign, exponent, and fraction as follows.

0	011 1111 1	100 0000 0000 0000 0000 0000
Sign (S)	Exponent (E)	Fraction (F)

- Sign: S = 0, so this is a positive number.
- Exponent: $E = (011\ 1111\ 1)_2 = (127)_{10}$. Since the IEEE 754 single-precision standard uses an excess-127 representation of the exponent, the actual exponent is: $E – 127 = 127 – 127 = 0$.
- Fraction: IEEE 754 uses an "assumed 1" format, so the actual fractional part of the value is 1.F. For this example, $1.F = (1.10…0)_2 = (1.5)_{10}$.

Thus, the value represented is:

$$+ 1.F = 2^E = 1.5 \times 2^0 = 1.5 \times 1 = \underline{1.5}$$

EXAMPLE QUESTION 2

Suppose we now want to represent –1.5 using the IEEE 754 single-precision format. What is the representation?

Answer

All we need to do is make the sign bit (S) a "1" to indicate a negative value. The sign, exponent, and fraction are as follows.

1	011 1111 1	100 0000 0000 0000 0000 0000
Sign (S)	Exponent (E)	Fraction (F)

The value would be stored in memory as follows.

Offset	*Contents (Hex)*	*Contents (Binary)*
0	00	0000 0000
1	00	0000 0000
2	C0	1100 0000
3	BF	1011 1111

Note that the most-significant bit of the most-significant byte (at offset 3) is a 1.