

**1.12** In single precision (IEEE-754 standard), 8 bits are used for storing the exponent (the bias is 127), and 23 bits are used for storing the mantissa.

- (a) What are the smallest and the largest positive numbers that can be stored in single precision?  
 (b) What is the smallest value of the mantissa that can be stored?

**Solution**

(a) The largest binary form of the exponent plus bias that can be stored in single precision is 11111111 or  $2^7 + 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0 = 255$ . Therefore the largest exponent that can be stored is  $255 - 127 = 128$ . The smallest exponent is 00000000 or  $0 - 127 = -127$ . The largest binary mantissa is:

111111111111111111111111 or in decimal form,

$$2^{-1} + 2^{-2} + \dots + 2^0 = 0.9999998807907105$$

Thus, the largest number that can be stored is  $1.9999998807907105 \times 2^{128}$ .

Similarly, the smallest binary mantissa is 00...0, or in decimal form 0. Thus, the smallest number that can be stored is  $1.0 \times 2^{-127}$ .

(b) From part(a) above, the smallest value of the mantissa that can be stored is 0.

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