2.2 DIGITAL NUMBER SYSTEMS

In digital representation, various number systems are used. The most common number systems used are *decimal*, *binary*, *octal*, and *hexadecimal* systems. Let us discuss these number systems briefly.

2.2.1 Decimal Number System

The *decimal system* is composed of 10 numerals or symbols (*Deca* means 10, that is why this system is called *decimal system*). These 10 symbols are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 ; using these symbols as *digits* of a number, we can express any quantity. The decimal system, also called the *base-10* system because it has 10 digits, has evolved naturally as a result of the fact that man has 10 fingers.

The decimal system is a *positional-value* system in which the value of a digit depends on its position. For example, consider the decimal number 729. We know that the digit 7 actually represents 7 *hundreds*, the 2 represents 2 *tens*, and the 9 represents 9 *units*. In essence, the 7 carries the most weight of three digits; it is referred to as the *most significant digit* (MSD). The 9 carries the least weight and is called the *least significant digit* (LSD).

Consider another example, 25.12. This number is actually equal to (2 *tens* plus 5 *units* plus 1 *tenths* plus 2 *hundredths*) *i.e.*, $2\times10+5\times1+\ 1\times\frac{1}{10}+2\times\frac{1}{100}$. The decimal point is used to separate the integer and fractional parts of the number.

More rigorously, the various positions relative to the decimal point carry weights that can be expressed as powers of 10. This is illustrated in Fig. 2.1 where the number 2512.1971 is represented. The decimal point separates the positive powers of 10 from the negative powers. The number 2512.1971 is thus equal to

$$2\times10^{3}+5\times10^{2}+1\times10^{1}+2\times10^{0}\ +1\times10^{-1}+9\times10^{-2}+7\times10^{-3}+1\times10^{-4}$$

In general, any number is simply the sum of the products of each digit value and its positional value.

The squence of decimal numbers goes as 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21.... See after 9, each successive number is a combination of two (or more) (unique) symbols of this system.

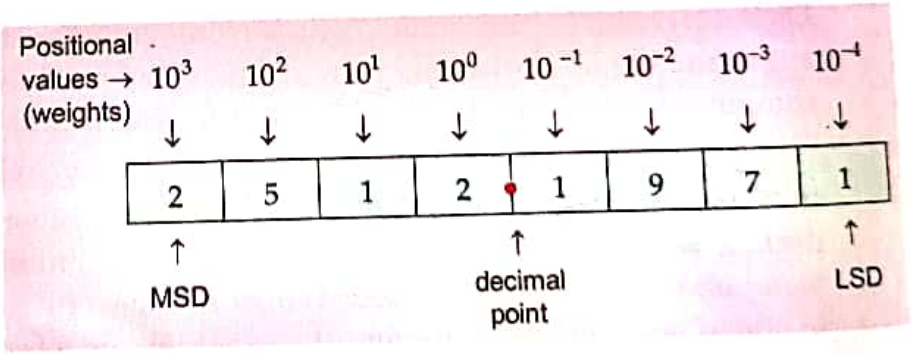

Figure 2.1 Positional values in decimal numbers.

2.2.2 Binary Number System

Unfortunately, the decimal number system does not lend itself to convenient implementation in digital systems. For example, it is very difficult to design electronic equipment so that it can work with 10 different voltage levels (each one representing one decimal character, 0 through 9). On the other hand, it is very easy to design simple, accurate electronic circuits that operate with only two voltage levels. For this reason, almost every digital system uses the binary number system (base 2) as the basic number system of its operations, although other systems are often used in conjunction with binary.