Computing Devices and their usage

Computing devices are the electronic devices which take inputs, process the inputs and then calculate results from the inputs. Or in simple words, these are basically the mathematical devices which can do the math much in faster way. One of the most common computing device is computer which we all know about it.

This is the vast field and it covers huge amount of devices today which we are using in one or another form and these devices ranging from the simple Calculator, Printers, Digital Cameras, Mobile phones, Smart phones , PC Desktops, Laptops and many more. These all do the math calculations on the streams of binary digits (bits i.e. 0 and 1) and produce the results in different forms that we need.

They simply take inputs from the users and process the inputs by doing calculations and then produce outputs. Let us take example of a computer, we enter the inputs to the computer (like pressing the keys from the keyboard or clicking through the mouse), it processes them and produces the output data on the screen of the monitor.

Features Common to Computing Devices

(i) Processors

Every computing device will have the electronic calculator i.e. processor. This executes calculations from the instructions given to them in the form of programming code.

(ii) Programming

Programming is the basic for executing computations. There can be two kinds of programming for computers and that are Operating systems and Applications. An operating system (OS) helps the people to interact with the computing machine through pressing keys on keyboard, clicking via mouse and many more. This is basically a program need for running a system in appropriate way. Applications also known as apps, are examples of specialized programs that enable the computer to carry out specific tasks.

(iii) Data Storage

This is another feature which all the computing devices have. Data storage is basically storing the programs as well as data on different memory devices used in the computing devices today and these programs and data which are stored can be used later for our needs. There are different storage devices using today.

Example: Let’s take an example which will cover the above three features of the computing devices.

Any Dell Computer is a computing devices and it has the processor inside it which does computations. When the Laptop is ON, it runs the software or program called Operating system which enables the user to interact with the laptop through keyboard and mouse and then the user stores the file on the storage element called hard drive for the later use.

Types of General-purpose Computers

There are basically two kinds of General-purpose computers and they are

1. Multi-user Computers
2. Dedicated Computers

1. Multi-user Computers

As the name suggests that this is a kind of computer that can handle multi users at a time. Mainframes, minicomputers, and supercomputers all fall into this category.

Example of Multi-user computer is the computerized cash registers in a large retail store, which typically connect to a multi-user computer that records transactions and adjusts the store’s stock list database so that all individual registers are synchronized.

2. Dedicated Computers

Dedicated computers are the computers which can be used by one user at a time. These computers have replaced multi-user computers because they are simple and have less cost. PC (Personal Computer is the most common dedicated computer these days. A typical PC has the other peripheral devices like keyboard, mouse and monitor which are used to interact with the system.

Number System in Computing

Concept of Number System in Computing

Computer stores information in bits (or binary digits). A bit is the smallest amount of information, the smallest unit of data that a computer system can handle. It can either be on (1) or off (0). Therefore, any thing represented in the binary system can immediately be understood by our computer, which really can understand only these two digits.

All numbering system works exactly the same way. The only difference between them is the base used.

- The decimal system uses 10 as base
- The binary system uses 2 as base
- The octal system uses 8 as base
- The hexadecimal system uses 16 as base

The numbering systems are expressed in the table below:

Binary (Base 2)	**Octal (Base 8)**	**Decimal (Base 10)**	**Hexadecimal (Base 16)**
0	0	0	0
1	1	1	1
10	2	2	2
11	3	3	3
100	4	4	4
101	5	5	5
110	6	6	6
111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F
10000	20	16	10

11111111	377	255	FF
11111010001	3721	2001	7D1

(i) Conversion from Decimal Numeral (Base 10) to Binary (Base 2) and Vice Versa

To convert decimal (i.e. base 10) to binary number (i.e. base 2), just take your decimal number and successively divide by the power of 2 until it is no longer divisible and note the remainder (which is either 0 or 1) at every point of division, e.g. Convert 93 to binary (i.e. base 2)

2	93
2	46 r 1
2	23 r 0
2	11 r 1
2	5 r 1
2	2 r 1
2	1r 0
	0 r 1

Therefore 93_{10} $=1011101_2$

To convert binary (i.e. base 2) numbers to decimal (base 10), each digits of the binary number should be multiplied by it base number and increasing the powers of the base number from right to left starting from zero, e.g. convert 1011101_2 to decimal (i.e. Base 10)

$=1^6 0^5 1^4 1^3 1^2 0^1 1^0{}_2$

$=1\times2^6+0x2^5+1\times2^4+1\times2^3+1\times2^2+0x2^1+1\times2^0$
$=1\times64+0x32+1\times16+1\times8+1\times4+0x2+1\times1$

$=64+0+16+8+0+1$

$=64+16+8+4+1=93$

I.e. $1011101_2$$=93_{10}$ = 93 (you do not need to write base 10)

(ii) – Octal Numbering System

The Octal numbering system is the base 8 number system and uses the digits 1 to 7 numerals by grouping consecutive binary digits into groups of three (starting from the right side), i.e. $2^3=8$. 3-digit format of conversion can be used for the conversion to base 8, e.g. convert 1001010_2 to base 8.

Step 1– group the binary representatives into three starting from the right side; i.e. **00**1,001,010,

N.B- two digits (i.e.**00**) were added to the last digits to make it a complete 3-digits format.

Step 2– now, we will convert each set of the three digits $0^2 1^1 0^0=0x2^2+1\times2^1+0x2^0=0+2+0=2$

$0^2 0^1 1^0=0x2^2+0x2^1+0x2^0=0+0+1=1$

$0^2 0^1 1^0=0x2^2+0x2^1+1\times2^0=0+0+1=1$

Thus, $10010102=112_8$

The above method is called **Binary Coded Decimal** (BCD) method.

Another method we can use to convert base 2 to base 8 is by first converting to base 10, then from base 10 to 8. This method is often called the **Convection Method**.

Example 1 – Convert 1001010^2 to base 8

Solution: Using the **Convectional Method**,

Step 1: convert the binary given to base 10

i.e. $1^6 0^5 0^4 1^3 0^2 1^1 0^0$

$=1\times2^6+0x2^5+0x2^4+1\times2^3+0x2^2+1\times2^1+0x2^0$

$=64+0+0+8+0+2+0$

$=74$

i.e. $1001010_2=74_{10}$ or simply 74

Step 2: convert the answer in base 10 to (in this case 74_{10}) to base 8

8	74

8	9 r 2
8	1 r 1
	0 r 1

i.e. $74_{10}=112_8$

i.e. $1001010_2=74_{10}=112_8$

i.e. $1001010_2=112_8$

Example 2 – Convert 1110110110111_2 to base 8

1. Using the **Convectional Method**
2. Using the **Binary Coded Decimal** methods.

Solution

Using the conventional method, we first convert the binary digits given to base 10, then the answer in base 10 to base 8

Step 1: $1^{12}1^{11}1^{10}0^{9}1^{8}1^{7}0^{6}1^{5}1^{4}0^{3}1^{2}1^{1}1^{0}{}_2$

$=1\times2^{12}+1\times2^{11}+1\times2^{10}+0x2^{9}+1\times2^{8}+1\times2^{7}+0x2^{6}+1\times2^{5}+1\times2^{4}+0x2^{3}+1\times2^{2}+1\times2^{1}+1\times2^{0}$

$=4096+2048+1024+0+256+128+0+32+16+0+4+2+1$

$=7607_{10}$

Step 2: Convert the answer in base 10 to base 8

8	7607
8	950 r 7
8	118 r 6
8	14 r 6
8	1 r 6
	0 r 1

Thus $11101101101112=7607_{10}=16667_8$

i.e. $1110110110111_2=16667_8$

Using the BCD method, we group the binary digits into 3-digits starting from the right side and convert each group to decimal.

Step 1: 001,110,110,110,111.

N/B: I added **00** to the last group to make it three bits.

Step 2: $1^2 1^1 1^0 = 1\times2^2+1\times2^1+1\times2^0=4+2+1=7$

$1^2 1^1 0^0=1\times2^2+1\times2^1+0x2^0=4+2+0=6$

$1^2 1^1 2^2=1\times2^2+1\times2^1+0x2^0=4+2+0=6$

$1^2 1^1 0^0=1X2^2+1\times2^1+0x2^0=4+2+0=6$

$0^2 0^1 1^0=0x2^2+0x2^1+1\times2^0=0+0+1=1$

i.e. $1110110110111_2=16667_8$

Example 3 – Convert 3062_8 to binary (i.e. base 2)

Using **Conventional** method

Using **Binary Coded Decimal** method

Solution: (i) Using Conventional method:

Step 1: Convert from base 8 to base 10

$3^3 0^2 6^1 2^0$ = $3\times8^3+0x8^2+6\times8^1+2\times8^0$ = $1536+0+48+2=1586_{10}$

Step 2: Convert the answer in base 10 to base 2

2	1586
2	793 r 0
2	396 r 1
2	198 r 0
2	99 r 0
2	49 r 1
2	24 r 1
2	12 r 0
2	6 r 0
2	3 r 0

2	1 r 1
	0 r 1

Thus $3062_8 = 11000110010_2$

(ii) Using **Binary Coded Decimal**

Using the BCD method, we pick each of the digits in base 8 and convert to base 2 up to **3 binary digits only.**

3

2	3
2	1 r 1
2	0 r 1
	0 r 0

= 011

0

2	0
2	0 r 0
2	0 r 0
	0 r 0

=000

6

2	6
2	3 r 0
2	1 r 1
	0 r 1

=110

2

2	2
2	1 r 0
2	0 r 1
	0 r 0

=010

Thus $3062_8 = \mathbf{0}11000110010_2$ the first digit which is zero can be remove to have 11000110010_2

(iii) Hexadecimal Numbering System

Hexadecimal stands for 16, and the base of the hexadecimal is 16. It is the most used base by computer programmers. In the hexadecimal, there are 16 relevant characters that make up the numbering system. This is also called a base 16 numbering system. The digits in the hexadecimal decimal system are: **0123456789ABCDEF**

Decimal (Our standard, base 10, number system) uses only 0 through 9, therefore the letters in hexadecimal numbering system are necessary. Computers have a standard unit for storing information, i.e. byte. It represents 8 bits which can either be 0 or 1. Hexadecimal numbering system uses 4-digits format of conversion, i.e. $2^4=16$;

To convert a binary digit to hexadecimal numbers, the binary digits are grouped into four bits starting from the right side.

Example 1 – Convert 11011111100_2 to base 16

Solution:

Step 1: group each binary number into four bits each.

0110, 1111, 1100

N/B: I added 0 to the last group to make it four bits.

Step 2: convert each group to decimal.

$1^3 1^2 0^1 0^0 = 1 \times 2^3 + 1 \times 2^2 + 0x2^1 + 0x2^0 = 8+4+0+0 = 12$

$1^3 1^2 1^1 1^0 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 8+4+2+1 = 15$

$0^3 1^2 1^1 0^0 = 0x2^3 + 1 \times 2^2 + 1 \times 2^1 + 0x2^0 = 0+4+2+0 = 6$

i.e. $11011111100_2 = 61512_{16}$ and from the hexadecimal section of numbering system table, 15= F, and 12=C, thus, 110111111100_2 = 61512_{16} =$6FC_{16}$

Example 2 – Convert 100100010111111_2 to base 16.

Solution:

Step 1: group each binary number into four bits each

0100, 1000, 1011, 1111

Step 2: convert each group to decimal

$1^3 1^2 1^1 1^0 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 8+4+2+1 = 15 = F$

$1^3 0^3 1^1 1^0 = 1 \times 2^3 + 0x2^2 + 1 \times 2^1 + 1 \times 2^0 = 8+0+2+1 = 11 = B$

$1^3 0^2 0^1 0^0 = 1 \times 2^3 + 0x2^2 + 0x2^1 + 0x2^0 = 8+0+0+0 = 8$

$0^3 1^2 0^1 0^0 = 0x2^3 + 1 \times 2^2 + 0x2^1 + 0x2^0 = 0+4+0+0 = 4$

i.e. $100100010111111_2 = 481115_{16} = 48BF_{16}$

Exercise:

1. Convert CDO_{16} to Binary (i.e. base 2)
2. Using Conventional method.
3. Using Binary Coded Decimals.