

Data Processing

Data processing occurs when data is collected and translated into usable information. Usually performed by a data scientist or team of data scientists, it is important for data processing to be done correctly as not to negatively affect the end product, or data output.

Data processing starts with data in its raw form and converts it into a more readable format (graphs, documents, etc.), giving it the form and context necessary to be interpreted by computers and utilized by employees throughout an organization.

ix stages of data processing

1. Data collection

Collecting data is the first step in data processing. Data is pulled from available sources, including [data lakes](#) and [data warehouses](#). It is important that the data sources available are trustworthy and well-built so the data collected (and later used as information) is of the highest possible quality.

2. Data preparation

Once the data is collected, it then enters the [data preparation](#) stage. Data preparation, often referred to as “pre-processing” is the stage at which raw data is cleaned up and organized for the following stage of data processing. During preparation, raw data is diligently checked for any errors. The purpose of this step is to eliminate bad data ([redundant](#), incomplete, or incorrect data) and begin to create high-quality data for the best [business intelligence](#).

3. Data input

The clean data is then entered into its destination (perhaps a CRM like [Salesforce](#) or a data warehouse like [Redshift](#)), and translated into a language that it can understand. Data input is the first stage in which raw data begins to take the form of usable information.

4. Processing

During this stage, the data inputted to the computer in the previous stage is actually processed for interpretation. Processing is done using [machine learning](#) algorithms, though the process itself may vary slightly depending on the source of data being processed (data lakes, social networks, connected devices etc.) and its intended use (examining advertising patterns, medical diagnosis from connected devices, determining customer needs, etc.).

5. Data output/interpretation

The output/interpretation stage is the stage at which data is finally usable to non-data scientists. It is translated, readable, and often in the form of graphs, videos, images, plain text, etc.). Members of the company or institution can now begin to [self-serve the data](#) for their own [data analytics](#) projects.

6. Data storage

The final stage of data processing is [storage](#). After all of the data is processed, it is then stored for future use. While some information may be put to use immediately, much of it will serve a purpose later on. Plus, properly stored data is a necessity for compliance with data protection legislation like [GDPR](#). When data is properly stored, it can be quickly and easily accessed by members of the organization when needed.

History Of Computing

A computer might be described with deceptive simplicity as “an apparatus that performs routine calculations automatically.” Such a definition would owe its deceptiveness to a naive and narrow view of calculation as a strictly mathematical process. In fact, calculation underlies many activities that are not normally thought of as mathematical. Walking across a room, for instance, requires many complex, [albeit](#) subconscious, calculations. Computers, too, have proved capable of solving a vast array of problems, from balancing a checkbook to even—in the form of guidance systems for robots—walking across a room.

Before the true [power](#) of computing could be realized, therefore, the naive view of calculation had to be overcome. The inventors who laboured to bring the computer into the world had to learn that the thing they were inventing was not just a number cruncher, not merely a calculator. For example, they had to learn that it was not necessary to invent a new computer for every new calculation and that a computer could be designed to solve numerous

problems, even problems not yet imagined when the computer was built. They also had to learn how to tell such a general problem-solving computer what problem to solve. In other words, they had to invent programming.

They had to solve all the heady problems of developing such a device, of implementing the design, of actually building the thing. The history of the solving of these problems is the history of the computer. That history is covered in this section, and links are provided to entries on many of the individuals and companies mentioned. In addition, see the articles computer science and supercomputer.

Early history

Computer precursors

The abacus

The earliest known calculating device is probably the abacus. It dates back at least to 1100 BCE and is still in use today, particularly in Asia. Now, as then, it typically consists of a rectangular frame with thin parallel rods strung with beads. Long before any systematic positional notation was adopted for the writing of numbers, the abacus assigned different units, or weights, to each rod. This scheme allowed a wide range of numbers to be represented by just a few beads and, together with the invention of zero in India, may have inspired the invention of the Hindu-Arabic number system. In any case, abacus beads can be readily manipulated to perform the common arithmetical operations—addition, subtraction, multiplication, and division—that are useful for commercial transactions and in bookkeeping.

The abacus is a digital device; that is, it represents values discretely. A bead is either in one predefined position or another, representing unambiguously, say, one or zero.

Analog calculators: from Napier's logarithms to the slide rule

Calculating devices took a different turn when John Napier, a Scottish mathematician, published his discovery of logarithms in 1614. As any person can attest, adding two 10-digit numbers is much simpler than multiplying them together, and the transformation of a multiplication problem into an addition problem is exactly what logarithms enable. This simplification is possible because of the following logarithmic property: the logarithm of the product of two numbers is equal to the sum of the logarithms of the numbers. By 1624,

tables with 14 significant digits were available for the logarithms of numbers from 1 to 20,000, and scientists quickly adopted the new labour-saving [tool](#) for tedious astronomical calculations.

Most significant for the development of computing, the transformation of multiplication into addition greatly simplified the possibility of mechanization. [Analog](#) calculating devices based on Napier's logarithms—representing digital values with [analogous](#) physical lengths—soon appeared. In 1620 [Edmund Gunter](#), the English mathematician who coined the terms *cosine* and *cotangent*, built a device for performing navigational calculations: the Gunter scale, or, as navigators simply called it, the gunter. About 1632 an English clergyman and mathematician named [William Oughtred](#) built the first [slide rule](#), drawing on Napier's ideas. That first slide rule was circular, but Oughtred also built the first rectangular one in 1633. The analog devices of Gunter and Oughtred had various advantages and disadvantages compared with digital devices such as the abacus. What is important is that the consequences of these design decisions were being tested in the real world.

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Digital calculators: from the Calculating Clock to the Arithmometer

In 1623 the German astronomer and mathematician [Wilhelm Schickard](#) built the first [calculator](#). He described it in a letter to his friend the astronomer [Johannes Kepler](#), and in 1624 he wrote again to explain that a machine he had commissioned to be built for Kepler was, apparently along with the [prototype](#), destroyed in a fire. He called it a [Calculating Clock](#), which modern engineers have been able to reproduce from details in his letters. Even general knowledge of the clock had been temporarily lost when Schickard and his entire family perished during the [Thirty Years' War](#).



The Calculating Clock A reproduction of Wilhelm Schickard's Calculating Clock. The device could add and subtract six-digit numbers (with a bell for seven-digit overflows) through six interlocking gears, each of which turned one-tenth of a rotation for each full rotation of the gear to its right. Thus, 10 rotations of any gear would produce a "carry" of one digit on the following gear and change the corresponding display. *The Computer Museum of America*

But Schickard may not have been the true inventor of the calculator. A century earlier, [Leonardo da Vinci](#) sketched plans for a calculator that were sufficiently complete and correct for modern engineers to build a calculator on their basis.

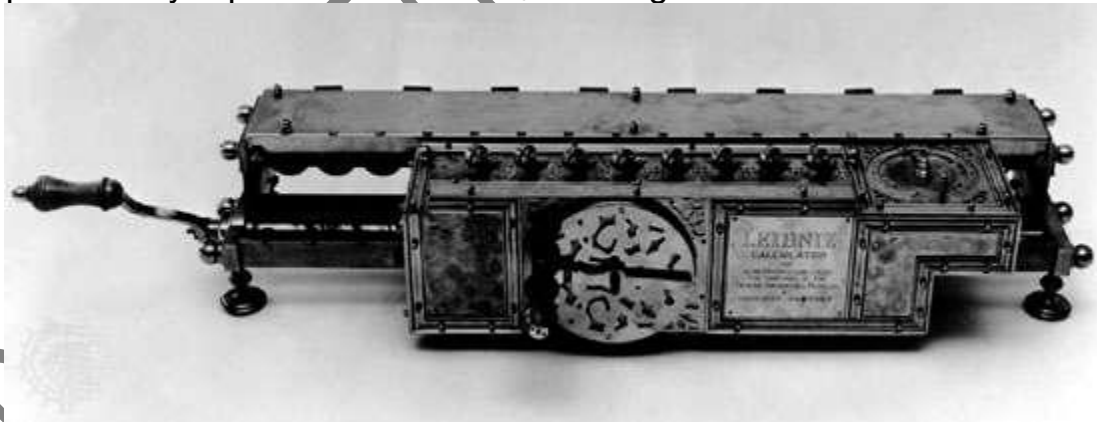
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The first calculator or [adding machine](#) to be produced in any quantity and actually used was the Pascaline, or [Arithmetic Machine](#), designed and built by the French mathematician-philosopher [Blaise Pascal](#) between 1642 and 1644. It could only do addition and subtraction, with numbers being entered by manipulating its dials. Pascal invented the machine for his father, a tax collector, so it was the first business machine too (if one does not count the abacus). He built 50 of them over the next 10 years.



The Arithmetic Machine, or Pascaline, a French monetary (nondecimal) calculator designed by Blaise Pascal c. 1642. Numbers could be added by turning the wheels (located along the bottom of the machine) clockwise and subtracted by turning the wheels counterclockwise. Each digit in the answer was displayed in a separate window, visible at the top of the photograph. *Courtesy of the Computer Museum History Center*

In 1671 the German mathematician-philosopher [Gottfried Wilhelm von Leibniz](#) designed a calculating machine called the [Step Reckoner](#). (It was first built in 1673.) The Step Reckoner expanded on Pascal's ideas and did multiplication by repeated addition and shifting.



The Step Reckoner A reproduction of Gottfried Wilhelm von Leibniz's Step Reckoner, from the original located in the Trinks Brunsviga Museum at Hannover, Germany. Turning the crank (left) rotated several drums, each of which turned a gear connected to a digital counter. *IBM Archives*

Leibniz was a strong advocate of the [binary number system](#). Binary numbers are ideal for machines because they require only two digits, which can easily be represented by the on and off states of a switch. When computers became

electronic, the binary system was particularly appropriate because an electrical [circuit](#) is either on or off. This meant that on could represent true, off could represent false, and the flow of current would directly represent the flow of logic.

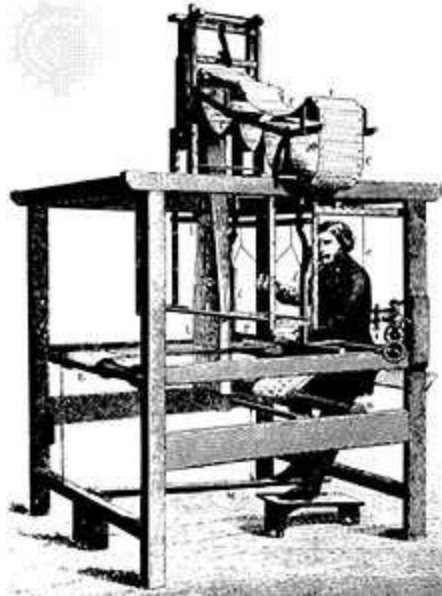
Leibniz was prescient in seeing the appropriateness of the binary system in calculating machines, but his machine did not use it. Instead, the Step Reckoner represented numbers in decimal form, as positions on 10-position dials. Even decimal representation was not a given: in 1668 Samuel Morland invented an adding machine specialized for British money—a decidedly nondecimal system.

Pascal's, Leibniz's, and Morland's devices were curiosities, but with the [Industrial Revolution](#) of the 18th century came a widespread need to perform repetitive operations efficiently. With other activities being mechanized, why not calculation? In 1820 [Charles Xavier Thomas de Colmar](#) of France effectively met this challenge when he built his [Arithmometer](#), the first commercial mass-produced calculating device. It could perform addition, subtraction, multiplication, and, with some more elaborate user involvement, division. Based on Leibniz's [technology](#), it was extremely popular and sold for 90 years. In contrast to the modern calculator's credit-card size, the Arithmometer was large enough to cover a desktop.

The [Jacquard loom](#)

Calculators such as the Arithmometer remained a fascination after 1820, and their potential for commercial use was well understood. Many other mechanical devices built during the 19th century also performed repetitive functions more or less automatically, but few had any application to computing. There was one major exception: the [Jacquard loom](#), invented in 1804–05 by a French weaver, [Joseph-Marie Jacquard](#).

The Jacquard loom was a marvel of the Industrial Revolution. A textile-weaving loom, it could also be called the first practical information-processing device. The loom worked by tugging various-coloured threads into patterns by means of an array of rods. By inserting a [card punched](#) with holes, an operator could [control](#) the motion of the rods and thereby alter the pattern of the weave. Moreover, the loom was equipped with a card-reading device that slipped a new card from a prepunched deck into place every time the shuttle was thrown, so that complex weaving patterns could be automated.



Jacquard loom, engraving, 1874 At the top of the machine is a stack of punched cards that would be fed into the loom to control the weaving pattern. This method of automatically issuing machine instructions was employed by computers well into the 20th century. *The Bettmann Archive*

What was extraordinary about the device was that it transferred the design process from a labour-intensive weaving stage to a card-punching stage. Once the cards had been punched and assembled, the design was complete, and the loom implemented the design automatically. The Jacquard loom, therefore, could be said to be programmed for different patterns by these decks of punched cards.

For those intent on mechanizing calculations, the Jacquard loom provided important lessons: the sequence of operations that a machine performs could be controlled to make the machine do something quite different; a punched card could be used as a medium for directing the machine; and, most important, a device could be directed to perform different tasks by feeding it instructions in a sort of language—i.e., making the machine programmable.

It is not too great a stretch to say that, in the Jacquard loom, programming was invented before the computer. The close relationship between the device and the program became apparent some 20 years later, with [Charles Babbage's](#) invention of the first computer.

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Computer Generations:

Generation in computer terminology is a change in technology a computer is/was being used. Initially, the generation term was used to distinguish between varying hardware technologies. Nowadays, generation includes both hardware and software, which together make up an entire computer system.

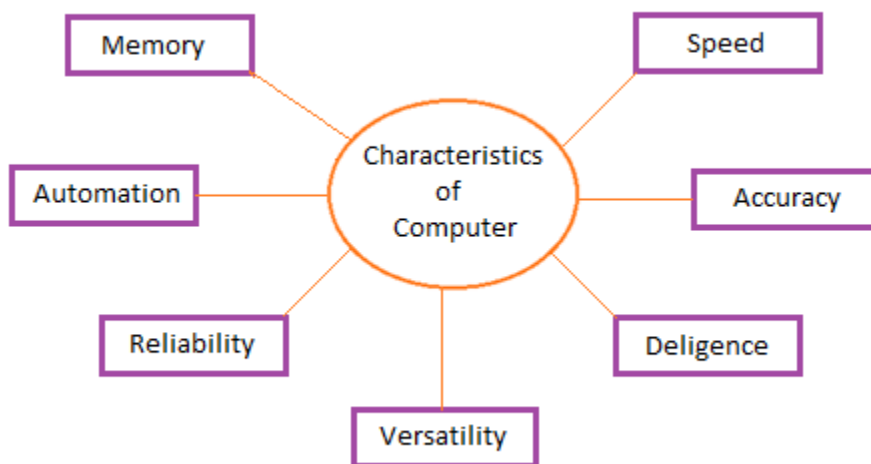
There are five computer generations known till date. Each generation has been discussed in detail along with their time period and characteristics. In the following table, approximate dates against each generation has been mentioned, which are normally accepted.

Following are the main five generations of computers.

S.No	Generation & Description
1	First Generation The period of first generation: 1946-1959. Vacuum tube based.
2	Second Generation The period of second generation: 1959-1965. Transistor based.
3	Third Generation The period of third generation: 1965-1971. Integrated Circuit based.
4	Fourth Generation The period of fourth generation: 1971-1980. VLSI microprocessor based.
5	Fifth Generation The period of fifth generation: 1980-onwards. ULSI microprocessor based.

Characteristics of Computer System

The characteristics of the computer system are as follows –



Speed

A computer works with much higher speed and accuracy compared to humans while performing mathematical calculations. Computers can process millions (1,000,000) of instructions per second. The time taken by computers for their operations is microseconds and nanoseconds.

Accuracy

Computers perform calculations with 100% accuracy. Errors may occur due to data inconsistency or inaccuracy.

Diligence

A computer can perform millions of tasks or calculations with the same consistency and accuracy. It doesn't feel any fatigue or lack of concentration. Its memory also makes it superior to that of human beings.

Versatility

Versatility refers to the capability of a computer to perform different kinds of works with same accuracy and efficiency.

Reliability

A computer is reliable as it gives consistent result for similar set of data i.e., if we give same set of input any number of times, we will get the same result.

Automation

Computer performs all the tasks automatically i.e. it performs tasks without manual intervention.

Memory

A computer has built-in memory called primary memory where it stores data. Secondary storage are removable devices such as CDs, pen drives, etc., which are also used to store data.

Anatomy of a Computer

When breaking down the components of a computer, they are oftentimes likened to the parts of the body. The processing unit may be compared to the brain, with the access memory and hard drive are equated to short and long term memory, while the motherboard is sometimes considered the central nervous system of a computer. All these parts hidden beneath the casing work much like organs, performing essential functions that allow a computer to perform tasks.

Central Processing Unit (CPU)

The central processing unit is an essential part of the computer. It controls and executes operations, interpreting input provided by the user and directing the output to complete a requested task. While it is generally a physical component of the computer, cloud computing can subdivide CPU operation into virtual central processing units (vCPU).

CPU's are distinguished by their computing speed, which is referred to as a clock rate. Depending on the speed, this is measured in hertz (Hz) or gigahertz (GHz) per second. Tasks like watching high-definition movies, simultaneous online gaming and streaming, manipulating graphics or other large programs generally require processors with higher speeds.

Random Access Memory (RAM)

Random access memory is just like it sounds: a computer's memory. More specifically, it stores the data and machine code currently being used. This allows the information to be read or written quickly regardless of where the physical location of the data is inside the complete memory.

The more RAM a computer has, the better it can manage several programs at once. It isn't difficult to add more memory after an initial build, but investing in more RAM is considered just as vital, if not more, than a good processor. A good starting point is at least 512 megabyte.

Hard Drive

While RAM could be regarded as short term memory, a hard drive is long term storage. It is a high-capacity, self-contained storage device with the ability to both store and recall data. It includes one or more hard disk inside a sealed unit, each of which can hold up to 12 terabytes of information.

All data created on the computer - from work files to installed programs - are stored on the hard drive. IBM compatible computers often labeled alphabetically, starting at "C:", with A and B reserved for removable media. Hard drives can also be external as well and are often used for backing up computer data or storing exceptionally large files.

COMPUTER CLASSIFICATION

Computers can be broadly classified by their speed and computing power.

Minicomputer

It is a midsize multi-processing system capable of supporting up to 250 users simultaneously.



Computer - Types

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Computers can be broadly classified by their speed and computing power.

S.No.	Type	Specifications
1	PC (Personal Computer)	It is a single user computer system having moderately powerful microprocessor
2	Workstation	It is also a single user computer system, similar to personal computer however has a more powerful microprocessor.
3	Mini Computer	It is a multi-user computer system, capable of supporting hundreds

		of users simultaneously.
4	Main Frame	It is a multi-user computer system, capable of supporting hundreds of users simultaneously. Software technology is different from minicomputer.
5	Supercomputer	It is an extremely fast computer, which can execute hundreds of millions of instructions per second.

PC (Personal Computer)



A PC can be defined as a small, relatively inexpensive computer designed for an individual user. PCs are based on the microprocessor technology that enables manufacturers to put an entire CPU on one chip. Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications. At home, the most popular use for personal computers is playing games and surfing the Internet.

Although personal computers are designed as single-user systems, these systems are normally linked together to form a network. In terms of power, now-a-days high-end models of the Macintosh and PC offer the same computing power and graphics capability as low-end workstations by Sun Microsystems, Hewlett-Packard, and Dell.

Workstation



Workstation is a computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other such types of applications which require a moderate amount of computing power and relatively high quality graphics capabilities.

Workstations generally come with a large, high-resolution graphics screen, large amount of RAM, inbuilt network support, and a graphical user interface. Most workstations also have mass storage device such as a disk drive, but a special type of workstation, called diskless workstation, comes without a disk drive.

Common operating systems for workstations are UNIX and Windows NT. Like PC, workstations are also single-user computers like PC but are typically linked together to form a local-area network, although they can also be used as stand-alone systems.

Minicomputer

It is a midsize multi-processing system capable of supporting up to 250 users simultaneously.



Mainframe

Mainframe is very large in size and is an expensive computer capable of supporting hundreds or even thousands of users simultaneously. Mainframe executes many programs concurrently and supports many simultaneous execution of programs



Supercomputer

Supercomputers are one of the fastest computers currently available. Supercomputers are very expensive and are employed for specialized applications that require immense amount of mathematical calculations (number crunching).



For example, weather forecasting, scientific simulations, (animated) graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting).

Number System

When we type some letters or words, the computer translates them in numbers as computers can understand only numbers. A computer can understand the positional number system where there are only a few symbols called digits and these symbols represent different values depending on the position they occupy in the number.

The value of each digit in a number can be determined using –

- The digit
- The position of the digit in the number
- The base of the number system (where the base is defined as the total number of digits available in the number system)

Decimal Number System

The number system that we use in our day-to-day life is the decimal number system. Decimal number system has base 10 as it uses 10 digits from 0 to 9. In decimal number system, the successive positions to the left of the decimal point represent units, tens, hundreds, thousands, and so on.

Each position represents a specific power of the base (10). For example, the decimal number 1234 consists of the digit 4 in the units position, 3 in the tens position, 2 in the hundreds position, and 1 in the thousands position. Its value can be written as

$$\begin{aligned} & (1 \times 1000) + (2 \times 100) + (3 \times 10) + (4 \times 1) \\ & (1 \times 10^3) + (2 \times 10^2) + (3 \times 10^1) + (4 \times 10^0) \\ & 1000 + 200 + 30 + 4 \\ & 1234 \end{aligned}$$

As a computer programmer or an IT professional, you should understand the following number systems which are frequently used in computers.

S.No.	Number System and Description
1	Binary Number System Base 2. Digits used : 0, 1
2	Octal Number System

	Base 8. Digits used : 0 to 7
3	Hexa Decimal Number System Base 16. Digits used: 0 to 9, Letters used : A- F

Binary Number System

Characteristics of the binary number system are as follows –

- Uses two digits, 0 and 1
- Also called as base 2 number system
- Each position in a binary number represents a **0** power of the base (2). Example 2^0
- Last position in a binary number represents a **x** power of the base (2). Example 2^x where **x** represents the last position - 1.

Example

Binary Number: 10101_2

Calculating Decimal Equivalent –

Step	Binary Number	Decimal Number
Step 1	10101_2	$((1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0))_{10}$
Step 2	10101_2	$(16 + 0 + 4 + 0 + 1)_{10}$
Step 3	10101_2	21_{10}

Note – 10101_2 is normally written as 10101.

Octal Number System

Characteristics of the octal number system are as follows –

- Uses eight digits, 0,1,2,3,4,5,6,7
- Also called as base 8 number system
- Each position in an octal number represents a **0** power of the base (8). Example 8^0

- Last position in an octal number represents a x power of the base (8). Example 8^x where x represents the last position - 1

Example

Octal Number: 12570_8

Calculating Decimal Equivalent -

Step	Octal Number	Decimal Number
Step 1	12570_8	$((1 \times 8^4) + (2 \times 8^3) + (5 \times 8^2) + (7 \times 8^1) + (0 \times 8^0))_{10}$
Step 2	12570_8	$(4096 + 1024 + 320 + 56 + 0)_{10}$
Step 3	12570_8	5496_{10}

Note - 12570_8 is normally written as 12570.

Hexadecimal Number System

Characteristics of hexadecimal number system are as follows -

- Uses 10 digits and 6 letters, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- Letters represent the numbers starting from 10. A = 10, B = 11, C = 12, D = 13, E = 14, F = 15
- Also called as base 16 number system
- Each position in a hexadecimal number represents a 0 power of the base (16). Example, 16^0
- Last position in a hexadecimal number represents a x power of the base (16). Example 16^x where x represents the last position - 1

Example

Hexadecimal Number: $19FDE_{16}$

Calculating Decimal Equivalent -

Step	Binary Number	Decimal Number
Step 1	$19FDE_{16}$	$((1 \times 16^4) + (9 \times 16^3) + (F \times 16^2) + (D \times 16^1) + (E \times 16^0))_{10}$

Step 2	19FDE ₁₆	$((1 \times 16^4) + (9 \times 16^3) + (15 \times 16^2) + (13 \times 16^1) + (14 \times 16^0))_{10}$
Step 3	19FDE ₁₆	$(65536 + 36864 + 3840 + 208 + 14)_{10}$
Step 4	19FDE ₁₆	106462 ₁₀

Number Conversion

There are many methods or techniques which can be used to convert numbers from one base to another. In this chapter, we'll demonstrate the following –

- Decimal to Other Base System
- Other Base System to Decimal
- Other Base System to Non-Decimal
- Shortcut method - Binary to Octal
- Shortcut method - Octal to Binary
- Shortcut method - Binary to Hexadecimal
- Shortcut method - Hexadecimal to Binary

Decimal to Other Base System

Step 1 – Divide the decimal number to be converted by the value of the new base.

Step 2 – Get the remainder from Step 1 as the rightmost digit (least significant digit) of the new base number.

Step 3 – Divide the quotient of the previous divide by the new base.

Step 4 – Record the remainder from Step 3 as the next digit (to the left) of the new base number.

Repeat Steps 3 and 4, getting remainders from right to left, until the quotient becomes zero in Step 3.

The last remainder thus obtained will be the Most Significant Digit (MSD) of the new base number.

Other Base System to Decimal System

Step 1 – Determine the column (positional) value of each digit (this depends on the position of the digit and the base of the number system).

Step 2 – Multiply the obtained column values (in Step 1) by the digits in the corresponding columns.

Step 3 – Sum the products calculated in Step 2. The total is the equivalent value in decimal.

Other Base System to Non-Decimal System

Step 1 – Convert the original number to a decimal number (base 10).

Step 2 – Convert the decimal number so obtained to the new base number.

Computer - Number Conversion

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- Shortcut method - Hexadecimal to Binary

Decimal to Other Base System

Step 1 – Divide the decimal number to be converted by the value of the new base.

Step 2 – Get the remainder from Step 1 as the rightmost digit (least significant digit) of the new base number.

Step 3 – Divide the quotient of the previous divide by the new base.

Step 4 – Record the remainder from Step 3 as the next digit (to the left) of the new base number.

Repeat Steps 3 and 4, getting remainders from right to left, until the quotient becomes zero in Step 3.

The last remainder thus obtained will be the Most Significant Digit (MSD) of the new base number.

Example

Decimal Number: 29_{10}

Calculating Binary Equivalent –

Step	Operation	Result	Remainder
Step 1	$29 / 2$	14	1
Step 2	$14 / 2$	7	0
Step 3	$7 / 2$	3	1
Step 4	$3 / 2$	1	1
Step 5	$1 / 2$	0	1

As mentioned in Steps 2 and 4, the remainders have to be arranged in the reverse order so that the first remainder becomes the Least Significant Digit (LSD) and the last remainder becomes the Most Significant Digit (MSD).

Decimal Number : 29_{10} = Binary Number : 11101_2

Other Base System to Decimal System

Step 1 – Determine the column (positional) value of each digit (this depends on the position of the digit and the base of the number system).

Step 2 – Multiply the obtained column values (in Step 1) by the digits in the corresponding columns.

Step 3 – Sum the products calculated in Step 2. The total is the equivalent value in decimal.

Example

Binary Number: 11101_2

Calculating Decimal Equivalent –

Step	Binary Number	Decimal Number
Step 1	11101 ₂	$((1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0))_{10}$
Step 2	11101 ₂	$(16 + 8 + 4 + 0 + 1)_{10}$
Step 3	11101 ₂	29 ₁₀

Binary Number : 11101₂ = Decimal Number : 29₁₀

Other Base System to Non-Decimal System

Step 1 – Convert the original number to a decimal number (base 10).

Step 2 – Convert the decimal number so obtained to the new base number.

Example

Octal Number : 25₈

Calculating Binary Equivalent –

Step 1 - Convert to Decimal

Step	Octal Number	Decimal Number
Step 1	25 ₈	$((2 \times 8^1) + (5 \times 8^0))_{10}$
Step 2	25 ₈	$(16 + 5)_{10}$
Step 3	25 ₈	21 ₁₀

Octal Number : 25₈ = Decimal Number : 21₁₀

Step 2 - Convert Decimal to Binary

Step	Operation	Result	Remainder
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Step 1	21 / 2	10	1
Step 2	10 / 2	5	0
Step 3	5 / 2	2	1
Step 4	2 / 2	1	0
Step 5	1 / 2	0	1

Decimal Number : 21_{10} = Binary Number : 10101_2

Octal Number : 25_8 = Binary Number : 10101

ASCII code

The full form of **ASCII code** is American Standard Code for Information Interchange. It is a seven bit code based on the English alphabet.

In 1967 this code was first published and since then it is being modified and updated. **ASCII code** has 128 characters some of which are enlisted below to get familiar with the code.

DEC	OCT	HEX	BIN	Symbol	Description
0	000	00	00000000	NUL	Null char
1	001	01	00000001	SOH	Start of Heading
2	002	02	00000010	STX	Start of Text
3	003	03	00000011	ETX	End of Text
4	004	04	00000100	EOT	End of Transmission

5	005	05	00000101	ENQ	Enquiry
6	006	06	00000110	ACK	Acknowledgment
7	007	07	00000111	BEL	Bell
8	010	08	00001000	BS	Back Space
9	011	09	00001001	HT	Horizontal Tab
10	012	0A	00001010	LF	Line Feed
11	013	0B	00001011	VT	Vertical Tab
12	014	0C	00001100	FF	Form Feed
13	015	0D	00001101	CR	Carriage Return
14	016	0E	00001110	SO	Shift Out / X-On
15	017	0F	00001111	SI	Shift In / X-O

EBCDIC code

The EBCDIC stands for Extended Binary Coded Decimal Interchange Code. IBM invented this code to extend the Binary Coded Decimal which existed at that time. All the IBM computers and peripherals use this code. It is an 8 bit code and therefore can accommodate 256 characters. Below is given some characters of **EBCDIC code** to get familiar with it.

Char	EBCDIC	HEX	Char	EBCDIC	HEX	Char	EBCDIC	HEX
------	--------	-----	------	--------	-----	------	--------	-----

A	1100 0001	C1	P	1101 0111	D7	4	1111 0100	F4
B	1100 0010	C2	Q	1101 1000	D8	5	1111 0101	F5
C	1100 0011	C3	R	1101 1001	D9	6	1111 0110	F6
D	1100 0100	C4	S	1110 0010	E2	7	1111 0111	F7
E	1100 0101	C5	T	1110 0011	E3	8	1111 1000	F8
F	1100 0110	C6	U	1110 0100	E4	9	1111 1001	F9
G	1100 0111	C7	V	1110 0101	E5	blank	...	...
H	1100 1000	C8	W	1110 0110	E6	.	...	...
I	1100 1001	C9	X	1110 0111	E7	(	...	...
J	1101 0001	D1	Y	1110 1000	E8	+	...	...
K	1101 0010	D2	Z	1110 1001	E9	\$	...	...
L	1101 0011	D3	0	1111 0000	F0	*	...	...
M	1101 0100	D4	1	1111 0001	F1	)	...	...
N	1101 0101	D5	2	1111 0010	F2	-	...	...
O	1101 0110	D6	3	1111 0011	F3	/		

Input Devices

Following are some of the important input devices which are used in a computer –

- Keyboard
- Mouse
- Joy Stick
- Light pen
- Track Ball
- Scanner
- Graphic Tablet
- Microphone
- Magnetic Ink Card Reader(MICR)
- Optical Character Reader(OCR)
- Bar Code Reader
- Optical Mark Reader(OMR)

Keyboard

Keyboard is the most common and very popular input device which helps to input data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.

Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

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The keys on the keyboard are as follows –

S.No	Keys & Description
1	<p>Typing Keys</p> <p>These keys include the letter keys (A-Z) and digit keys (09) which generally give the same layout as that of typewriters.</p>
2	<p>Numeric Keypad</p> <p>It is used to enter the numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and</p>

	calculators.
3	<p>Function Keys</p> <p>The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has a unique meaning and is used for some specific purpose.</p>
4	<p>Control keys</p> <p>These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).</p>
5	<p>Special Purpose Keys</p> <p>Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.</p>

Mouse

Mouse is the most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.

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Advantages

- Easy to use
- Not very expensive
- Moves the cursor faster than the arrow keys of the keyboard.

Joystick

Joystick is also a pointing device, which is used to move the cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.

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The function of the joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

Light Pen

Light pen is a pointing device similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube.

Scanner

Scanner is an input device, which works more like a photocopy machine. It is used when some information is available on paper and it is to be transferred to the hard disk of the computer for further manipulation

Output Devices

Following are some of the important output devices used in a computer.

- Monitors
- Graphic Plotter
- Printer

Monitors

Monitors, commonly called as **Visual Display Unit (VDU)**, are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

There are two kinds of viewing screen used for monitors.

- Cathode-Ray Tube (CRT)
- Flat-Panel Display

Cathode-Ray Tube (CRT) Monitor

The CRT display is made up of small picture elements called pixels. The smaller the pixels, the better the image clarity or resolution. It takes more than one illuminated pixel to form a whole character, such as the letter 'e' in the word help.

A finite number of characters can be displayed on a screen at once. The screen can be divided into a series of character boxes - fixed location on the screen where a standard character can be placed. Most screens are capable of displaying 80 characters of data horizontally and 25 lines vertically.

There are some disadvantages of CRT –

- Large in Size
- High power consumption

Flat-Panel Display Monitor

The flat-panel display refers to a class of video devices that have reduced volume, weight and power requirement in comparison to the CRT. You can hang them on walls or wear them on your wrists. Current uses of flat-panel displays include calculators, video games, monitors, laptop computer, and graphics display.

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The flat-panel display is divided into two categories –

- **Emissive Displays** – Emissive displays are devices that convert electrical energy into light. For example, plasma panel and LED (Light-Emitting Diodes).
- **Non-Emissive Displays** – Non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. For example, LCD (Liquid-Crystal Device).

Printers

Printer is an output device, which is used to print information on paper.

There are two types of printers –

- Impact Printers
- Non-Impact Printers

Impact Printers

Impact printers print the characters by striking them on the ribbon, which is then pressed on the paper.

Characteristics of Impact Printers are the following –

- Very low consumable costs
- Very noisy
- Useful for bulk printing due to low cost
- There is physical contact with the paper to produce an image

These printers are of two types –

- Character printers
- Line printers

Character Printers

Character printers are the printers which print one character at a time.

These are further divided into two types:

- Dot Matrix Printer(DMP)
- Daisy Wheel

Dot Matrix Printer

In the market, one of the most popular printers is Dot Matrix Printer. These printers are popular because of their ease of printing and economical price. Each character printed is in the form of pattern of dots and head consists of a Matrix of Pins of size (5*7, 7*9, 9*7 or 9*9) which come out to form a character which is why it is called Dot Matrix Printer.

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Advantages

- Inexpensive
- Widely Used
- Other language characters can be printed

Disadvantages

- Slow Speed
- Poor Quality

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Advantages

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- Noisy
- More expensive than DMP

Line Printers

Line printers are the printers which print one line at a time.



These are of two types –

- Drum Printer
- Chain Printer

Drum Printer

This printer is like a drum in shape hence it is called drum printer. The surface of the drum is divided into a number of tracks. Total tracks are equal to the size of the paper, i.e. for a paper width of 132 characters, drum will have 132 tracks. A character set is embossed on the track. Different character sets available in the market are 48 character set, 64 and 96 characters set. One rotation of drum prints one line. Drum printers are fast in speed and can print 300 to 2000 lines per minute.

Advantages

- Very high speed

Disadvantages

- Very expensive
- Characters fonts cannot be changed

Chain Printer

In this printer, a chain of character sets is used, hence it is called Chain Printer. A standard character set may have 48, 64, or 96 characters.

Advantages

- Character fonts can easily be changed.
- Different languages can be used with the same printer.

Disadvantages

- Noisy

Non-impact Printers

Non-impact printers print the characters without using the ribbon. These printers print a complete page at a time, thus they are also called as Page Printers.

These printers are of two types –

- Laser Printers
- Inkjet Printers

Characteristics of Non-impact Printers

- Faster than impact printers
- They are not noisy
- High quality
- Supports many fonts and different character size

Laser Printers

These are non-impact page printers. They use laser lights to produce t

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- They are not noisy
- High quality
- Supports many fonts and different character size

Laser Printers

These are non-impact page printers. They use laser lights to produce the dots needed to form the characters to be printed on a page.



Advantages

- Very high speed
- Very high quality output
- Good graphics quality
- Supports many fonts and different character size

Disadvantages

- Expensive
- Cannot be used to produce multiple copies of a document in a single printing

Inkjet Printers

Inkjet printers are non-impact character printers based on a relatively new technology. They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features.

They make less noise because no hammering is done and these have many styles of printing modes available. Color printing is also possible. Some models of Inkjet printers can produce multiple copies of printing also.

Advantages

- High quality printing
- More reliable

Disadvantages

- Expensive as the cost per page is high
- Slow as compared to laser printer

DDR COLLEGE OF PHARMACY

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