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Computer – Hardware components



Computers have become an integral part of our lives. In the current scenario, we use computers in many different forms. The tablets and the smartphones are the latest forms of computers.

Recap on basic concepts

We know that a computer is an electronic device that accepts input data from keyboard and mouse, processes them in the CPU by performing arithmetic and logical operations and produces the expected output through the monitor and printer. Large amount of data and information are stored in the memory devices.

The concept of generating processed information from the given input data is termed as Input-Process-Output (IPO) cycle.



Data and information

Data are raw facts and figures that are used by the computer and information is the processed data that is understandable.

About hardware and software

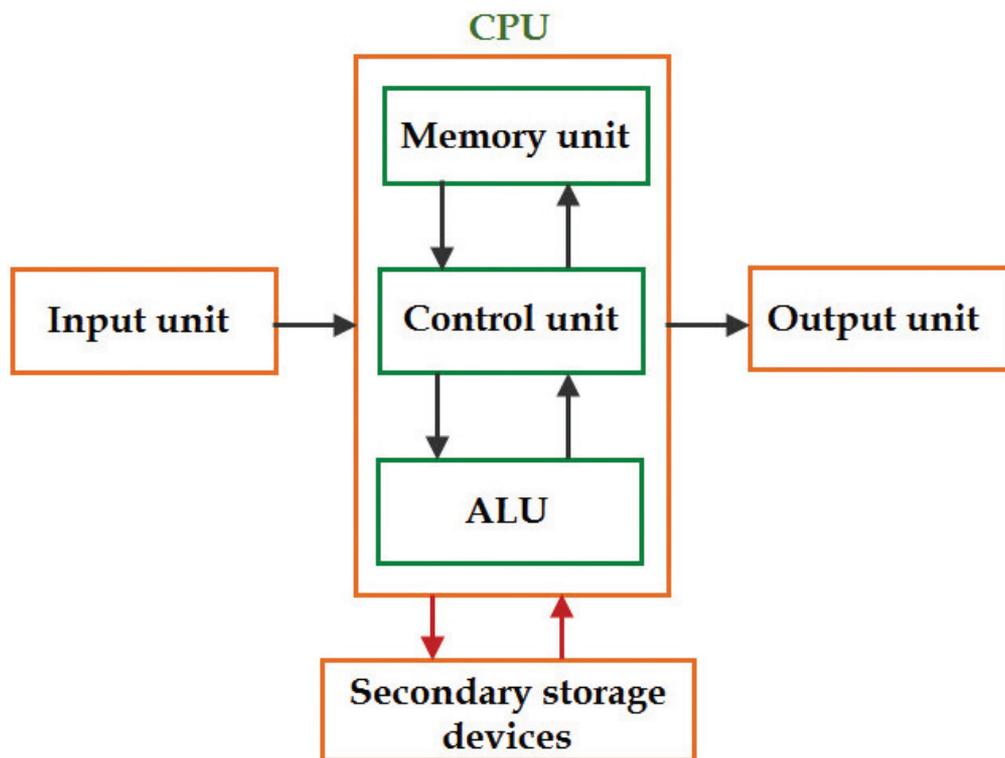
A computer system consists of two major elements – Hardware and Software. Hardware refers to all the visible physical components of a computer that could be touched. Software is a set of instructions given to a computer to perform specific operations. Both the hardware and software make the computer work.



Functional units of computer system

The computer system has three key functional units. They are:

- Input unit
- Central Processing Unit (CPU)
- Output unit



Functional units of computer system

Input unit

This unit accepts data and instructions from input devices. It converts it to a form that can be understood by a computer and sends it to the CPU for further processing. Some of the input devices are - keyboard, mouse, joystick, light pen, etc.

Central Processing Unit (CPU)

This is the heart of a computer system, as all the operations are carried out in the CPU only. In modern computers, a single chip performs all calculations, takes decisions, controls and coordinates all the units of a computer. It stores data temporarily and takes care of external requests.

The CPU is subdivided into three subsystems - Memory unit, Control unit and Arithmetic and Logic unit (ALU).

- **Memory unit** - The information given by the input unit is immediately stored in the main memory. It is a volatile (temporary) memory i.e., the stored information gets erased, when there is a power failure. To avoid this situation, we use the secondary



storage devices like CD, DVD and pen drives. These are non-volatile (permanent) in nature.

- **Control unit** - This unit instructs the computer to carry out instructions. It directs the data flow between the Memory unit and ALU. It controls and coordinates the entire computer system. It instructs the Input unit on, where to store the received input from the user. It directs the ALU to perform necessary calculations, receives the result and directs it to the output unit to display the result.
- **Arithmetic and Logic unit (ALU)** - The ALU performs all the arithmetic and logical operations. All the arithmetic operations like addition, subtraction, multiplication and division are performed in the arithmetic unit and all logical operations like comparison are performed in the logical unit.

Output unit

This unit provides information and results are received from the CPU through the output devices like monitor, printer, etc. It is the communication between the user and the computer.

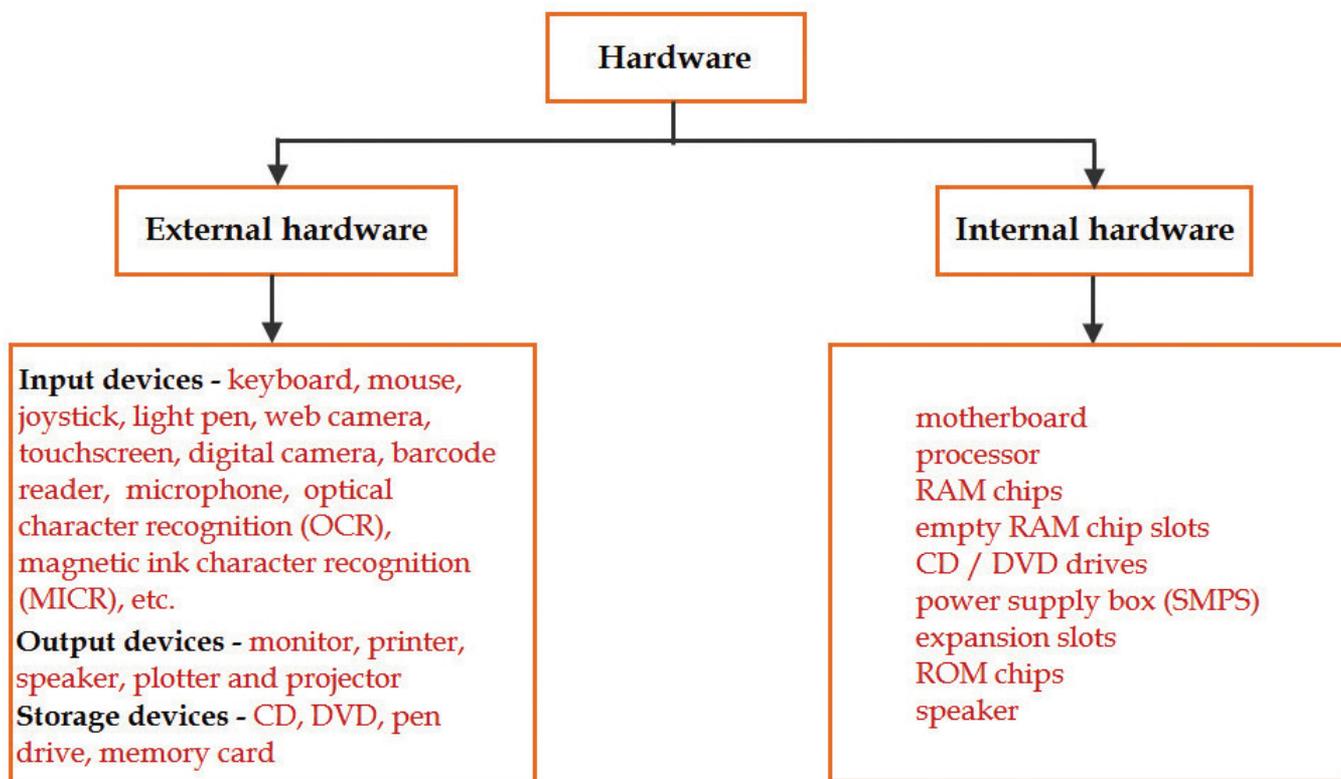


Tech corner

A cache memory is a small memory between the CPU and the main memory. It is faster than the main memory.

Hardware classification

The hardware of a computer is classified into external hardware and internal hardware.



External and internal devices classification



External hardware

Input devices

The input devices accept information from the users. Let us see some of the common input devices.

- **Keyboard:** It is the first input device developed to work with the computer to get information. The standard keyboard layout comes with 104 keys organised into four groups – alphanumeric keys (A – Z, 0 – 9), location keys (Home, End, etc.), numeric keypad, function keys (F1 – F12).



Computer keyboard



Computer mouse

- **Mouse:** It is the most common pointing device connected to the computer. It became popular after the evolution of the GUI operating system like Windows, Linux, etc. The default option of the left mouse button selects the objects. The right mouse button opens an options menu. The scroll wheel helps to scroll up and down on the active pages.

- **Joystick:** This device comes with a stick with buttons attached to a base. It is often used to control the video games. Trackball is an advanced type of joystick. They are commonly used for playing video games.



Joystick



Light pen

- **Light pen:** A light pen appears like an ordinary pen. It is a light sensitive computer input device that is used to select text, draw pictures and point elements on a monitor. Mostly CRT monitors are used by the light pens to scan the screen. It has a light sensitive detector on the tip of the light pen which identifies pen location on the screen.

- **Web camera:** A web camera is an input device that captures digital images. It also captures full motion video images. It is connected to the computer on the USB port. It is placed above the computer screen. Laptops come with built-in web camera.



Web camera





Touchscreen

- **Touchscreen:** It is a display screen input device. The user interacts with the computer by touching the pictures or words on the screen. The screens are sensitive to pressure. The smartphones, tablets and ATM machines are examples of touchscreen.

- **Digital camera:** A digital camera (also called as digicam) captures photographs in digital memory. The captured images can be brought into memory of a computer and stored. Nowadays, digital cameras are incorporated into mobile devices.



Digital camera



Barcode reader

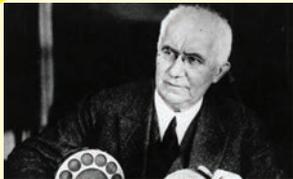
- **Barcode reader:** A barcode reader scans a barcode, which is a pattern printed with lines of different thickness seen on many products. This eliminates the chance of typing errors. Transactions are done fast. They are most widely used in the supermarkets.

- **Microphone:** A microphone is a hardware peripheral input device that allows computer users to input audio into their computers.



Microphone

Tech facts



Microphones were originally invented by Emile Berliner in 1877.

- **Optical Character Recognition (OCR):** It describes the process of capturing and converting the paper documents into editable computer files. This helps to enter the text directly into the computer, without retyping them.



OCR

Tech corner



Biometric devices measure human traits like fingerprints, retinal for authentication.

- **Magnetic Ink Character Recognition (MICR):** MICR is mainly used for processing and clearing cheques by the banks. The MICR fonts are used for easy recognition by the MICR readers. The font gets printed with magnetic ink on a cheque. This technology helps to make transactions fast and secure.



MICR reader



MICR cheque

Output devices



Monitor

- **Monitor:** A monitor is a standard output device. The visual display is created from the processed data for users to be viewed. It is widely called as Visual Display Unit (VDU). Monitors come in different shapes and sizes. The latest technology being the Flat screen Light Emitting Diode (LED) monitors.

- **Printer:** A printer produces output in a hard copy. Printers vary in size, speed, quality and cost. The higher the price of a printer the higher the quality of printing.



Printer



Speakers

- **Speaker:** A computer speaker is a hardware device that connects to a computer to generate sound. The sound card creates a signal that produces sound from the speaker.

- **Plotter:** A plotter produces a hard copy of the output based on the instructions from the system. It is called as vector graphic printer or graph plotter. Plotters are widely used to print designs of cars and buildings using a pen on a piece of paper. They are mostly used in engineering applications. Plotters are more expensive than normal printers.



Plotters





Projector

- **Projector:** A projector is an optical output device, which uses light and lenses to take an image and project a magnified image onto a larger screen or wall. Magnified still or moving images can also be projected. The image must be shown through a sealed tube or frame that passes through the lenses to maintain focus.

Storage devices

- **Compact Disk (CD):** A compact disk is an optical storage medium that records digital data. The digital data can be in the form of audio, video or computer information. The floppy disks were replaced by the CDs. A CD drive is essential to play the content recorded in a CD. CDs can store up to 700 MB of data. They are of two types - CD-R (CD of Recordable type) and CD-RW (CD of Rewritable type).



- **Digital Versatile Disk (DVD):** A DVD can store 12 times more data than a CD. They are similar to CD, but with great capacity. DVDs require separate DVD drive to copy, record and play the content. A CD is compatible with a DVD drive. The storage capacity of a DVD is 4.7 GB single side and 9.4 GB double side.



Tech corner

The term 'burn' is a colloquial term used to write the contents to a CD and DVD. The data is written onto the disks with a laser light.



Pen drive

- **Pen drive:** A pen drive is a device that can be plugged into a Universal Serial Bus (USB) port attached to a computer or a laptop. It is called as USB flash drive. The data can be rewritten any number of times. It stores up to 64 GB of data.

- **Memory card:** It stores data in digital format that is used in different electronic devices such as mobile phones, digital cameras, tablets, etc. It is very small in size and is rewritable. It stores large amount of data.



Memory card

Internal hardware

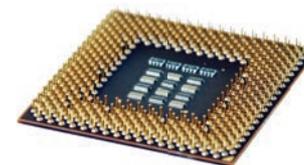
- **Motherboard:** All the electronic components of a computer are mounted on a Printed Circuit Board (PCB) called the motherboard. Thin lines of metal on the surface of the fibreglass connect pins from one component to another that forms the computer's electronic circuits.



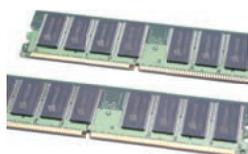


Motherboard

- **Processor:** This is referred to as microprocessor and is the most important component. It carries out all the operations inside the computer. It is a chip present inside a computer. Pentium and AMD are some of the famous processors that come with different versions.



Processor



RAM chips

- **RAM chips:** Random Access Memory (RAM) is used for the purpose of holding the program and its data, when a computer is switched on and is running a program. When the computer is turned off, all contents in RAM will be lost.

- **Empty RAM chip slots:** These slots help to expand the computer's memory by adding extra RAM chips or modules.



RAM chip slot



CD/DVD drive

- **CD / DVD drives:** This consists of a slot to accept either CD or DVD or both. A motor spins the disk and a recording / reading device that moves across the disk in order to write or read data.

- **Power supply box (SMPS - Switch Mode Power Supply):** All the components in a PC need electric power supply. The SMPS converts the normal household electric AC supply to $\pm 5V$ and $\pm 12V$ DC supply. Usually $\pm 12V$ DC supply is connected to motherboard and $\pm 5V$ DC supply to other peripherals such as CD / DVD drive, hard disk, etc.



SMPS



Expansion slots

- **Expansion slots:** These long narrow connectors allow us to plug expansion chords (adaptor chords), which offer extra options not available in a normal computer.

- **ROM chips:** Read Only Memory (ROM) chips have data written on them during manufacturing itself that instructs the CPU what to do, when the computer is switched on. The data always remains intact even if we switch off the computer. The contents are non-volatile in nature.



ROM chips



- **Speaker:** This refers to the internal speaker that produces a beep sound, when the system is switched on. This is attached to the motherboard. It is different from the external speakers.

Internal speakers

- **CMOS battery:** CMOS stands for Complementary Metal-Oxide Semiconductor. It is an on-board, battery powered semiconductor chip inside the CPU case that stores information. It appears like a coin and its standard lifetime is around 10 years. But depends on the use and environment. The CMOS battery maintains the correct system time and date to system hardware settings of the computer.



CMOS battery)

It is alternatively called as Real-Time Clock (RTC), Non-Volatile RAM (NVRAM). Today, most of the computers have moved their settings from CMOS and integrated them into the Super I/O chips.

Tech facts

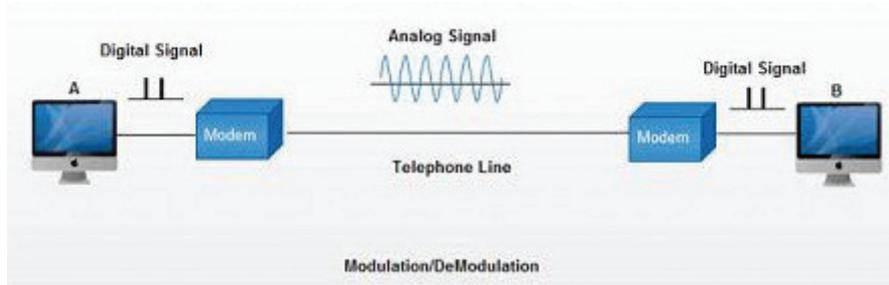


The first RTC and CMOS RAM chip is the Motorola 146818 used in the early IBM computers. It is capable of storing a total of 64 bytes of data.

Modem

Modem is an abbreviation of Modulator-Demodulator. It is used for data transfer from one computer network to another computer network through telephone lines. Modulator converts information from digital mode to analog mode at the transmitting end. Demodulator converts the information from analog mode to digital mode at the receiving end.





Modulation / DeModulation

Thus, the process of converting analog signals of one computer network into digital signals of another computer network that can be processed by a receiving computer is referred to as **digitizing**.

Let us revise

- Hardware refers to all the visible physical components of a computer that could be touched.
- Software is a set of instructions given to a computer to perform specific operations.
- The computer system has three key functional units. They are: Input unit, Central Processing Unit (CPU) and Output unit.
- The CPU is subdivided into three subsystems - Memory unit, Control unit and Arithmetic and Logic unit (ALU).
- Touchscreen is a display screen input device. The user interacts with the computer by touching the pictures or words on the screen.
- A digital camera (also called as digicam) captures photographs in digital memory. Antivirus software is used to prevent, detect and remove malicious software.
- A barcode reader scans a barcode, which is a pattern printed with lines of different thickness seen on many products.
- Optical Character Recognition (OCR) describes the process of capturing and converting the paper documents into editable computer files.
- Magnetic Ink Character Recognition (MICR) is mainly used for processing and clearing cheques by the banks.
- A plotter produces a hard copy of the output based on the instructions from the system. It is called as vector graphic printer or graph plotter.
- All the electronic components of a computer are mounted on a Printed Circuit Board (PCB) called the motherboard.

- The CMOS battery maintains the correct system time and date to system hardware settings of the computer.
- The process of converting analog signals of one computer network into digital signals of another computer network that can be processed by a receiving computer is referred to as digitizing.

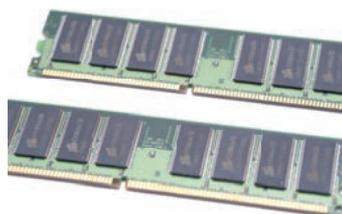
Quick check



A. Fill in the blanks.

1. _____ is a set of instructions given to a computer to perform specific operations.
2. A _____ is a small memory between the CPU and the main memory.
3. A _____ scans a barcode, which is a pattern printed with lines of different thickness seen on many products.
4. SMPS stands for _____.

B. Identify and write the names of the parts in a computer.



C. State whether the given statements are True (T) or False (F).

1. Both hardware and software make the computer to work.

2. Frequent retyping of text is done with OCR.

3. The contents in ROM chips are non-volatile in nature.

4. Biometric devices are used to scan text in the book.

Question time



A. Choose the correct answer.

1. Which instructs the computer to carry out instructions?

a. Memory unit

b. Control unit

c. ALU

d. Output unit

2. This is a light sensitive input device that is used to select text and draw pictures.

a. light pen

b. touchscreen

c. joystick

d. mouse

3. These are also called adaptor chords.

a. RAM chips

b. ROM chips

c. Expansion slots

d. SMPS

B. Answer the following questions.

1. Define hardware and software.

2. Write a note on MICR.

3. Why is a motherboard considered as an important component inside a computer?



4. Define the term 'digitizing'.
5. Discuss about a plotter and a projector.
6. Explain the functional units of a computer.
7. Explain the storage devices of external hardware.
8. Describe the importance of CMOS battery.

Hands-on

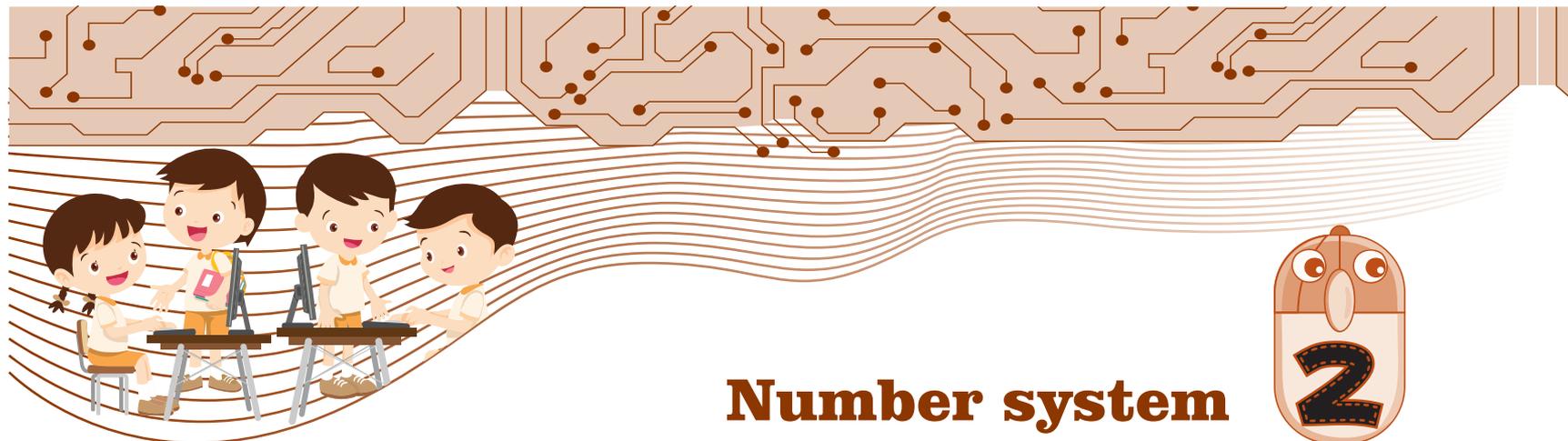
1. In the computer lab, analyse how the internet connection is established for the systems?
2. Switch on the system and check whether the system date and time is correct. This is due to the correct function of CMOS battery.
3. With the help of your computer teacher, open the CPU cabinet and have a look at the internal components.

Tips for teachers

Accompany the students to the computer lab and open the CPU cabinet of a computer system. Dismantle and explain the functions of internal hardware. This will enable in better understanding of the concept of hardware. Recapitulate the entire chapter by conducting quiz.

Refer more

<https://study.com/academy/lesson/what-is-computer-hardware-components-definition-examples.html>



Number system



A number is used for counting or to express the amount of some quantity. It consists of a group of symbols called digits which are arranged in a definite manner.

Number system is classified into two categories:

- **Non-positional number system**
- **Positional number system**

Non-positional number system: This type is widely used by the human beings in the early days for counting. They used fingers, lines, stones, sticks and symbols for counting.

Positional number system: This is the type used today. We can perform addition, subtraction, multiplication and division. Each number is identified by its position. When we type letters or numbers, the computer translates them into numbers, as they can understand only numbers based on their position of digits.

Example: 123 - One hundred twenty-three

The four types of positional number system are:

- **Decimal number system**
- **Binary number system**
- **Octal number system**
- **Hexadecimal number system**

Decimal number system

This is the number system that we use today in our daily life. Most of the arithmetic operations are performed with decimal numbers.

| | |
|--------------------|--------------------|
| Base value: | 10 |
| Digits: | 0,1, 2,...9 |

The number of digits represent the base value of the number system.

Example:

| | | | |
|---|---|---|-----------------------|
| 1 | 2 | 3 | |
| | | | $3 \times 10^0 = 3$ |
| | | | $2 \times 10^1 = 20$ |
| | | | $1 \times 10^2 = 100$ |
| | | | 123_{10} |



Binary number system

This number system contains only two digits: 0 and 1. This is the number system used in all the digital computers.

The data entered into the computer gets converted into binary for execution. The executed result is again converted into its corresponding decimal number and is displayed as output.

Example: 1101011, 110, 010111, etc.

| | |
|-------------|-----|
| Base value: | 2 |
| Digits: | 0,1 |



Finger tips

The positional value of each digit increases from right to left.

Octal number system

All the octal numbers are represented using these eight digits.

Example: 374, 103, 4375, etc.

| | |
|-------------|------------|
| Base value: | 8 |
| Digits: | 0,1,2,...7 |

Hexadecimal number system

| | |
|-------------|--|
| Base value: | 16 |
| Digits: | 0, 1, 2,...9, (A-10, B-11, C-12, D-13, E-14, F-15) |

All the hexadecimal numbers are represented using these sixteen digits.

Example: 3FA, 78B, 91C, 115, etc.

Conversion between number systems

Conversion of decimal number into binary number

The steps to convert a given decimal number into binary number are:

- Divide the given decimal number by 2.
- Take the remainder to extreme right as given and divide the quotient again by 2.
- Repeat the above step, till the quotient becomes less than the base value 2.
- Write the remainder values from bottom to top.
- This is the equivalent binary number.



Examples: $(42)_{10}$ and $(513)_{10}$

| | |
|---|--|
| $\begin{array}{r} 2 \overline{) 42} \\ \underline{21} \\ 2 \overline{) 21} \\ \underline{10} \\ 2 \overline{) 10} \\ \underline{5} \\ 2 \overline{) 5} \\ \underline{2} \\ 2 \overline{) 2} \\ \underline{1} \\ 1 \end{array}$ <p style="text-align: right; margin-right: 100px;">remainder</p> <p><u>Ans:-</u> $(101010)_2$</p> | $\begin{array}{r} 2 \overline{) 513} \\ \underline{256} \\ 2 \overline{) 256} \\ \underline{128} \\ 2 \overline{) 128} \\ \underline{64} \\ 2 \overline{) 64} \\ \underline{32} \\ 2 \overline{) 32} \\ \underline{16} \\ 2 \overline{) 16} \\ \underline{8} \\ 2 \overline{) 8} \\ \underline{4} \\ 2 \overline{) 4} \\ \underline{2} \\ 2 \overline{) 2} \\ \underline{1} \\ 1 \end{array}$ <p style="text-align: right; margin-right: 100px;">remainder</p> <p><u>Ans:-</u> $(1000000001)_2$</p> |
|---|--|

Conversion of decimal fraction into binary

The steps to convert a given decimal fraction into binary number are:

- Multiply the decimal fraction successively by 2.
- The resulting number has two parts - integer part and fractional part.
- Pick up 0 or 1 from the integer part of each product and write it in the binary result.
- Repeat the process with only the remaining fraction of each product for specific number of times or until the fraction part becomes 0.

Examples: $(0.39)_{10}$ and $(0.865)_{10}$

| | | | |
|--|-------------------|---|--|
| $0.39 \times 2 = 0.78 \longrightarrow 0.78$ | with a carry of 0 | ↓ | |
| $0.78 \times 2 = 1.56 \longrightarrow 0.56$ | with a carry of 1 | | |
| $0.56 \times 2 = 1.12 \longrightarrow 0.12$ | with a carry of 1 | | |
| <u>Ans:-</u> $(0.011)_2$ | | | |
| $0.865 \times 2 = 1.730 \longrightarrow 0.730$ | with a carry of 1 | ↓ | |
| $0.730 \times 2 = 1.460 \longrightarrow 0.460$ | with a carry of 1 | | |
| $0.460 \times 2 = 0.920 \longrightarrow 0.920$ | with a carry of 0 | | |
| <u>Ans:-</u> $(0.110)_2$ | | | |

Convert $(42.33)_{10}$ to its equivalent binary number

The integer part for the above decimal number is 42 and the fraction part is 0.33.

| | | | | | | | | | | |
|---|---|------------------------|---|------------------------|------------------------|---|------------------------|------------------------|---|------------------------|
| $\begin{array}{r l} 2 & 42 \\ \hline 2 & 21 & \text{--- } 0 \\ 2 & 10 & \text{--- } 1 \\ 2 & 5 & \text{--- } 0 \\ 2 & 2 & \text{--- } 1 \\ & 1 & \text{--- } 0 \end{array}$ | <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">$0.33 \times 2 = 0.66$</td> <td style="width: 10%; text-align: center;">→</td> <td style="width: 40%;">0.66 with a carry of 0</td> </tr> <tr> <td>$0.66 \times 2 = 1.32$</td> <td style="text-align: center;">→</td> <td>0.32 with a carry of 1</td> </tr> <tr> <td>$0.32 \times 2 = 0.64$</td> <td style="text-align: center;">→</td> <td>0.64 with a carry of 0</td> </tr> </table> | $0.33 \times 2 = 0.66$ | → | 0.66 with a carry of 0 | $0.66 \times 2 = 1.32$ | → | 0.32 with a carry of 1 | $0.32 \times 2 = 0.64$ | → | 0.64 with a carry of 0 |
| $0.33 \times 2 = 0.66$ | → | 0.66 with a carry of 0 | | | | | | | | |
| $0.66 \times 2 = 1.32$ | → | 0.32 with a carry of 1 | | | | | | | | |
| $0.32 \times 2 = 0.64$ | → | 0.64 with a carry of 0 | | | | | | | | |
| <u>Ans:-</u> $(101010)_2$ | <u>Ans:-</u> $(0.010)_2$ | | | | | | | | | |
| Final result:- $(101010.010)_2$ | | | | | | | | | | |

Conversion of binary number into decimal number

The steps to convert a given binary number into decimal number are:

- Multiply each binary digit with its positional value (i.e., with its powers of 2) starting from extreme right digit.
- Increase the power one by one, but the base value 2 must be fixed.
- Sum up all the products to get the decimal number.

Examples: $(101010)_2$ and $(1101)_2$

| | |
|---|--|
| $\begin{array}{r} 1 \ 0 \ 1 \ 0 \ 1 \ 0 \\ \begin{array}{l} \rightarrow 0 \times 2^0 = 0 \\ \rightarrow 1 \times 2^1 = 2 \\ \rightarrow 0 \times 2^2 = 0 \\ \rightarrow 1 \times 2^3 = 8 \\ \rightarrow 0 \times 2^4 = 0 \\ \rightarrow 1 \times 2^5 = 32 \end{array} \\ \hline 42 \end{array}$ | $\begin{array}{r} 1 \ 1 \ 0 \ 1 \\ \begin{array}{l} \rightarrow 1 \times 2^0 = 1 \\ \rightarrow 0 \times 2^1 = 0 \\ \rightarrow 1 \times 2^2 = 4 \\ \rightarrow 1 \times 2^3 = 8 \end{array} \\ \hline 13 \end{array}$ |
| <u>Ans:-</u> $(42)_{10}$ | <u>Ans:-</u> $(13)_{10}$ |

Let us revise



- Non-positional number system uses lines and symbols for counting.
- The number of digits represent the base value of the number system.
- The positional value of each digit increases from right to left.
- The four types of positional number system are Binary number system, Decimal number system, Octal number system and Hexadecimal number system.
- Binary number system contains only two digits: 0 and 1.
- Decimal number system contains digits from 0 to 9 with a base value of 10.
- Octal number system contains digits from 0 to 7 with a base value of 8.
- Hexadecimal number system contains digits from 0 to 9, A - 10, B - 11, C - 12, D - 13, E - 14 and F - 15 with a base value of 16.
- Conversion between the number systems can be done by following the respective rules.

Quick check



A. Fill in the blanks.

1. Non-positional number system uses _____ and _____ for counting.
2. The base of octal number system is _____ .
3. The values from 10 to 15 are represented by letters in _____ number system.
4. To convert a decimal fraction to binary, we have to _____ the fraction successively by 2.

B. State whether the given statements are True (T) or False (F).

1. The base is represented by the number of digits of the number system.
2. The digits used in octal number system are 1 to 8.
3. The remainder values obtained from decimal to binary conversion must be written from bottom to top.
4. No specific rules are involved in the conversion of inter-number systems.



Question time



Answer the following questions.

1. Define non-positional number system.
2. State the importance of positional number system.
3. What are the four types of positional number system?
4. What are the digits used in hexadecimal number system?
5. What are the steps to convert a given decimal number to binary? Illustrate with an example.
6. What are the steps to convert a binary fraction to decimal? Illustrate with an example.

Hands-on



1. Convert the decimal numbers to binary numbers.

a.

$(786)_{10}$

b.

$(1245)_{10}$

c.

$(598.756)_{10}$

d. $(2105.36)_{10}$

2. Convert the binary numbers to decimal numbers.

a. $(1111)_2$

b. $(0101101)_2$

c. $(100101.1101)_2$

d. $(111101.011101)_2$

3. Prepare a presentation on different number systems in MS PowerPoint 2010 with slides exceeding not more than 10 in numbers.
4. Prepare a presentation on the conversions between number systems in MS PowerPoint 2010 with slides exceeding not more than 6 in numbers.

Tips for teachers



Insist on the use of number system. Classify through examples the types of number systems. Work out few problems. Explain the conversions between different number systems with few examples. Give few problems for better clarity. Motivate the students to solve the hands-on problems for better understanding. Recapitulate the entire concept by conducting quiz in the class.

Refer more



https://www.tutorialspoint.com/computer_fundamentals/computer_number_system.htm