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# Subject: Fundamental of Computer Science

## **Unit-1** INTRODUCTION TO COMPUTER AND ITS ARCHITECTURE

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# 1. Introduction and Characteristics

A computer is a fast electronic device that processes raw data, performs arithmetic and logical operations, and produces output.

Nowadays, the computer has become a part of our life and can be used in most fields.

In a computer, there are various characteristics of computer systems depending on their size, capacity, and specifications. But, the major characteristics of the computer can be classified into **Speed, Accuracy, Diligence, Versatility, Reliability, Consistency, Memory, Storage Capacity, Remembrance Power, and Automation**.

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# 1. Introduction and Characteristics

Let's go over the characteristics of computers.

**1. Speed**

Executing mathematical calculation, a computer works faster and more accurately than human. **Computers have the ability to process so many millions (1,000,000) of instructions per second.** Computer operations are performed in micro and nano seconds. A computer is a time saving device. It performs several calculations and tasks in few seconds that we take hours to solve. The speed of a computer is measure in terms of GigaHertz and MegaHertz.

**2. Diligence**

A human cannot work for several hours without resting, yet a computer never tires. A computer can conduct millions of calculations per second with complete precision without stopping. **A computer can consistently and accurately do millions of jobs or calculations. There is no weariness or lack of concentration.** Its memory ability also places it ahead of humans.

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# 1. Introduction and Characteristics

**3. Reliability**

A computer is reliable. The output results never differ unless the input varies. the output is totally depend on the input. when an input is the same the output will also be the same. **A computer produces consistent results for similar sets of data, if we provide the same set of input at any time we will get the same result.**

**4. Automation**

The world is quickly moving toward AI (Artificial Intelligence)-based technology. A computer may conduct tasks automatically after instructions are programmed. By executing jobs automatically, this computer feature replaces thousands of workers. **Automation in computing is often achieved by the use of a program, a script, or batch processing.**

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# 1. Introduction and Characteristics

**5. Versatility**

Versatility refers to a capacity of computer. Computer perform different types of tasks with the same accuracy and efficiency. **A computer can perform multiple tasks at the same time this is known as versatility.** For example, while listening to music, we may develop our project using PowerPoint and Wordpad, or we can design a website.

**6. Memory**

A computer can store millions of records. these records may be accessed with complete precision. **Computer memory storage capacity is measured in Bytes, Kilobytes(KB), Megabytes(MB), Gigabytes(GB), and Terabytes(TB).** A computer has built-in memory known as primary memory.

**7. Accuracy**

When a computer performs a computation or operation, the chances of errors occurring are low. Errors in a computer are caused by human's submitting incorrect data. **A computer can do a variety of operations and calculations fast and accurately.**

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# 2. Computer Architecture

Computer Architecture refers to the design and organization of a computer's components, particularly:

- **The CPU (Central Processing Unit)**
- **Memory hierarchy**
- **Input/Output (I/O) mechanisms**
- **Data pathways and buses**

Key aspects:
- **Instruction Set Architecture (ISA):** How software communicates with hardware.
- **Microarchitecture:** How each instruction is executed in hardware.

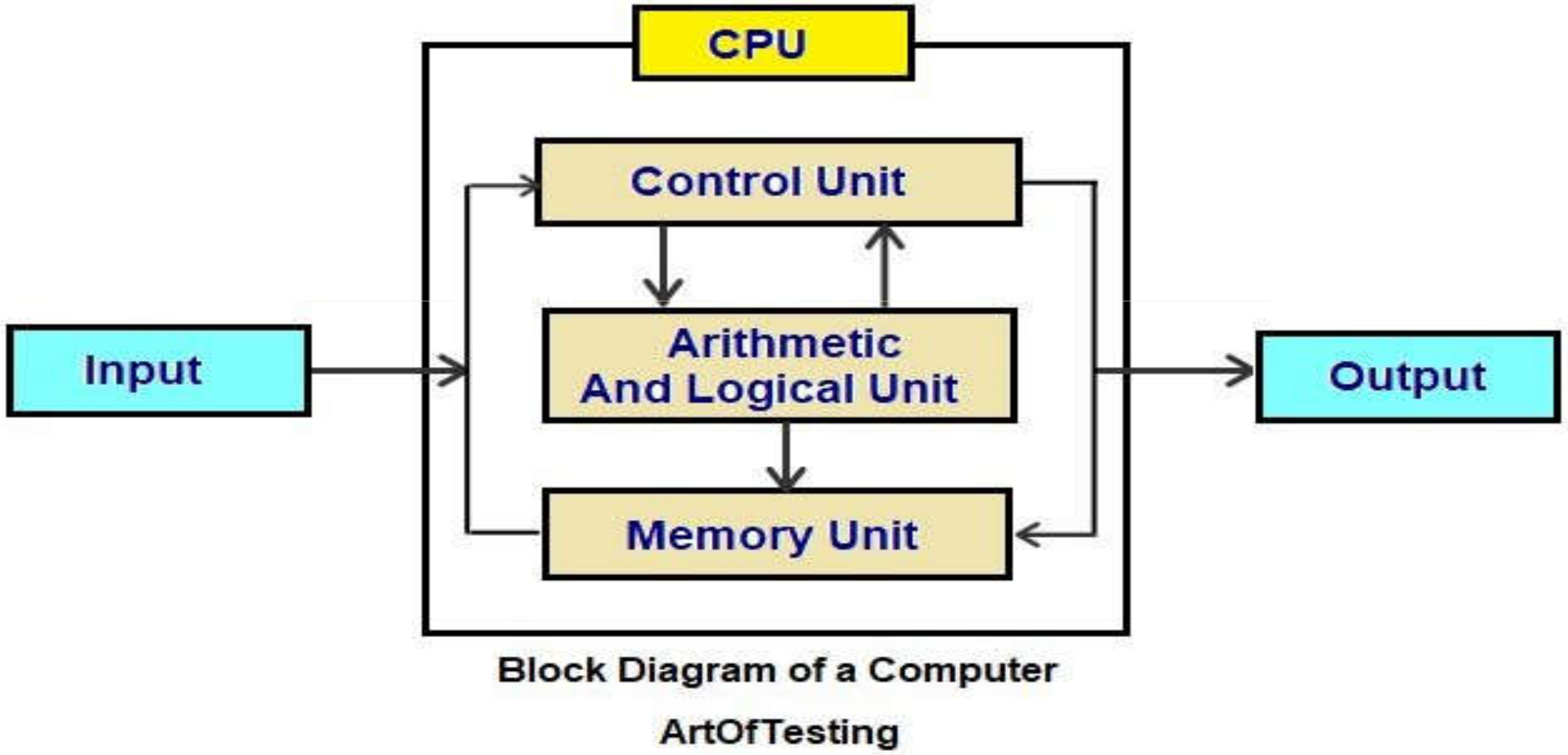


Image Source: https://artoftesting.com/block-diagram-of-computer

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# 2. Computer Architecture

Computer Organization and Architecture is used to design computer systems.

**Computer architecture** It covers high level design and functional behavior of a computer system, mostly from the point of view of a programmer including the Instruction Set Architecture (or ISA), addressing modes, logic design, and implementation.

**Computer Organization** is about how the components of a computer system, like the CPU, memory, and input/output devices, are connected and work together to execute programs. It focuses on the operational aspects and how hardware components are implemented to support the architecture.

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# 2. Computer Architecture

While computer architectures can differ greatly depending on the purpose of the computer, several key components generally contribute to its structure. These include:

**Central Processing Unit (CPU) -** Often referred to as the "brain" of the computer, the CPU executes instructions, performs calculations, and manages data. Its architecture dictates factors such as instruction set, clock speed, and cache hierarchy, all of which significantly impact overall system performance.

**Memory Hierarchy -** This includes various types of memory, such as cache memory, random access memory (RAM), and storage devices. The memory hierarchy plays a crucial role in optimizing data access times, as data moves between different levels of memory based on their proximity to the CPU and the frequency of access.

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# 2. Computer Architecture

**Input/Output (I/O) System -** The I/O system enables communication between the computer and external devices, such as keyboards, monitors, and storage devices. It involves designing efficient data transfer mechanisms to ensure smooth interaction and data exchange.

**Storage Architecture -** This deals with how data is stored and retrieved from storage devices like hard drives, solid-state drives (SSDs), and optical drives. Efficient storage architectures ensure data integrity, availability, and fast access times.

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# 3. Generations of Computers

1st Generation (1940-1956): **Vacuum Tubes – e.g., ENIAC**

2nd Generation (1956-1963): **Transistors – e.g., IBM 1401**

3rd Generation (1964-1971): **Integrated Circuits – e.g., IBM 360**

4th Generation (1971-Present): **Microprocessors – e.g., Personal Computers**

5th Generation (Present & Beyond):

**AI & Quantum Computing – e.g., Robots, AI Tools**

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Image Source: https://informationq.com/computer-generations-classified-into-five-types/

First Generation

Second Generation

Third Generation

Fourth Generation

Fifth Generation

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# 3. Generations of Computers

**First Generation Computers**

The technology behind the **primary generation of computers was a fragile glass device, which was called a vacuum tube**.

These computers were very heavy and really large. These weren't very reliable, and programming on them was a tedious task as **they used a low-level programming language and had no OS.**

First-generation computers were used for calculation, storage, and control purposes. They were too bulky and large**; they needed a full room and consumed a lot of electricity.**

**Punch cards were used to improve the information for external storage. Magnetic card used. Machine and assembly language is developed.**

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# 3. Generations of Computers

## Second Generation Computers

Second-generation computers used the technology of **transistors rather than bulky vacuum tubes.** Another feature was the core storage. A transistor may be a device composed of semiconductor material that amplifies a sign or opens or closes a circuit.

**Central Processing Unit (CPU), memory, programming language, and input, and output units** also came into the force within the second generation. The programming language was shifted from high level to programming language and made programming comparatively a simple task for programmers. Languages used for programming during this era were **FORTRAN (1956), ALGOL (1958), and COBOL (1959).**

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# 3. Generations of Computers

## Third Generation Computers

During the third generation, **technology envisaged a shift from huge transistors to integrated circuits, also referred to as ICs.** Here, a variety of transistors were placed on silicon chips, called semiconductors. The most important feature of this era's computers was speed and reliability. **IC was made from silicon, also called silicon chips.**

Because of the operating system machine could execute multiple jobs simultaneously.

Programming was now wiped out **Higher level languages like BASIC (Beginners All-purpose Symbolic Instruction Code). Minicomputers found their shape during this era.**

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# 3. Generations of Computers

**Fourth Generation Computers**

In 1971 First microprocessors were used, the large-scale of integration LSI circuits built on one chip called microprocessors.
Very Large Scale Integrated (VLSI) circuits replaced LSI circuits.

The Intel 4004 chip, developed in 1971, located all the components of the pc from the central processing unit and memory to input/ output controls on one chip and allowed the dimensions to reduce drastically.

VLSI placed several hundred thousand transistors on a single silicon chip. This silicon chip is known as the microprocessor.
**Technologies like multiprocessing, multiprogramming, time-sharing, operating speed, and virtual memory made it a more user-friendly and customary device. The concept of private computers and computer networks came into being within the fourth generation.**

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# 3. Generations of Computers

## Fifth Generation Computers

The technology behind the **fifth generation of computers is AI**. It allows computers to behave like humans. It is often seen in programs **like voice recognition, the area of medicine, and entertainment.**

Within the field of game playing also it has also shown **remarkable performance where computers are capable of beating human competitors.**

To summarize the features of varied generations of computers, it is often said that a big improvement has been seen so far because of the **speed and accuracy of functioning care, but if we mention the dimensions, it's been small over the years**. The value is additionally diminishing and reliability is increasing.

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# 4. Classifications of Computers

**Based on Size:**
- Microcomputer (PC)
- Minicomputer
- Mainframe
- Supercomputer

**Based on Purpose:**
- General-purpose computers
- Special-purpose computers

**Based on Data Handling:**
- Analog
- Digital
- Hybrid

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# 4. Classifications of Computers

**Classification by Size**:

**Supercomputers:**

These are the most powerful and expensive computers, used for complex scientific computations and research.

**Mainframe Computers:**

Large, powerful systems used by organizations for handling large amounts of data and processing many transactions.

**Minicomputers:**

Smaller than mainframes, but still powerful, often used by research institutions and medium-sized businesses.

**Microcomputers:**

Also known as personal computers, designed for individual use.

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# 4. Classifications of Computers

**Classification by Data Handling**:

**Digital Computers:**
The most common type of computer, processing data represented in discrete binary digits (0s and 1s).

**Analog Computers:**
Handle continuous data, such as temperature or pressure, using physical quantities that vary continuously.

**Hybrid Computers:**
Combine features of both digital and analog computers, often used in specialized applications like process control.

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# 4. Classifications of Computers

**Classification by Purpose**:

**General-Purpose Computers:**
Designed to perform a wide range of tasks, such as word processing, internet browsing, and gaming.

**Special-Purpose Computers:**
Designed for specific tasks, like controlling an elevator or managing a car's engine.

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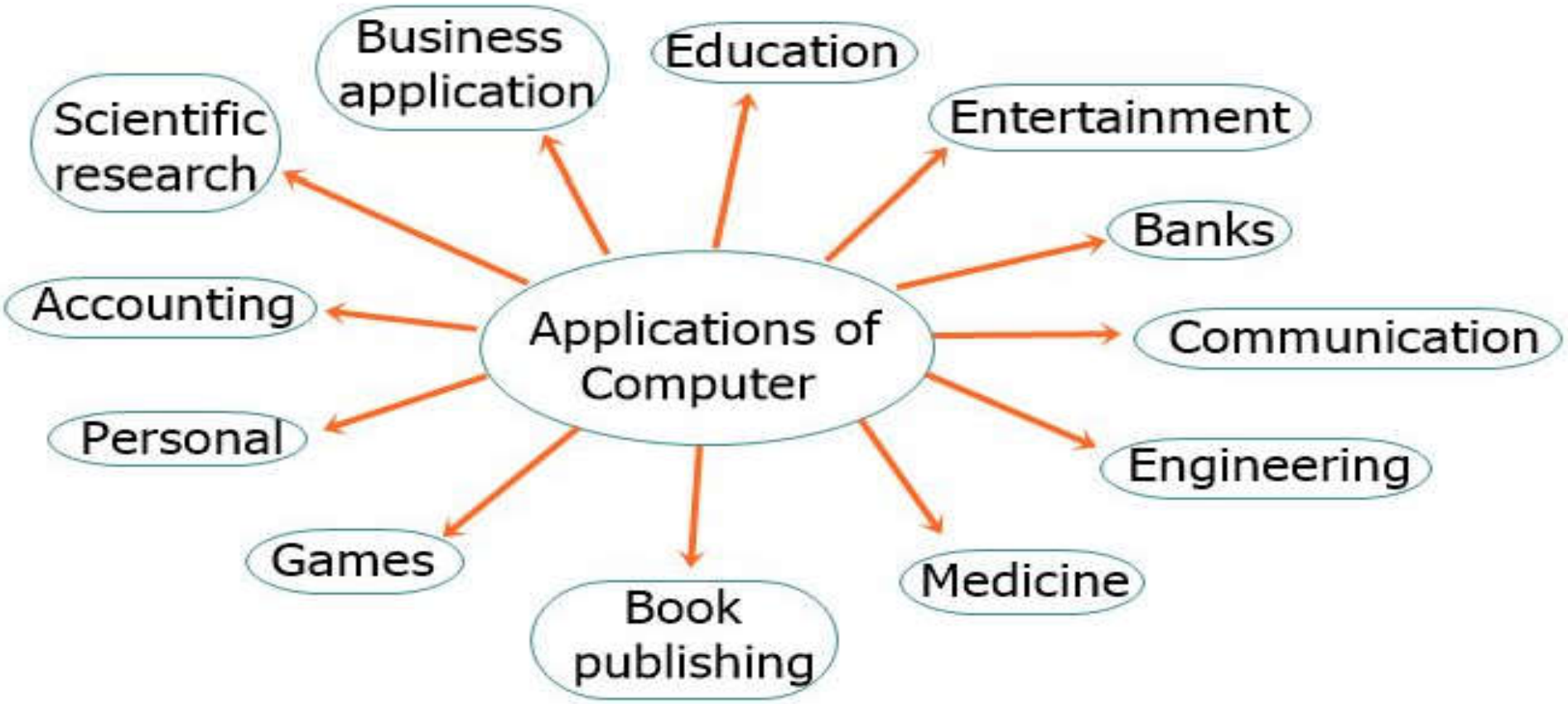
# 5. Applications of Computers

- **Education:** E-learning, simulations
- **Business:** Data analysis, transactions
- **Healthcare:** Diagnostics, record keeping
- **Defense:** Weapon systems, simulations
- **Entertainment:** Gaming, movies, music
- **Communication:** Emails, video calls
- **Scientific Research:** Data modeling, experiments

**Image Source: https://codescracker.com/computer-fundamental/basic-applications-of-computer.htm**



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# 6. CPU and Memory

The CPU (Central Processing Unit) is the "**brain" of a computer**, responsible for processing instructions and performing calculations.

Memory, specifically RAM (Random Access Memory), is the **computer's short-term data storage**, allowing the CPU to quickly access information it needs to operate.

They work together, with the CPU fetching instructions and data from RAM to execute tasks.
CPU (Central Processing Unit):

**Function:**
Executes instructions, performs calculations, and manages overall system operations.
**Analogy:**
Like a human brain, it handles all the processing and decision-making.

**Key Components:**
**Control Unit:** Fetches instructions from memory and decodes them.
**Arithmetic Logic Unit (ALU):** Performs calculations and logical operations.

# 6. CPU and Memory

Memory (RAM):

**Function:**
Provides temporary storage for data and instructions that the CPU is actively using.
**Analogy:**
Like a workspace, it holds the information the CPU is currently working with.
**Key Characteristics:**
**Volatile:** Data is lost when power is turned off.
**Fast Access:** Allows the CPU to quickly retrieve information it needs.

**Types:**
**DRAM (Dynamic RAM):** Common type of RAM used in computers.
**SRAM (Static RAM):** Used in cache memory due to its speed.
**ROM (Read-Only Memory):** Stores data permanently, even when the computer is off.

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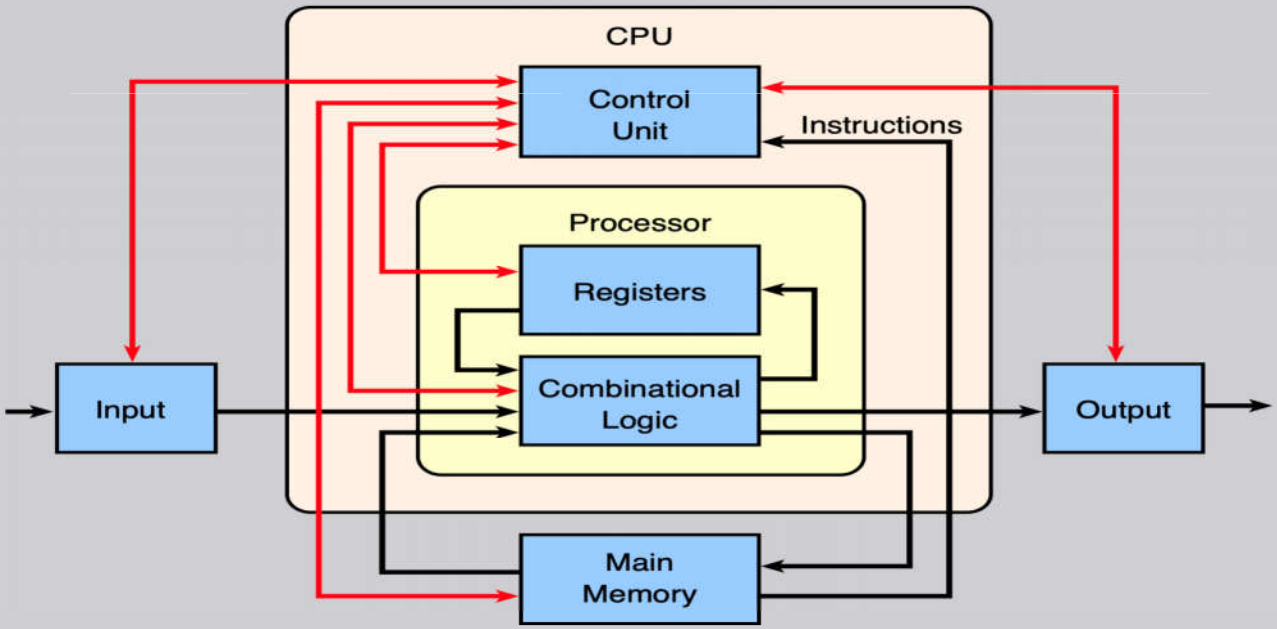
Image Source: https://deepgram.com/ai-glossary/central-processing-unit-cpu



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# 7. Communication Between Various Units

Uses buses for communication:

- **Data Bus:** Transfers data.

- **Address Bus:** Transfers memory address.

- **Control Bus:** Transfers control signals.

All components communicate through the system bus controlled by the motherboard.

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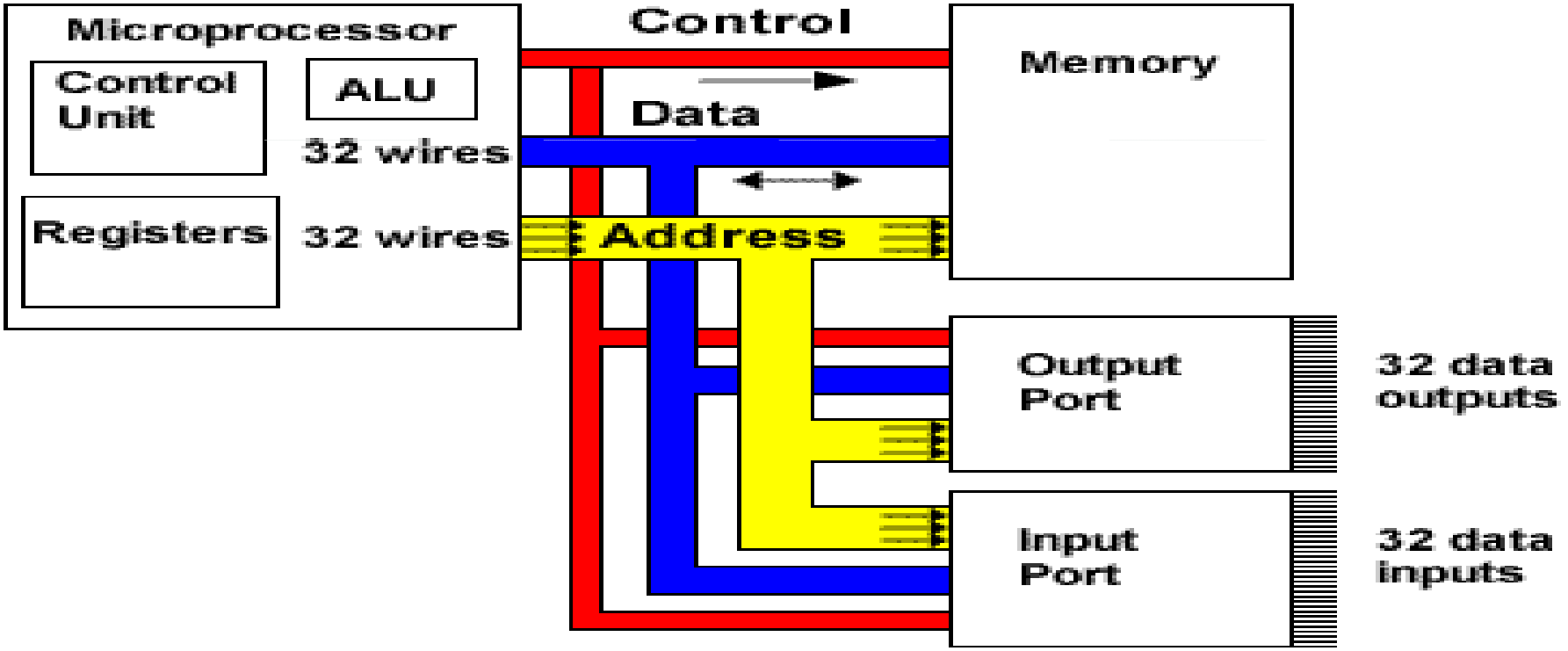
Image Source: http://www-mdp.eng.cam.ac.uk/web/library/enginfo/mdp_micro/lecture1/lecture1-3-1.html



# 8. Processor Speed

Measured in Hertz (Hz) – Number of instructions per second.

**Units:**

- MHz (Megahertz) – million cycles/sec
- GHz (Gigahertz) – billion cycles/sec

**Factors affecting speed:**

- Clock speed
- Cache size
- Number of cores
- Architecture efficiency

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# 9. Multiprocessor System

System with more than one CPU.

**Benefits:**

- Parallel processing
- Improved performance
- Fault tolerance

**Types:**

- Symmetric Multiprocessing (SMP): All processors share memory equally.
- Asymmetric Multiprocessing (AMP): One master and others are slaves.

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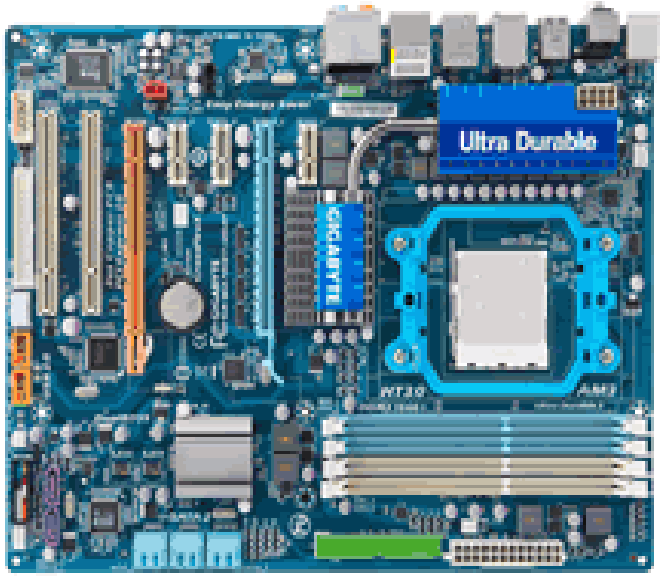
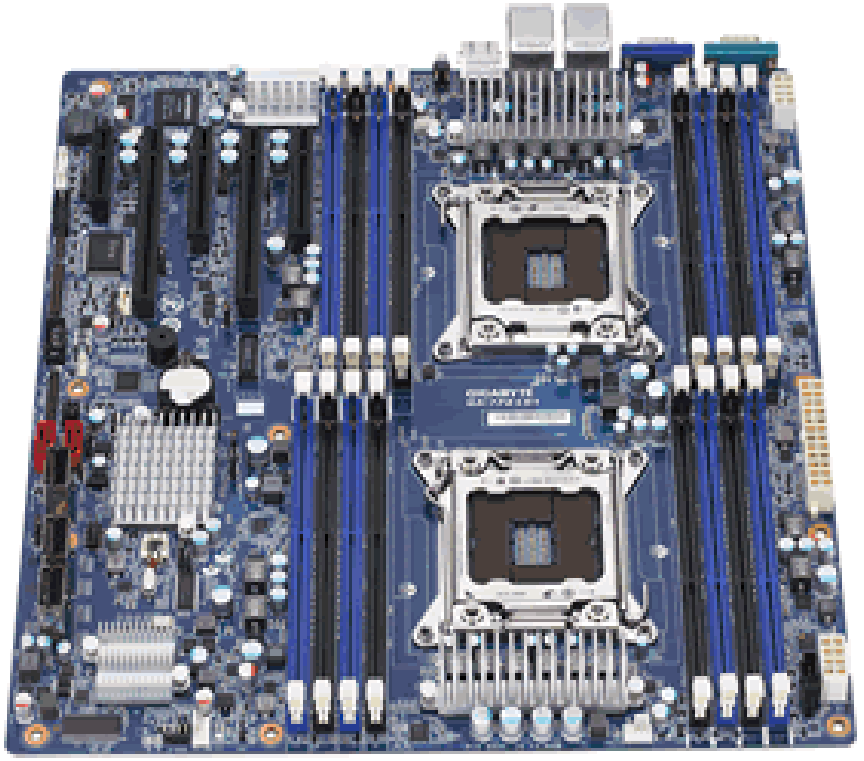
Image Source: http://allroundexpert.blogspot.com/2015/01/difference-between-single-and_29.html




Single Processor System

VS



Multi Processor System

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# 10. Peripheral Buses

Peripheral buses connect external devices:

**- PCI (Peripheral Component Interconnect)**

**- USB (Universal Serial Bus)**

**- SATA (Serial ATA): For storage devices**

They help in communication between motherboard and peripheral devices like keyboard, mouse, printer, etc.

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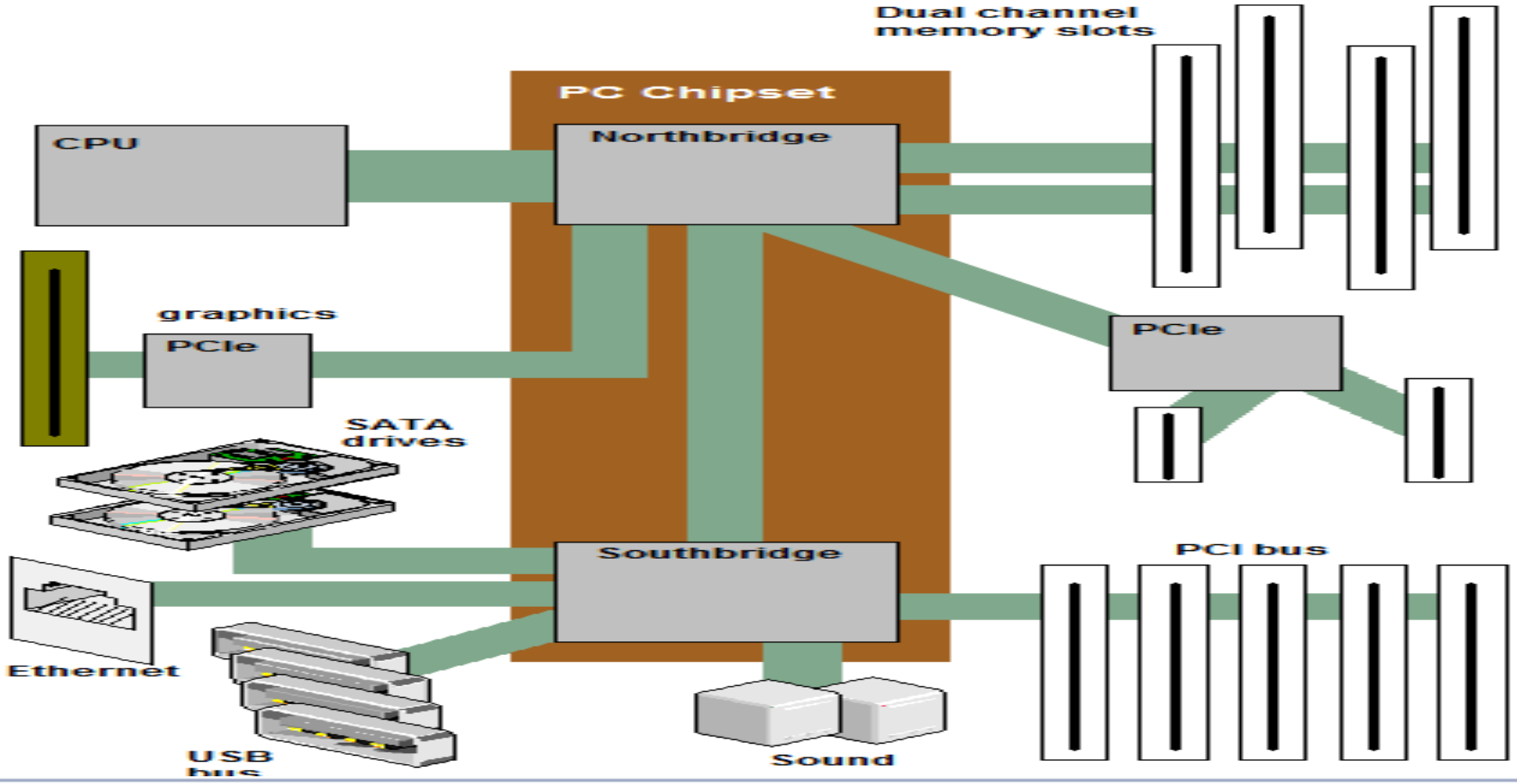
Image Source: https://www.pcmag.com/encyclopedia/term/bus



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# 11. Motherboard Demonstration

- The motherboard is the main circuit board. It holds:

  - CPU socket

  - RAM slots

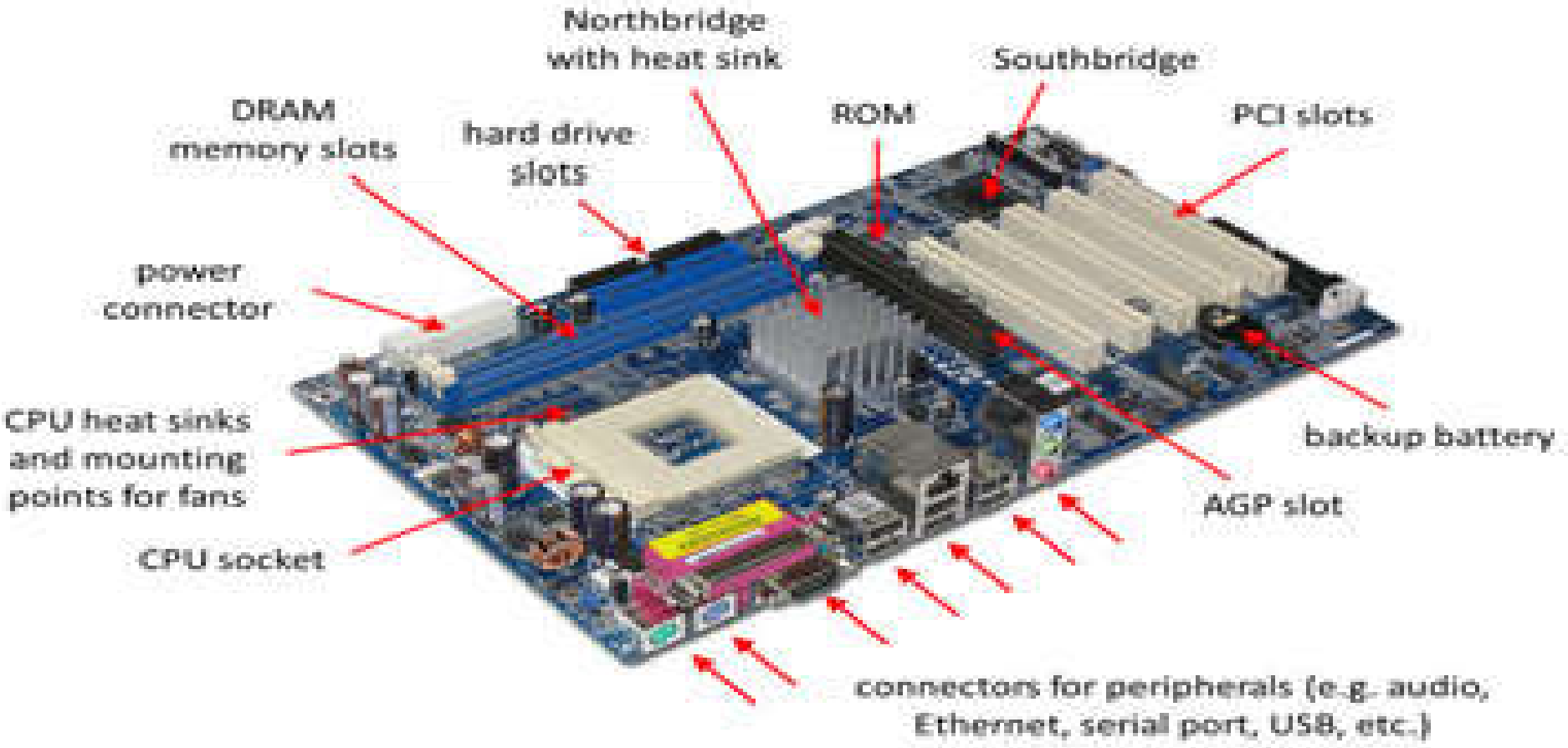
  - Expansion slots (PCIe)

  - Power connectors

  - BIOS chip

  - I/O ports and controllers

**Image Source: https://study.com/academy/lesson/what-is-a-motherboard-definition-function-diagram.html**



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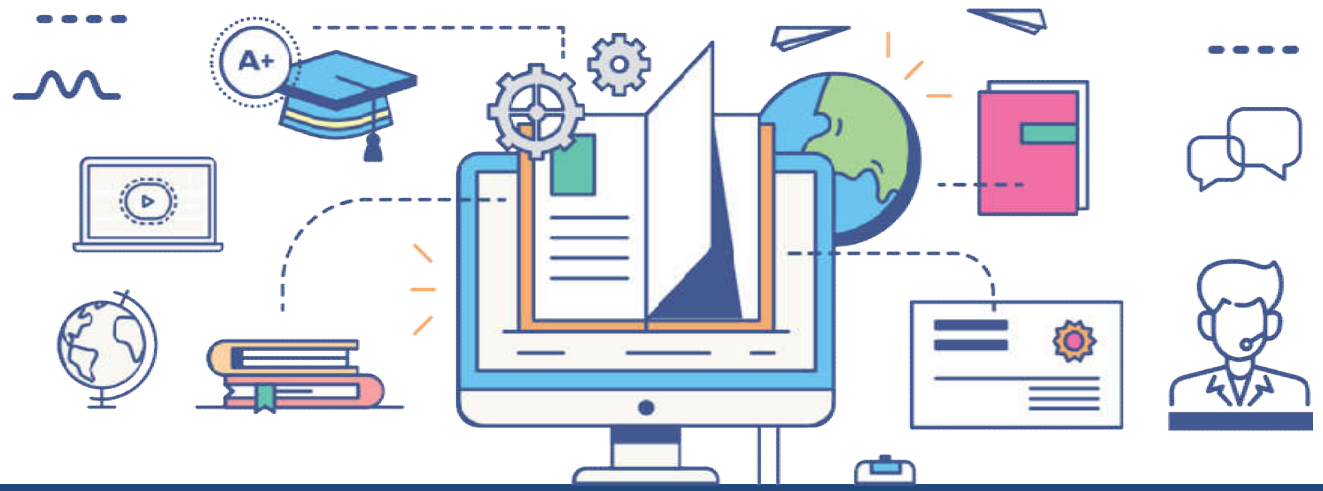


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