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## Chapter 1

# Introduction to Computing and ICT

## Information and Communication Technology (ICT)

Information and Communication Technology (ICT) is defined as a comprehensive set of computing tools that collectively allow people and organizations to interact in the digital world. It is an umbrella term encompassing communication devices (television, cell phones), computer and network hardware, satellite systems, and various associated services and applications such as video conferencing, distance learning, and e-commerce. ICT also represents the technological convergence of telephone networks with computer networks via a single link system, enabling integrated data, voice, and video communication.

### What is a System?

A system is a collection of interconnected components working together cohesively to achieve specific goals or objectives by processing inputs to produce desired outputs. Systems exist in both natural and artificial domains. Understanding a system's structure allows for better design, management, and optimization across fields like engineering, biology, and computing.

A system is described by four fundamental concepts:

1. **Objective/Purpose:** The primary goal the system is designed to achieve.
2. **Components:** The essential building blocks or parts that constitute the system.
3. **Environment:** Everything external to the system that interacts with or influences it.
4. **Communication/Interaction:** The mechanisms through which components and the system itself exchange information and coordinate their functions.

### Types of Systems

Systems are broadly categorized into two main types:

#### 1.3.1 Natural Systems

These occur organically in nature without human intervention. They are characterized by self-regulation, adaptability, stability, and are governed by natural laws (physics, chemistry, biology). They are highly intricate and interdependent.

- **Examples:** Ecosystems (forests, oceans), weather patterns, the solar system, the human body (circulatory, nervous systems), DNA, psychological systems (thoughts, emotions).

### 1.3.2 Artificial Systems

These are intentionally designed and built by humans to fulfill specific needs or solve problems. They are structured, require maintenance, and operate under predefined human-set rules and protocols.

- **Examples:**
  - **Knowledge Systems:** Mathematics, logic, databases, information management systems.
  - **Engineering Systems:** Civil (bridges, roads), mechanical (robotic arms), chemical (water treatment plants), electrical (home automation), software (library management systems).
  - **Social Systems:** Academic institutions, governments, corporations.
  - **Computer Systems:** The primary focus of this chapter.

#### Key Differences:

Feature	Natural Systems	Artificial Systems
<b>Origin</b>	Occur naturally.	Designed and built by humans.
<b>Complexity</b>	Highly intricate and interdependent.	Structured and relatively simpler.
<b>Energy Source</b>	Natural (sunlight, water flow).	Artificial (electricity, fuel).
<b>Adaptation</b>	Evolve autonomously over time.	Require human updates/redesign.
<b>Governance</b>	Natural laws.	Human-defined rules and protocols.

### Systems and Science

The study of systems aligns with different scientific approaches:

- **Natural Science:** Focuses on understanding and describing existing natural systems (e.g., studying a forest ecosystem).
- **Design Science:** Focuses on creating new artificial systems to solve problems (e.g., developing conservation software).



- **Computer Science:** Utilizes methods from both. It studies the natural laws of computation (e.g., algorithm efficiency) and engages in the design science of creating new software and hardware systems.

## The Computer as a System

### Definition of a Computer

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A computer is a programmable electronic device that accepts raw data as **input**, processes it according to a set of stored instructions (a program), produces useful **output**, and stores (**storage**) the results for future use. It performs arithmetic and logical operations automatically and without human intervention during processing.

### Objectives of a Computer System

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The main objectives are to perform computations, process data, and execute tasks efficiently to provide useful information to the user. This includes running software applications, managing files, facilitating communication, and automating complex processes.

### Core Components of a Computer System (Hardware)

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Computer hardware consists of physical, tangible components.

#### Input Devices

Tools that allow users to enter data and instructions into the computer.

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- **Keyboard:** For entering text, numbers, and commands. The standard layout is QWERTY.
- **Mouse/Pointing Device:** Controls the cursor on the screen for selection and navigation. Includes touchpads on laptops.
- **Scanner:** Converts physical documents and images into a digital format.
- **Microphone:** Inputs audio data.
- **Webcam:** Captures live video and images.
- **Barcode Reader:** Scans barcodes to input product information quickly.
- **Touch Screen:** Serves as both an input (touch) and output (display) device.
- **Joystick/Gamepad:** Used for gaming and simulations.
- **Light Pen:** A historical pointing device for drawing directly on CRT screens.



## The System Unit

The central case that houses the primary electronic components.

- **Motherboard:** The main circuit board that connects and allows communication between all components (CPU, RAM, storage, ports).
- **Central Processing Unit (CPU)/Microprocessor:** The "brain" of the computer. It fetches, decodes, and executes instructions from memory.

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- **Control Unit (CU):** Directs and coordinates operations within the processor and manages the flow of data.
- **Arithmetic Logic Unit (ALU):** Performs all mathematical calculations (addition, subtraction, etc.) and logical comparisons (AND, OR, NOT).
- **Registers:** High-speed temporary storage locations within the CPU for holding data, instructions, and addresses currently being processed (e.g., Memory Address Register - MAR, Memory Data Register - MDR, Accumulator - AC, Program Counter - PC, Current Instruction Register - CIR).
- **Memory (Primary Storage):**
  - **Random Access Memory (RAM):** Volatile, read/write memory. It temporarily holds the operating system, application programs, and data currently in use. It is much faster than secondary storage but loses its contents when power is off.
  - **Read-Only Memory (ROM):** Non-volatile memory that stores permanent, essential instructions like the BIOS (Basic Input/Output System) for booting the computer. Its contents are typically not modifiable by the user.
  - **Cache Memory:** Extremely fast, small memory located inside (L1) or close to (L2, L3) the CPU. It stores frequently used data and instructions to speed up processing by reducing the time the CPU waits for data from RAM.

## Storage Devices (Secondary/Backing Storage)

Non-volatile media for the long-term retention of data, programs, and information.

- **Hard Disk Drive (HDD):** Magnetic storage using spinning platters. Offers large capacity at a lower cost but is slower and more fragile than SSDs.
- **Solid State Drive (SSD):** Chip-based storage using flash memory. Much faster, more durable, silent, and energy-efficient than HDDs, but typically more expensive per gigabyte.
- **Optical Discs:** CDs, DVDs, and Blu-ray discs that use lasers to read and write data.
- **USB Flash Drive:** Portable, rewritable chip-based storage.



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- **Memory Cards (SD Cards):** Portable storage used in cameras, phones, and other devices.

### Output Devices

Hardware used to present processed data (information) to the user.

- **Monitor/Visual Display Unit (VDU):** Displays text, graphics, and video (soft copy). Types: CRT (older, bulky), LCD, LED (modern, flat-panel).
- **Printer:** Produces physical hard copies. Types: Impact (e.g., dot-matrix) and Non-Impact (e.g., inkjet, laser).
- **Plotter:** Used for printing large-scale graphics like engineering drawings and architectural blueprints.
- **Speakers/Headphones:** Output audio.

- **Multimedia Projector:** Projects the computer's display onto a larger surface like a wall or screen.

### Ports, Expansion Slots, and Cards

- **Ports:** Interfaces on the system unit for connecting peripheral devices (e.g., USB, HDMI, Ethernet, audio jacks, VGA).
- **Expansion Slots:** Sockets on the motherboard (e.g., PCI, PCI Express) where expansion cards can be inserted to add new capabilities.
- **Expansion Cards:** Circuit boards that add new functions (e.g., graphics card for enhanced video, sound card for improved audio, network interface card for networking).

### Interaction among Components & the Environment

Components interact seamlessly via the motherboard's buses and system software. For example, opening a file involves:

1. **Input:** User double-clicks a file icon via the mouse.
2. **Processing:** Signal sent to CPU via motherboard.
3. **Memory Access:** CPU fetches the associated program instructions from RAM and the file data from storage (HDD/SSD).
4. **Execution:** CU and ALU process the instructions to decode and display the file.
5. **Output:** The file's content is displayed on the monitor.



The computer **environment** includes external factors like the power supply, network connections, all connected peripherals (printers, scanners), and the user themselves.

## Basic Operations of a Computer (IPO Cycle)

All computer tasks, regardless of complexity, involve four fundamental operations:

1. **Input:** Accepting data and instructions from the outside world.
2. **Processing:** Manipulating and transforming the data as per instructions (performed by the CPU).
3. **Storage:** Holding data, instructions, and intermediate or final results (in primary memory or secondary storage).
4. **Output:** Presenting the processed information to the user.

## Computer Architecture: The Von Neumann Model

### Overview

Proposed by mathematician John von Neumann, this is the fundamental architecture underlying almost all modern computers. Its key, revolutionary principle is the **stored-program concept**, where both program instructions and data reside in the same memory unit. This allows programs to be easily modified and treated as data.

### Key Components

1. **Central Processing Unit (CPU):** Contains the ALU, CU, and Registers.
2. **Memory Unit (RAM):** A single store for both instructions and data.
3. **Input/Output (I/O) Devices:** Facilitate communication with the external world.
4. **System Buses:** Parallel electrical pathways for data transmission between components.
  - **Data Bus:** Carries the actual data being processed.
  - **Address Bus:** Carries the memory location (address) from which data is to be fetched or to which it is to be sent.
  - **Control Bus:** Carries control and timing signals (read, write, interrupt) from the CU to other units.

## The Instruction Cycle (Fetch-Decode-Execute Cycle)

The CPU executes instructions in a repetitive, continuous cycle:

1. **Fetch:** The CU retrieves the next instruction from the memory address held in the Program Counter (PC) and loads it into the Current Instruction Register (CIR). The PC is then incremented.
2. **Decode:** The CU interprets the instruction to determine what operation (opcode) is to be performed and on what data (operands).
3. **Execute:** The appropriate component (often the ALU) performs the required calculation or operation (e.g., add two numbers, load data from memory).
4. **Store (Write Back):** The result is written back to memory, a register, or sent to an output device.

## Characteristics, Advantages, and Disadvantages

- **Characteristics:** Single memory store for data/instructions, sequential instruction execution, stored-program concept.
- **Advantages:** Simplified design and construction, flexibility (programs are easily changed by modifying memory contents), efficiency.
- **Disadvantages:**
  - **Von Neumann Bottleneck:** The shared bus system for transferring both instructions and data can limit the speed at which the CPU can process information, as only one piece of data can be transferred at a time.
  - **Security Risk:** Since instructions and data are stored together in the same memory space, a program could accidentally (or maliciously, as in a buffer overflow attack) modify other instructions or critical data.

## Software: The Driving Force

### Definition

Software is a set of instructions, data, or programs that tell the computer hardware how to function and perform specific tasks. It acts as the essential interface between the user and the hardware, transforming a general-purpose machine into a specific tool.



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## System Software

Manages and controls the hardware, providing a stable platform for running application software.

- **Operating System (OS):** Essential software that manages hardware resources (CPU, memory, I/O), provides user interfaces (Graphical User Interface - GUI / Command Line Interface - CLI), runs applications, and handles file and memory management. **Examples:** Windows, macOS, Linux, Android, iOS.
- **Device Drivers:** Specialized programs that enable the OS to communicate with and control specific hardware devices (e.g., printer driver, graphics card driver, scanner driver).
- **Utility Programs:** Perform maintenance, optimization, and management tasks (e.g., antivirus software, disk cleanup/defragmentation, file compression tools (ZIP), backup software, system monitors).
- **Language Processors (Translators):** Convert human-readable programming code into machine-executable code.
  - **Compiler:** Translates the entire high-level program (source code) into machine code (object code) at once. The resulting executable can be run independently. (e.g., C, C++ compilers).
  - **Interpreter:** Translates and executes the source code line-by-line. It does not produce a separate executable file. (e.g., Python, JavaScript interpreters).
  - **Assembler:** Translates assembly language (a low-level symbolic code) into machine code.

## Application Software

Programs designed to help end-users perform specific tasks or solve particular problems.

- **Productivity Software:** Word processors (MS Word), spreadsheets (MS Excel), presentation software (MS PowerPoint), database management systems (MS Access).
- **Business Software:** Accounting packages (QuickBooks), Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) software (Salesforce), payroll systems.
- **Entertainment Software:** Video games, media players (VLC, Windows Media Player), video/audio editing software.
- **Educational Software:** Learning Management Systems (LMS like Moodle), educational games, simulation software, classroom management tools.



- **Graphic & Design Tools:** Image editors (Adobe Photoshop, GIMP), vector graphics editors (Adobe Illustrator), computer-aided design (CAD) software, online design platforms (Canva).

## Software Terminologies

- **Open Source Software:** Software whose source code is made freely available to the public to use, study, modify, and distribute. **Examples:** Linux kernel, Firefox web browser, LibreOffice suite, Apache web server.
- **Freeware:** Copyrighted software that is distributed free of charge but typically with proprietary, unmodifiable source code. **Examples:** Skype, Adobe Reader, WhatsApp.
- **Shareware:** Proprietary software that is offered on a trial basis free of charge; payment is required for continued legal use or to unlock full features after the trial period expires.

## Types of Computers

### Based on Technology and Data Representation

- **Analog Computers:** Process continuous physical data (e.g., voltage, pressure, temperature). They measure inputs directly and provide output as a continuous signal. *Less accurate but faster for simulations.* **Examples:** Speedometer, thermometer, analog clock, traditional voltmeter.
- **Digital Computers:** Process discrete data represented in binary digits (0s and 1s). They are general-purpose, highly accurate, and versatile. *All modern general-purpose computers are digital.* **Examples:** All modern PCs, smartphones, servers, calculators.
- **Hybrid Computers:** Combine features of both analog and digital systems. They use analog components for fast input measurement and initial processing, and digital components for precision, complex calculation, storage, and logical control. **Example:** Medical equipment like ECG machines, ICU patient monitors, fuel pumps with digital price calculators.

### Classification of Digital Computers (by Size, Power & Purpose)

1. **Supercomputers:** The most powerful, fastest, and most expensive computers. Used for highly complex scientific and engineering tasks that require immense calculations. **Applications:** Weather forecasting, nuclear research, cryptography, molecular modeling, astrophysics. **Example:** CRAY series, IBM Summit, Fugaku.
2. **Mainframe Computers:** Large, powerful, highly reliable systems that support hundreds or thousands of users simultaneously. Used by large organizations for critical applications

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requiring high-volume transaction processing. **Applications:** Banking, airline reservations, census data, enterprise resource planning. **Examples:** IBM Z series.

3. **Minicomputers (Mid-range Servers):** Smaller than mainframes but larger than microcomputers, capable of supporting multiple users. Historically used by small businesses/departments. Largely replaced by powerful microcomputer-based servers and cloud solutions.
4. **Microcomputers (Personal Computers - PCs):** The most common type, designed for individual use.

- o **Desktop Computers**
- o **Laptop/Notebook Computers**
- o **Tablets**
- o **Smartphones** (convergence devices)

### Cutting-Edge and Specialized Technologies

- **Smart Watches/Wearables:** Wearable computers with health monitoring, connectivity, and app functionality.
- **Quantum Computers:** Utilize quantum bits (qubits) that can exist in multiple states simultaneously (superposition). Potential to solve specific problems intractable for classical computers (e.g., complex cryptography, drug discovery, material science).
- **3D Printers (Additive Manufacturing):** Create physical objects from digital models by adding material layer by layer.
- **Biometric Systems:** Use unique biological traits for identification and authentication (e.g., fingerprint scanners, facial recognition, iris scanners).

### Data Representation and Number Systems

#### Machine-Level Representation

At the machine level, all data is represented using **binary digits (bits)**, which can be either **0** or **1**. This binary system aligns with the two-state nature of electronic switches in computer hardware (ON/HIGH/1 and OFF/LOW/0).

- A single binary digit is called a **bit**.

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- Groups of bits form codes that represent all types of data: numbers, text, images, sound.
- **Example:** The decimal number 5 is **101** in binary. The ASCII character 'A' is **01000001**.

## Number Systems

A **number system** defines a set of values and rules used to represent quantity. The four primary systems in computing are:

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System	Base	Digits/Symbols	Primary Use
<b>Decimal</b>	10	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	Human-centric counting and math.
<b>Binary</b>	2	0, 1	Fundamental representation inside all computers.
<b>Octal</b>	8	0, 1, 2, 3, 4, 5, 6, 7	Compact representation of binary (historically significant).
<b>Hexadecimal</b>	16	0-9, A(10), B(11), C(12), D(13), E(14), F(15)	Compact representation of binary; used for memory addresses, color codes.

All are **positional-value systems**: the value of a digit depends on its position.

- **Most Significant Digit (MSD):** Leftmost digit (carries the most weight).
- **Least Significant Digit (LSD):** Rightmost digit (carries the least weight).

## Number System Conversions

**A. Conversion to Decimal (from any base):** Multiply each digit by the base raised to its positional power (starting at 0 for the LSD) and sum the results.

- **Binary to Decimal:**  $(1011.101)_2 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} = (11.625)_{10}$
- **Hexadecimal to Decimal:**  $(3AF)_{16} = 3 \times 16^2 + 10 \times 16^1 + 15 \times 16^0 = (943)_{10}$



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## B. Conversion from Decimal (to any base):

- For the **integer part**: Repeatedly divide by the target base and record remainders in **reverse order**.
- For the **fractional part**: Repeatedly multiply by the target base and record the integer parts in **forward order**.

**C. Direct Conversions Between Binary, Octal, and Hexadecimal:** (Efficient because bases are powers of 2).

- **Binary ↔ Octal:** Group binary digits into sets of **3** (from the binary point outward), pad if necessary, then convert each group to its octal digit (0-7).
- **Binary ↔ Hexadecimal:** Group binary digits into sets of **4**, then convert each group to its hex digit (0-9, A-F).
- **Octal ↔ Hexadecimal:** Use binary as an intermediary (Octal → Binary → Hexadecimal, or vice-versa).

## Binary Arithmetic

Computers perform all arithmetic using binary digits.

**Binary Addition:** Rules:  $0+0=0$ ,  $0+1=1$ ,  $1+0=1$ ,  $1+1=0$  with a **carry of 1** to the next higher bit.

**Binary Subtraction via Complements:** To simplify hardware, subtraction is often performed using **complements**.

- **1's Complement:** Invert all bits of a binary number ( $0 \rightarrow 1$ ,  $1 \rightarrow 0$ ).
- **2's Complement:** Add **1** to the 1's complement. **This is the standard method for representing signed integers in modern computers.**
  - **To get 2's complement of a number:** (1) Invert all bits (1's complement). (2) Add **1** to the result.
  - **Subtraction using 2's Complement:**  $A - B = A + (2\text{'s complement of } B)$ . Discard any final carry-out bit.

## Signed vs. Unsigned Numbers

- **Unsigned Numbers:** All bits represent the magnitude. Range for **n** bits: **0** to  $(2^n - 1)$ .
- **Signed Numbers (using 2's Complement):** The most significant bit (MSB) acts as the sign bit (**0** for positive, **1** for negative). Range for **n** bits:  $-2^{(n-1)}$  to  $+2^{(n-1)} - 1$ .



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## Character Encoding

### ASCII (American Standard Code for Information Interchange):

- **Original ASCII-7:** Uses 7 bits, representing 128 characters (letters A-Z/a-z, digits 0-9, punctuation, control codes).
- **Extended ASCII-8:** Uses 8 bits (1 byte), representing 256 characters, including additional symbols and accented letters.
- **Key Ranges:** Digits '0'-'9' = 48-57; Uppercase 'A'-'Z' = 65-90; Lowercase 'a'-'z' = 97-122.

**Unicode:** A universal character set designed to support **all written languages** of the world (over 100,000 characters). It is compatible with ASCII. Common **encoding forms**:

- **UTF-8:** Variable-length (1-4 bytes per character), most common on the web. Backward compatible with ASCII.
- **UTF-16:** Uses one or two 16-bit code units.
- **UTF-32:** Fixed-length 32-bit representation.

## Operating Systems: Core Concepts

### Definition and Core Functions

An **Operating System (OS)** is essential system software that acts as an intermediary between users/application programs and the computer hardware. It manages resources and provides common services.

1. **Process Management:** Creates, schedules, synchronizes, and terminates processes; allocates CPU time.
2. **Memory Management:** Allocates and deallocates memory space for programs; manages swapping between RAM and secondary storage (virtual memory).
3. **File Management:** Creates, reads, writes, deletes, and organizes files and directories on storage devices.
4. **Device Management:** Controls and coordinates input/output devices via drivers.
5. **Security & Protection:** Enforces access controls, user authentication, and protects system resources.

6. **User Interface:** Provides interfaces (GUI/CLI) for user interaction.

## Process Management in Detail

- **Process:** A program in execution. It is a dynamic entity (with a Process Control Block - PCB) residing in RAM, as opposed to a static program file on disk.
- **Process States:** New → Ready → Running → Blocked/Waiting → Terminated.
- **Thread:** A lightweight unit of execution *within* a process. A single process can contain multiple threads that share resources (memory, files) but can execute independently, enabling concurrency.
- **Process Scheduler:** OS component that selects which ready process runs next on the CPU using algorithms (First-Come-First-Served, Shortest Job Next, Round Robin, Priority).
- **Interrupts:** Signals from hardware or software that require immediate CPU attention, causing it to pause and execute an **Interrupt Service Routine (ISR)**.
- **Deadlock:** A situation where two or more processes are stuck, each waiting for a resource held by the other, preventing any progress.

## Types of Operating Systems

- **Batch Processing OS:** Processes similar jobs in groups ("batches") without user interaction.
- **Multitasking/Time-Sharing OS:** Allows multiple users/tasks to interact concurrently by rapidly switching CPU time, creating the illusion of simultaneous execution (e.g., Windows, macOS, Linux).
- **Real-Time OS (RTOS):** Designed for time-critical applications with strict deadlines (e.g., medical systems, robotics, industrial controllers). Can be Hard RTOS (absolute deadline) or Soft RTOS (preferred deadline).
- **Distributed OS:** Manages a group of networked computers as a single, cohesive system, transparently distributing tasks.
- **Embedded OS:** Built into the hardware of a dedicated device with limited resources (e.g., microwave, car engine controller, smartwatch - FreeRTOS, Embedded Linux).

## File Systems

A file system organizes, stores, retrieves, and manages data on storage devices.

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- **Structure:** Hierarchical (tree-structured) using directories/folders and files.
- **File Allocation Methods:**
  - **Contiguous:** File occupies consecutive disk blocks. Fast access but prone to external fragmentation.
  - **Linked:** File blocks are scattered but linked via pointers. Efficient space use, but slow for random access.
  - **Indexed:** Uses an index block (like a file's table of contents) to point to all data blocks. Good balance.
- **Common File Systems:** NTFS (Windows), APFS (macOS), ext4 (Linux), FAT32 (removable drives).

## Data Communication and Networks

### Fundamentals and Components

Data communication is the process of exchanging data between two or more devices via a transmission medium.

- **Components:** Sender → Message/Data → Transmission

### Modes of Data Transmission

- **Simplex:** One-way only (e.g., keyboard to computer, traditional TV/radio broadcast).
- **Half-Duplex:** Two-way communication, but only one direction at a time (e.g., walkie-talkies).
- **Full-Duplex:** Two-way simultaneous communication (e.g., telephone call, modern network connection).

### Communication Devices

- **Hub:** Basic connector that broadcasts incoming data to all devices on a network segment. Inefficient.
- **Switch:** Intelligent device that learns device addresses (MAC) and directs data only to the specific intended port, improving network efficiency.



- **Router:** Connects different networks (e.g., a home LAN to the Internet). Routes data packets between networks based on IP addresses.
- **Gateway:** A router that connects networks using different communication protocols.

## Network Types (by Geographical Scope)

- **Personal Area Network (PAN):** Very small area, around an individual (e.g., Bluetooth connection).
- **Local Area Network (LAN):** Covers a small area like a building, home, or campus. High speed, low error rate, owned by the organization. **Example:** School computer lab, office network.
- **Metropolitan Area Network (MAN):** Covers a city or large campus (size between LAN and WAN). **Example:** City-wide Wi-Fi.
- **Wide Area Network (WAN):** Spans large geographical areas (cities, countries, globally). Connects multiple LANs. Often uses leased telecommunication lines. **Example:** The Internet.

## Network Architectures

- **Client-Server Network:** Dedicated, powerful servers provide resources (files, applications, email) to client computers. Centralized, easier to manage, secure, and backup. Common in businesses.
- **Peer-to-Peer (P2P) Network:** All computers (peers) have equal status, acting as both clients and servers. Simpler and cheaper for very small networks (e.g., home), but less secure and less manageable as it scales.

## Network Topologies (Physical/Logical Layout)

- **Bus Topology:** All devices connected to a single backbone cable. Simple, low cost, but a cable break disables the network. Poor scalability.
- **Star Topology:** All devices connected to a central hub or switch. Easy to install/manage; failure of one node doesn't affect others. Central device is a single point of failure.
- **Ring Topology:** Devices connected in a closed loop. Data travels in one direction (often token-passing). Orderly access, but a single node/cable failure can break the entire ring.

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- **Mesh Topology:** Every device is connected to every other device. Highly reliable (redundant paths) and high performance, but very expensive and complex to wire and manage. Common in backbone networks.
- **Hybrid Topology:** Combination of two or more basic topologies to leverage their advantages (e.g., Star-Bus, Star-Ring).

## The Internet and World Wide Web

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- **Internet:** A global, public WAN – a "network of networks" connecting billions of devices using standardized protocols (TCP/IP).
  - **Key Concepts:**
    - **TCP/IP Suite:** The fundamental communication protocol of the Internet (Transmission Control Protocol / Internet Protocol).
    - **Packet-Switching:** Data is broken into **packets**, sent independently across the network via the best available routes, and reassembled at the destination.
    - **Domain Name System (DNS):** Translates human-readable domain names ([www.example.com](http://www.example.com){.underline}) into machine-readable IP addresses (e.g., 192.0.2.1).
  - **World Wide Web (WWW):** An information system on the Internet where documents and resources are identified by URLs, linked via hypertext, and accessed via browsers using HTTP/HTTPS.

## Software Development Life Cycle (SDLC)

### Phases of the SDLC

A structured process for planning, creating, testing, and deploying high-quality software.

1. **Planning & Feasibility Study:** Define project scope, estimate resources/costs/schedule. Assess technical, economic, operational, and legal feasibility.
2. **Requirement Analysis & Engineering:** Gather, analyze, validate, and document detailed functional and non-functional requirements from stakeholders.
3. **System Design:** Create high-level (architecture) and low-level (detailed) design. Define system components, data flow, algorithms, and user interfaces (using tools like UML, flowcharts).



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4. **Development/Coding:** Write the actual program code in the chosen programming language(s), following coding standards.
5. **Testing:** Systematic process to identify defects.
  - **Levels:** Unit Testing (individual modules), Integration Testing (combined modules), System Testing (entire system), Acceptance Testing (by client).
  - **Types: Black Box** (tests functionality without seeing code), **White Box** (tests internal logic and structures of the code).
  - **Debugging:** The process of identifying the root cause of a bug (error) and fixing it.
6. **Deployment/Implementation:** Making the software operational for end-users.
  - **Methods:** Direct (immediate cutover), Parallel (run old & new simultaneously), Phased (gradual rollout), Pilot (limited group first).
7. **Maintenance & Support:** Fixing issues (corrective), adapting to new environments (adaptive), improving performance (perfective), and preventing future problems (preventive).

## Software Development Models

- **Waterfall Model:** Linear, sequential phases. Simple to understand, good for stable, well-defined requirements. Inflexible to changes late in the cycle.
- **Agile Model:** Iterative and incremental. Development occurs in small cycles (**sprints**), with continuous feedback and adaptation. Emphasizes flexibility, collaboration, and customer satisfaction. Suitable for projects with evolving requirements. Frameworks: Scrum, Kanban.

## Digital Logic and Circuit Design

### Analog vs. Digital Signals

Feature	Analog Signal	Digital Signal
Nature	Continuous waveform, infinite values within a range.	Discrete, represents data using binary values (0/1).

<b>Noise Immunity</b>	Susceptible to noise and degradation; quality loss when copied.	More resistant to noise; can be regenerated perfectly.
<b>Examples</b>	Human voice, analog radio, vinyl records.	MP3 files, digital TV, data in computer memory.

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## 11.2 Logic Gates

Fundamental building blocks of digital circuits. They perform basic logical functions on one or more binary inputs to produce a single binary output.

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Gate	Boolean Expression (2-input)	Truth Table (A B   F)	Function
<b>AND</b>	$F = A \cdot B$	0 0   0 0 1   0 1 0   0 1 1   1	Output is 1 only if ALL inputs are 1.
<b>OR</b>	$F = A + B$	0 0   0 0 1   1 1 0   1 1 1   1	Output is 1 if AT LEAST ONE input is 1.
<b>NOT</b>	$F = \bar{A}$ (or $A'$ )	0   1 1   0	Output is the inverse (complement) of the input.
<b>NAND</b>	$F = A \cdot B \bar{A} \cdot B$	0 0   1 0 1   1 1 0   1 1 1   0	Output is 0 only if ALL inputs are 1 (AND + NOT).
<b>NOR</b>	$F = A + B \bar{A} + B$	0 0   1 0 1   0 1 0   0 1 1   0	Output is 1 only if ALL inputs are 0 (OR + NOT).



		1 0   0 1 1   0	
<b>XOR</b>	$F = A \oplus B$	0 0   0 0 1   1 1 0   1 1 1   0	Output is 1 only if inputs are DIFFERENT.

## Boolean Algebra and Simplification

- **Boolean Algebra:** A mathematical system for logic operations using variables that can be true (1) or false (0) and operators (AND, OR, NOT).
- **Truth Table:** Lists all possible input combinations and their corresponding output for a Boolean function or logic circuit.
- **Boolean Identities:** Fundamental laws (Identity, Domination, Idempotent, Complement, Commutative, Associative, Distributive, De Morgan's Theorem) used to simplify expressions, leading to circuits with fewer gates.
- **Karnaugh Maps (K-Maps):** A graphical method for simplifying Boolean expressions. Adjacent 1s on the map (grouped in powers of two) represent terms where variables can be eliminated.

## Applications of Logic Gates

Logic gates are combined to build complex digital systems:

- **Arithmetic Circuits:** Adders (Half-Adder, Full-Adder), Subtractors, built into the ALU.
- **Memory Elements:** Flip-flops and latches (basic 1-bit storage) which form registers and RAM.
- **Combinational Circuits:** Multiplexers (select one of many inputs), Demultiplexers, Encoders, Decoders.
- **Control Systems:** Traffic light controllers, elevator controllers, digital watches.

## Emerging Paradigms: Cloud Computing and Cybersecurity

### Cloud Computing Fundamentals



The on-demand delivery of IT resources (servers, storage, databases, networking, software, analytics) over the internet with pay-as-you-go pricing.

**Key Characteristics:** On-Demand Self-Service, Broad Network Access, Resource Pooling, Rapid Elasticity, Measured Service.

### Service Models:

- **Infrastructure as a Service (IaaS):** Rents fundamental computing resources (VMs, storage, networks). *User manages OS, apps, data.* **Example:** Amazon EC2, DigitalOcean.
- **Platform as a Service (PaaS):** Provides a platform (OS, database, web server, development tools) for developing and deploying applications. *User manages apps and data only.* **Example:** Google App Engine, Microsoft Azure App Services.
- **Software as a Service (SaaS):** Delivering software applications over the internet, on a subscription basis. *User only uses the software.* **Example:** Gmail, Microsoft 365, Salesforce.

### Deployment Models:

- **Public Cloud:** Resources owned/operated by a third-party provider and shared by multiple organizations (e.g., AWS, Azure, Google Cloud).
- **Private Cloud:** Cloud infrastructure used exclusively by a single organization (more control, higher cost).
- **Hybrid Cloud:** Combines public and private clouds, allowing data and applications to be shared between them for flexibility.

### Cybersecurity Principles

The practice of protecting systems, networks, programs, and data from digital attacks, damage, or unauthorized access.

### Common Cyber Threats:

- **Malware:** Malicious software (Viruses, Worms, Trojans, Ransomware, Spyware, Adware).
- **Phishing/Spear Phishing:** Deceptive emails/websites designed to steal sensitive information.
- **Denial-of-Service (DoS) / Distributed DoS (DDoS):** Overwhelming a system with traffic to make it unavailable.
- **Man-in-the-Middle (MitM) Attacks:** Intercepting communication between two parties.

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- **Insider Threats:** Malicious actions by employees or trusted individuals.

### Essential Protection Measures:

- **Defense in Depth:** Use multiple, layered security controls.
- **Strong Authentication:** Use strong, unique passwords and **Multi-Factor Authentication (MFA)**.
- **Regular Updates:** Patch OS, applications, and firmware promptly.
- **Firewalls & Antivirus:** Deploy network firewalls and endpoint protection.
- **Encryption:** Protect data at rest (storage) and in transit (network). **Symmetric** (single key, e.g., AES) and **Asymmetric** (public/private key pair, e.g., RSA) encryption.
- **Backups:** Maintain regular, tested backups of critical data (3-2-1 rule).
- **User Education & Awareness:** Train users to recognize and report threats.

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## Human-Computer Interaction (HCI), Usability, and Ethics

### Human-Computer Interaction (HCI)

The study of how people interact with computers and the design of user-friendly, efficient, and accessible interfaces.

- **Elements:** User, Task, Interface (GUI, voice, touch), Environment.

### Usability

The measure of how effectively, efficiently, and satisfactorily a user can achieve goals in a particular context.

- **Key Components:** Learnability, Efficiency, Memorability, Error Handling, Satisfaction.
- **Usability Testing:** Methods include Moderated/Unmoderated, Qualitative (interviews)/Quantitative (metrics), A/B Testing.

### Accessibility

Designing systems to be usable by people with a wide range of abilities and disabilities.

- **Principles (POUR):** Perceivable, Operable, Understandable, Robust.



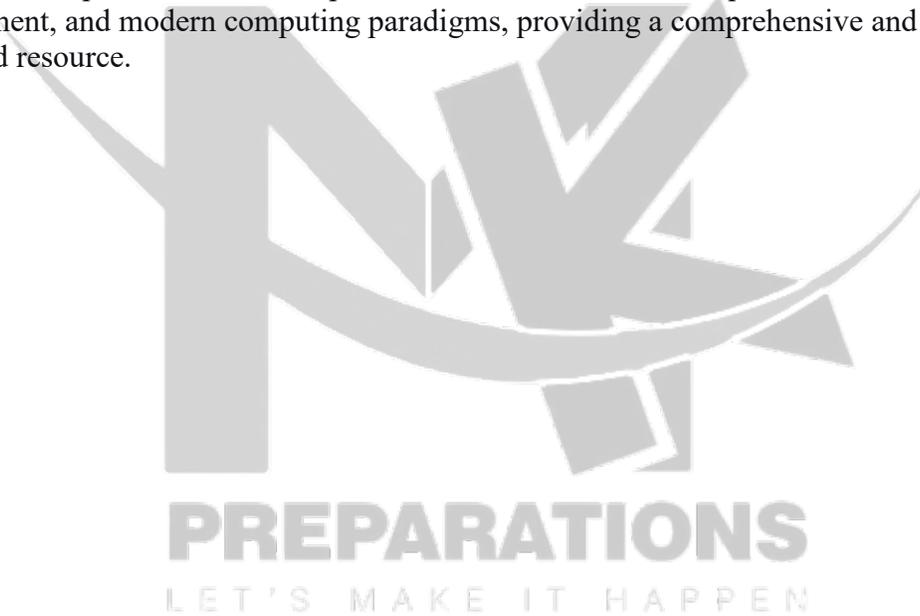
- **Solutions:** Screen readers, captions, keyboard navigation, voice control, high-contrast modes.

## Ethics and Societal Impact

System design involves balancing competing priorities like **Usability vs. Security** (e.g., complex passwords vs. user convenience).

- **Ethical Considerations:** Data privacy, user consent, algorithmic bias, transparency.
- **Societal Impact:** Digital divide, effects on employment, environmental impact (e-waste, energy use), social media influence.

This master chapter integrates the complete foundational knowledge of computer systems, from basic components and data representation to advanced concepts in networking, software development, and modern computing paradigms, providing a comprehensive and self-contained resource.



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## One Liners: Introduction to Computing and ICT

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1. ICT is an umbrella term for computing tools enabling interaction in the digital world, representing the convergence of telephone and computer networks.
2. A system is a collection of interconnected components working cohesively to achieve a specific objective by processing inputs into outputs.
3. The four fundamental concepts describing any system are its Objective, Components, Environment, and Communication/Interaction.
4. Natural systems occur organically, are self-regulated, adaptable, and governed by natural laws, such as ecosystems and the human body.
5. Artificial systems are human-designed, structured, require maintenance, and operate under predefined rules, like engineering, social, and computer systems.
6. Natural systems are governed by natural laws, while artificial systems operate under human-defined rules and protocols.
7. Design Science focuses on creating new artificial systems, like conservation software, to solve problems.
8. A computer is a programmable electronic device that accepts input, processes it according to stored instructions, produces output, and stores results.
9. The primary objectives of a computer system are to perform computations, process data, and execute tasks efficiently to provide useful information.
10. An input device allows users to enter data and instructions into a computer, such as a keyboard, mouse, or scanner.
11. The standard keyboard layout is QWERTY.
12. A touch screen serves as both an input (touch) and output (display) device.
13. The system unit houses the primary electronic components of a computer, including the motherboard and CPU.
14. The motherboard is the main circuit board connecting all components like the CPU, RAM, storage, and ports.
15. The CPU, or microprocessor, is the computer's "brain," responsible for fetching, decoding, and executing instructions.
16. The Control Unit (CU) directs and coordinates operations within the processor and manages data flow.
17. The Arithmetic Logic Unit (ALU) performs all mathematical calculations and logical comparisons.
18. Registers are high-speed temporary storage locations within the CPU for data and addresses being processed.
19. The Memory Address Register (MAR) holds the memory location of data to be fetched or stored.
20. The Memory Data Register (MDR) holds the data fetched from or to be written to memory.
21. The Program Counter (PC) holds the address of the next instruction to be executed.
22. The Current Instruction Register (CIR) holds the instruction currently being decoded and executed.

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23. Random Access Memory (RAM) is volatile, read/write memory that temporarily holds the OS, applications, and data in use.
24. Read-Only Memory (ROM) is non-volatile memory storing permanent, essential instructions like the BIOS.
25. Cache memory is extremely fast memory located close to the CPU to store frequently used data and speed up processing.
26. Secondary storage devices provide non-volatile, long-term retention of data, programs, and information.
27. Hard Disk Drives (HDD) use magnetic storage on spinning platters, offering large capacity at lower cost but are slower than SSDs.
28. Solid State Drives (SSD) use chip-based flash memory, offering faster speeds, durability, and energy efficiency than HDDs.
29. Output devices present processed data to the user, such as monitors (soft copy) and printers (hard copy).
30. A plotter is an output device used for printing large-scale graphics like engineering drawings.
31. Ports are interfaces on the system unit for connecting peripheral devices (e.g., USB, HDMI).
32. Expansion slots on the motherboard allow the insertion of expansion cards to add new capabilities like enhanced graphics or audio.
33. The computer's environment includes external factors like the power supply, network connections, peripherals, and the user.
34. The fundamental operations of a computer are Input, Processing, Storage, and Output, known as the IPO cycle.
35. The Von Neumann architecture's revolutionary principle is the stored-program concept, where both instructions and data reside in the same memory.
36. In the Von Neumann model, the CPU contains the ALU, CU, and Registers.
37. The three types of system buses are the Data Bus, Address Bus, and Control Bus.
38. The Data Bus carries the actual data being processed between components.
39. The Address Bus carries memory location (address) information.
40. The Control Bus carries control and timing signals, such as read and write commands.
41. The instruction cycle consists of four stages: Fetch, Decode, Execute, and Store (Write Back).
42. During the Fetch stage, the CU retrieves an instruction from memory into the CIR and increments the Program Counter.
43. The Von Neumann Bottleneck is the limitation in processing speed caused by the shared bus system transferring both instructions and data.
44. A security risk in the Von Neumann architecture is that instructions and data share the same memory, allowing a program to accidentally or maliciously modify other instructions.
45. Software is a set of instructions, data, or programs that tell computer hardware how to function and perform tasks.
46. System software manages and controls hardware, providing a stable platform for application software.



47. The Operating System (OS) manages hardware resources, provides user interfaces, runs applications, and handles file and memory management.
48. Device drivers are specialized programs enabling the OS to communicate with and control specific hardware devices.
49. Utility programs perform maintenance tasks like antivirus scanning, disk cleanup, and file compression.
50. A compiler translates an entire high-level program into machine code at once, producing an independent executable file.
51. An interpreter translates and executes source code line-by-line, without producing a separate executable.
52. An assembler translates assembly language (low-level symbolic code) into machine code.
53. Application software helps end-users perform specific tasks, such as using a word processor or spreadsheet.
54. Open Source Software has its source code made freely available for use, study, modification, and distribution (e.g., Linux).
55. Freeware is copyrighted software distributed free of charge, but its source code is typically not modifiable (e.g., Adobe Reader).
56. Shareware is proprietary software offered on a trial basis; payment is required for continued use or full features.
57. The first generation of computers (1940-1956) used vacuum tubes, were large, expensive, slow, and consumed high power.
58. The second generation of computers (1956-1963) used transistors, making them smaller, faster, and more reliable than the first generation.
59. The third generation of computers (1964-1971) used Integrated Circuits (ICs), leading to significant reductions in size, cost, and power consumption.
60. The fourth generation of computers (1971-Present) uses microprocessors (VLSI), placing the entire CPU on a single chip and enabling the PC revolution.
61. The fifth generation of computers focuses on Artificial Intelligence (AI), natural language processing, and parallel processing.
62. Analog computers process continuous physical data, such as voltage or temperature, and are less accurate but faster for simulations.
63. Digital computers process discrete data represented in binary digits (0s and 1s) and are highly accurate and versatile.
64. Hybrid computers combine analog and digital systems, using analog for fast measurement and digital for precision and control.
65. Supercomputers are the most powerful, fastest, and most expensive computers, used for highly complex scientific tasks.
66. Mainframe computers are large, powerful systems that support hundreds or thousands of users simultaneously for critical, high-volume transaction processing.
67. Microcomputers, or Personal Computers (PCs), are designed for individual use and are the most common computer type.
68. Quantum computers use qubits, which can exist in superposition, potentially solving problems intractable for classical computers.



69. At the machine level, all data is represented using binary digits (bits), which align with the two-state nature of electronic switches.
70. A single binary digit is called a bit.
71. A number system defines a set of values and rules used to represent quantity; the four primary systems in computing are Decimal, Binary, Octal, and Hexadecimal.
72. Decimal system has a base of 10 and uses digits 0-9.
73. Binary system has a base of 2 and uses digits 0 and 1.
74. Octal system has a base of 8 and uses digits 0-7.
75. Hexadecimal system has a base of 16 and uses digits 0-9 and letters A-F.
76. The Most Significant Digit (MSD) is the leftmost digit in a number, carrying the most weight.
77. The Least Significant Digit (LSD) is the rightmost digit in a number, carrying the least weight.
78. To convert from any base to decimal, multiply each digit by the base raised to its positional power and sum the results.
79. To convert the integer part of a decimal number to another base, repeatedly divide by the target base and record remainders in reverse order.
80. To convert the fractional part of a decimal number, repeatedly multiply by the target base and record integer parts in forward order.
81. Binary to Octal conversion involves grouping binary digits into sets of 3 and converting each group to its octal digit.
82. Binary to Hexadecimal conversion involves grouping binary digits into sets of 4 and converting each group to its hex digit.
83. The binary addition rule  $1+1$  equals 0 with a carry of 1 to the next higher bit.
84. The 1's complement of a binary number is obtained by inverting all its bits ( $0 \rightarrow 1$ ,  $1 \rightarrow 0$ ).
85. The 2's complement is found by adding 1 to the 1's complement and is the standard method for representing signed integers.
86. Subtraction using 2's complement is performed as  $A - B = A + (2\text{'s complement of } B)$ .
87. In signed numbers using 2's complement, the Most Significant Bit (MSB) acts as the sign bit (0 for positive, 1 for negative).
88. The range for an n-bit unsigned number is 0 to  $(2^n - 1)$ .
89. The range for an n-bit signed number using 2's complement is  $-2^{(n-1)}$  to  $+2^{(n-1)} - 1$ .
90. ASCII-7 uses 7 bits, representing 128 characters including letters, digits, and control codes.
91. In ASCII, the digit '0' has a decimal value of 48, 'A' has 65, and 'a' has 97.
92. Unicode is a universal character set designed to support all written languages of the world, compatible with ASCII.
93. UTF-8 is a variable-length Unicode encoding (1-4 bytes per character) that is backward compatible with ASCII.
94. An Operating System acts as an intermediary between users/application programs and computer hardware.
95. Core OS functions include Process Management, Memory Management, File Management, Device Management, Security, and providing a User Interface.



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96. A process is a program in execution, a dynamic entity with a Process Control Block (PCB), as opposed to a static program file.
97. A thread is a lightweight unit of execution within a process; multiple threads in a process can execute independently and share resources.
98. The process states are New, Ready, Running, Blocked/Waiting, and Terminated.
99. The Process Scheduler selects which ready process runs next on the CPU using algorithms like Round Robin or Priority.
100. An interrupt is a signal from hardware or software requiring immediate CPU attention, causing it to execute an Interrupt Service Routine (ISR).
101. A deadlock is a situation where two or more processes are each waiting for a resource held by the other, preventing any progress.
102. A Real-Time OS (RTOS) is designed for time-critical applications with strict deadlines, such as medical systems or robotics.
103. An Embedded OS is built into the hardware of a dedicated device with limited resources, like a smartwatch or car controller.
104. In a file system, contiguous allocation assigns consecutive disk blocks to a file, allowing fast access but causing external fragmentation.
105. Linked file allocation stores file blocks scattered across the disk, linked by pointers, which is space-efficient but slow for random access.
106. Indexed file allocation uses an index block to point to all data blocks of a file, offering a good balance between access speed and management.
107. Data communication involves a Sender, Message, Transmission Medium, Protocol, and Receiver.
108. In simplex mode, data transmission is one-way only (e.g., keyboard to computer).
109. In half-duplex mode, two-way communication is possible, but only one direction at a time (e.g., walkie-talkies).
110. In full-duplex mode, two-way simultaneous communication occurs (e.g., telephone call).
111. A hub is a basic network connector that broadcasts incoming data to all devices on a segment, making it inefficient.
112. A switch is an intelligent network device that learns MAC addresses and directs data only to the specific intended port.
113. A router connects different networks (e.g., a LAN to the Internet) and routes data packets based on IP addresses.
114. A gateway is a router that connects networks using different communication protocols.
115. A LAN (Local Area Network) covers a small area like a building, offers high speed, and is typically owned by the organization.
116. A WAN (Wide Area Network) spans large geographical areas, connects multiple LANs, and often uses leased telecommunication lines.
117. In a Client-Server network, dedicated servers provide resources to client computers, offering centralized management and security.
118. In a Peer-to-Peer (P2P) network, all computers have equal status, acting as both clients and servers, which is simpler but less secure.
119. In a bus topology, all devices connect to a single backbone cable; a cable break can disable the entire network.



120. In a star topology, all devices connect to a central hub/switch; failure of one node doesn't affect others, but the central device is a single point of failure.
121. In a ring topology, devices are connected in a closed loop with data traveling in one direction; a single node failure can break the ring.
122. In a mesh topology, every device is connected to every other device, providing high reliability through redundant paths but at high cost and complexity.
123. The Internet is a global public WAN, a "network of networks" using standardized TCP/IP protocols.
124. Packet-switching involves breaking data into packets, sending them independently via the best routes, and reassembling them at the destination.
125. DNS (Domain Name System) translates human-readable domain names into machine-readable IP addresses.
126. The World Wide Web (WWW) is an information system on the Internet where documents are identified by URLs and linked via hypertext.
127. The first phase of the Software Development Life Cycle (SDLC) is Planning & Feasibility Study, which assesses technical, economic, and operational viability.
128. Requirement Analysis involves gathering, analyzing, validating, and documenting detailed functional and non-functional requirements.
129. System Design involves creating high-level architecture and low-level detailed designs, often using tools like UML.
130. In the Testing phase, Unit Testing checks individual modules, Integration Testing checks combined modules, and System Testing checks the entire system.
131. Black Box testing examines functionality without seeing the internal code, while White Box testing examines internal logic and structures.
132. Debugging is the process of identifying the root cause of a software bug and fixing it.
133. Deployment methods include Direct cutover, Parallel running, Phased rollout, and Pilot implementation with a limited group.
134. Software Maintenance includes Corrective (fixing bugs), Adaptive (adapting to new environments), Perfective (improving performance), and Preventive activities.
135. The Waterfall model is a linear, sequential SDLC model suitable for projects with stable, well-defined requirements.
136. The Agile model is iterative and incremental, emphasizing flexibility, collaboration, and customer satisfaction through small development cycles called sprints.
137. An analog signal is a continuous waveform with infinite values within a range, such as a human voice, and is susceptible to noise.
138. A digital signal is discrete, representing data using binary values (0/1), and is more resistant to noise as it can be regenerated.
139. An AND logic gate outputs 1 only if all its inputs are 1.
140. An OR logic gate outputs 1 if at least one of its inputs is 1.
141. A NOT logic gate outputs the inverse (complement) of its single input.
142. A NAND gate is a combination of an AND gate followed by a NOT gate; it outputs 0 only if all inputs are 1.
143. A NOR gate is a combination of an OR gate followed by a NOT gate; it outputs 1 only if all inputs are 0.



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144. An XOR (Exclusive OR) gate outputs 1 only if its inputs are different.
145. Boolean Algebra is a mathematical system for logic operations using variables that can be true (1) or false (0).
146. A truth table lists all possible input combinations and their corresponding output for a Boolean function.
147. De Morgan's Theorem states that the complement of a conjunction is the disjunction of the complements, and vice versa.
148. A Karnaugh Map (K-Map) is a graphical method for simplifying Boolean expressions by grouping adjacent 1s.
149. A half-adder is a combinational circuit that adds two single binary digits and produces a sum and a carry output.
150. A full-adder adds three single binary digits (including a carry-in) and produces a sum and a carry-out.
151. A flip-flop is a basic 1-bit memory element that forms the building block for registers and RAM.
152. Cloud computing delivers IT resources over the internet with on-demand self-service, broad network access, and pay-as-you-go pricing.
153. IaaS (Infrastructure as a Service) rents fundamental computing resources like VMs and storage; the user manages the OS and applications.
154. PaaS (Platform as a Service) provides a platform for developing and deploying applications; the user manages only the apps and data.
155. SaaS (Software as a Service) delivers software applications over the internet on a subscription basis; the user only uses the software.
156. Public cloud resources are owned by a third-party provider and shared by multiple organizations.
157. Private cloud infrastructure is used exclusively by a single organization, offering more control at a higher cost.
158. Malware is malicious software, encompassing viruses, worms, Trojans, ransomware, spyware, and adware.
159. Phishing uses deceptive emails or websites to steal sensitive information like passwords or credit card numbers.
160. A Denial-of-Service (DoS) attack overwhelms a system with traffic to make it unavailable to legitimate users.
161. Multi-Factor Authentication (MFA) requires two or more verification factors to gain access, significantly improving security.
162. Symmetric encryption uses a single shared key for both encryption and decryption (e.g., AES).
163. Asymmetric encryption uses a public/private key pair, where the public key encrypts and the private key decrypts (e.g., RSA).
164. The 3-2-1 backup rule advises having at least 3 total copies of data, 2 of which are on different media, and 1 stored offsite.
165. Human-Computer Interaction (HCI) studies how people interact with computers and designs user-friendly, efficient interfaces.



166. Usability measures how effectively, efficiently, and satisfactorily a user can achieve goals with a product.
167. Usability testing methods include moderated/unmoderated sessions and A/B testing.
168. Accessibility design principles (POUR) aim for systems that are Perceivable, Operable, Understandable, and Robust for all users.
169. Screen readers and captions are examples of accessibility solutions for visually and hearing-impaired users.
170. A key ethical consideration in system design is balancing Usability vs. Security, such as complex passwords versus user convenience.

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1. In the context of systems, which of the following is NOT one of the four fundamental concepts that describe any system?

- a) Objective/Purpose
- b) Components
- c) Efficiency
- d) Environment

**Answer: c) Efficiency**

2. What is the key, revolutionary principle proposed by John von Neumann that underlies almost all modern computer architectures?

- a) The use of vacuum tubes
- b) The stored-program concept
- c) The Harvard architecture separation
- d) Binary arithmetic logic

**Answer: b) The stored-program concept**

3. During the Fetch stage of the instruction cycle, what happens to the Program Counter (PC) after an instruction is retrieved?

- a) It is decremented
- b) It is loaded with the address of the fetched instruction
- c) It is incremented
- d) It is compared with the CIR

**Answer: c) It is incremented**

4. Which component of the CPU is specifically responsible for performing all mathematical calculations and logical comparisons?

- a) Control Unit (CU)
- b) Memory Data Register (MDR)
- c) Arithmetic Logic Unit (ALU)
- d) Cache Memory

**Answer: c) Arithmetic Logic Unit (ALU)**

5. What is the primary vulnerability associated with the Von Neumann architecture that can be exploited in attacks like buffer overflows?

- a) Slow processing speed due to the bottleneck
- b) Instructions and data residing in separate memory units
- c) Instructions and data residing in the same memory space
- d) The use of a single system bus

**Answer: c) Instructions and data residing in the same memory space**

6. Which of the following best distinguishes a compiler from an interpreter?

- a) A compiler is used for system software, an interpreter for application software.
- b) A compiler translates code line-by-line, while an interpreter translates the entire program at once.
- c) A compiler translates the entire source code into machine code at once, producing an executable.
- d) An interpreter produces an object file, while a compiler does not.

**Answer: c) A compiler translates the entire source code into machine code at once, producing an executable.**

7. A software that is copyrighted and distributed free of charge, but whose source code is typically not modifiable by the user, is classified as:

- a) Open Source Software
- b) Shareware
- c) Freeware
- d) Firmware

**Answer: c) Freeware**

1. Introduction to Computing and ICT



8. The technological shift from vacuum tubes to transistors primarily characterized which generation of computers?

- a) First to Second
- b) Second to Third
- c) Third to Fourth
- d) Fourth to Fifth

**Answer: a) First to Second**

9. Which type of computer is specifically designed to process continuous physical data like voltage or pressure and is considered faster for simulations but less accurate?

- a) Digital Computer
- b) Hybrid Computer
- c) Analog Computer
- d) Quantum Computer

**Answer: c) Analog Computer**

10. In a hybrid computer system, what is the typical role of the analog component?

- a) Long-term data storage
- b) Complex logical decision-making
- c) Fast input measurement and initial processing
- d) User interface management

**Answer: c) Fast input measurement and initial processing**

11. What is the correct decimal range for an 8-bit *unsigned* binary number?

- a) -128 to +127
- b) 0 to 255
- c) -256 to +255
- d) 0 to 511

**Answer: b) 0 to 255**

12. To perform the subtraction  $7 - 5$  using the 2's complement method in an 8-bit system, what operation would the ALU actually carry out?

- a)  $7 + (1\text{'s complement of } 5)$

- b)  $7 + (2\text{'s complement of } 5)$
- c)  $5 + (2\text{'s complement of } 7)$
- d) Direct binary subtraction of 0101 from 0111

**Answer: b)  $7 + (2\text{'s complement of } 5)$**

13. In the ASCII-7 character encoding standard, what is the decimal value assigned to the uppercase letter 'A'?

- a) 48
- b) 65
- c) 97
- d) 32

**Answer: b) 65**

14. Which Unicode encoding form is variable-length (1-4 bytes), backward compatible with ASCII, and the most common on the web?

- a) UTF-16
- b) UTF-32
- c) UTF-8
- d) ASCII-8

**Answer: c) UTF-8**

15. In process management, what is a 'thread'?

- a) A complete, independent program in execution
- b) A high-priority system process
- c) A lightweight unit of execution within a process that shares resources
- d) The state of a process when it is waiting for an I/O operation

**Answer: c) A lightweight unit of execution within a process that shares resources**

16. Which type of operating system is designed for time-critical applications where missing a deadline could have catastrophic consequences?

- a) Batch Processing OS
- b) Time-Sharing OS
- c) Soft Real-Time OS



d) Hard Real-Time OS

**Answer: d) Hard Real-Time OS**

17. In the context of file systems, which allocation method stores file blocks scattered across the disk, linked together by pointers, making it efficient for space but slow for random access?

- a) Contiguous Allocation
- b) Indexed Allocation
- c) Linked Allocation
- d) Sequential Allocation

**Answer: c) Linked Allocation**

18. In data communication, which mode allows for two-way communication but only in one direction at a time, similar to a walkie-talkie?

- a) Simplex
- b) Half-Duplex
- c) Full-Duplex
- d) Multiplex

**Answer: b) Half-Duplex**

19. What is the key functional difference between a network hub and a network switch?

- a) A hub operates at the network layer, while a switch operates at the data link layer.
- b) A hub broadcasts data to all connected devices, while a switch directs data only to the specific destination device.
- c) A switch connects different networks, while a hub connects devices within the same network.
- d) A hub has more ports than a switch.

**Answer: b) A hub broadcasts data to all connected devices, while a switch directs data only to the specific destination device.**

20. Which network topology connects every device to every other device,

providing maximum redundancy but at the highest cost and complexity?

- a) Star
- b) Bus
- c) Ring
- d) Mesh

**Answer: d) Mesh**

21. In the TCP/IP model used by the Internet, what is the primary function of the Domain Name System (DNS)?

- a) To encrypt data packets for secure transmission
- b) To route packets between different networks
- c) To translate domain names into IP addresses
- d) To establish and manage communication sessions

**Answer: c) To translate domain names into IP addresses**

22. During which phase of the SDLC are detailed functional and non-functional requirements gathered, analyzed, validated, and documented?

- a) Planning & Feasibility
- b) System Design
- c) Requirement Analysis & Engineering
- d) Testing

**Answer: c) Requirement Analysis & Engineering**

23. What is the defining characteristic of the Agile software development model compared to the Waterfall model?

- a) It follows a strict, sequential phase approach.
- b) It is only suitable for small projects.
- c) It is iterative, incremental, and emphasizes adaptability.
- d) It requires all requirements to be fixed before design begins.

**Answer: c) It is iterative, incremental, and emphasizes adaptability.**



24. A digital signal is preferred over an analog signal in computing primarily because it:
- a) Carries more information per unit time.
  - b) Is a continuous representation of data.
  - c) Is more resistant to noise and can be perfectly regenerated.
  - d) Requires simpler circuitry to process.

**Answer: c) Is more resistant to noise and can be perfectly regenerated.**

25. According to the truth table of a logic gate, the output is 1 only when all inputs are 0. Which gate is this?

- a) AND
- b) OR
- c) NAND
- d) NOR

**Answer: d) NOR**

26. In Boolean Algebra, which theorem states that the complement of a sum (OR) is equal to the product (AND) of the complements?

- a) Distributive Law
- b) Associative Law
- c) De Morgan's Theorem
- d) Commutative Law

**Answer: c) De Morgan's Theorem**

27. Which digital circuit is considered a basic 1-bit memory element and forms the foundation for computer registers?

- a) Half-Adder
- b) Multiplexer
- c) Decoder
- d) Flip-Flop

**Answer: d) Flip-Flop**

28. In cloud computing, which service model provides a platform including OS, database, and development tools, allowing users to deploy their applications without managing the

underlying infrastructure?

- a) Infrastructure as a Service (IaaS)
- b) Platform as a Service (PaaS)
- c) Software as a Service (SaaS)
- d) Hardware as a Service (HaaS)

**Answer: b) Platform as a Service (PaaS)**

29. Which type of cyber attack involves overwhelming a target system with excessive traffic to make it unavailable to legitimate users?

- a) Phishing
- b) Man-in-the-Middle (MitM)
- c) Denial-of-Service (DoS)
- d) SQL Injection

**Answer: c) Denial-of-Service (DoS)**

30. The security practice that involves using a combination of something you know (password), something you have (phone), and something you are (fingerprint) is known as:

- a) Single Sign-On (SSO)
- b) Encryption
- c) Multi-Factor Authentication (MFA)
- d) Firewalling

**Answer: c) Multi-Factor Authentication (MFA)**

31. Which of the following describes a key characteristic of symmetric encryption?

- a) It uses a public/private key pair.
- b) The same key is used for both encryption and decryption.
- c) It is inherently slower than asymmetric encryption.
- d) The encryption key is publicly shared while the decryption key is kept private.

**Answer: b) The same key is used for both encryption and decryption.**

32. The "POUR" principles are a cornerstone of which important area in



computing?

- a) Cybersecurity threat modeling
- b) Software testing methodologies
- c) System performance optimization
- d) Accessibility design

**Answer: d) Accessibility design**

**33.** What is the standard method used by modern computers to represent signed integers internally?

- a) Sign-and-Magnitude
- b) 1's Complement
- c) 2's Complement
- d) Binary Coded Decimal (BCD)

**Answer: c) 2's Complement**

**34.** Which of the following is NOT a component of the core definition of a system?

- a) A collection of interconnected components
- b) Working together to achieve a goal
- c) Must be created by humans
- d) Processes inputs to produce outputs

**Answer: c) Must be created by humans**

**35.** Which register in the CPU holds the memory address of the next instruction to be fetched for execution?

- a) Memory Address Register (MAR)
- b) Memory Data Register (MDR)
- c) Program Counter (PC)
- d) Current Instruction Register (CIR)

**Answer: c) Program Counter (PC)**

**36.** Which of the following best describes the primary role of cache memory?

- a) To provide permanent storage for the BIOS
- b) To serve as the main working memory for running programs
- c) To act as a high-speed buffer between the CPU and RAM

d) To store the operating system kernel

**Answer: c) To act as a high-speed buffer between the CPU and RAM**

**37.** In which computer generation did the introduction of keyboards and monitors as primary I/O devices become prominent?

- a) First Generation
- b) Second Generation
- c) Third Generation
- d) Fourth Generation

**Answer: c) Third Generation**

**38.** Which type of software is designed to perform specific, user-oriented tasks like word processing or accounting?

- a) System Software
- b) Firmware
- c) Application Software
- d) Utility Software

**Answer: c) Application Software**

**39.** The term "ICT" represents the convergence of which two major technological networks?

- a) Television and Radio networks
- b) Telephone and Computer networks
- c) Satellite and Cable networks
- d) Power and Communication networks

**Answer: b) Telephone and Computer networks**

**40.** What is the base of the hexadecimal number system?

- a) 2
- b) 8
- c) 10
- d) 16

**Answer: d) 16**

**41.** In the SDLC, which type of testing is conducted by the client to determine if the system meets the agreed-upon requirements before final acceptance?



- a) Unit Testing
- b) Integration Testing
- c) System Testing
- d) Acceptance Testing

**Answer: d) Acceptance Testing**

**42.** Which network device operates at the network layer and is primarily used to connect different networks together, such as a LAN to the Internet?

- a) Hub
- b) Switch
- c) Router
- d) Bridge

**Answer: c) Router**

**43.** Which logic gate's output is the exact inverse of an AND gate?

- a) OR
- b) NOT
- c) NAND
- d) XOR

**Answer: c) NAND**

**44.** What is the primary goal of a Karnaugh Map (K-Map) in digital logic design?

- a) To convert analog signals to digital
- b) To visualize the timing of sequential circuits
- c) To simplify Boolean expressions algebraically
- d) To simplify Boolean expressions graphically

**Answer: d) To simplify Boolean expressions graphically**

**45.** Which cloud deployment model combines public and private clouds, allowing data and applications to be shared between them?

- a) Public Cloud
- b) Private Cloud
- c) Hybrid Cloud

d) Community Cloud

**Answer: c) Hybrid Cloud**

**46.** The 3-2-1 backup rule is a best practice primarily associated with which domain?

- a) Network Topology Design
- b) Data Security and Recovery
- c) Software Development
- d) User Interface Design

**Answer: b) Data Security and Recovery**

**47.** In HCI, which metric specifically measures how easy it is for users to accomplish basic tasks the first time they encounter the design?

- a) Efficiency
- b) Memorability
- c) Learnability
- d) Satisfaction

**Answer: c) Learnability**

**48.** Which component is responsible for carrying control and timing signals, such as read and write commands, between the CPU and other units?

- a) Data Bus
- b) Address Bus
- c) Control Bus
- d) System Bus

**Answer: c) Control Bus**

**49.** A system that is "non-volatile" is characterized by its ability to:

- a) Retain stored information even when power is turned off.
- b) Process data at very high speeds.
- c) Be easily modified by the user.
- d) Connect to multiple input/output devices.

**Answer: a) Retain stored information even when power is turned off.**



## Chapter 2

# History of Computers

### Introduction to Computers:

**M** The word 'computer' originally referred to people who performed mathematical calculations. Before modern computers existed, these human 'computers' were employed to carry out complex arithmetic operations, often used in fields like astronomy, engineering, and navigation. This practice dates back to at least the 17th century.

**K**

**P** The first recorded use of the word 'computer' in English was in 1613, describing a person who computes. Over the centuries, as technology progressed, mechanical and electronic devices took over the computational role. This evolution marked the transition from manual computing to the automated systems we rely on today.

**R** Understanding the history of computing helps us appreciate the innovations and challenges faced by early scientists and inventors who laid the foundation for today's digital age.

### **E** **P** **A** **R** **A** **T** **I** **O** **N** **S** **The Mechanical Era (1600–1900)**

**R** During the Mechanical Era, inventors developed physical devices to assist in computation. These devices worked without electricity and were typically operated by hand.

### **A** **T** **I** **O** **N** **S** **Tally Sticks**

**T** Tally sticks were simple tools used since ancient times to record numbers, debts, or messages. They were not calculators but rather record-keeping aids. A notch on a stick represented a unit of value or count. These were used extensively in medieval Europe, especially for tax collection.

### **N** **S** **Abacus (c. 2400 BC)**

**S** The abacus is one of the oldest calculating tools known to humanity. First used in Babylon around 2400 BC and later perfected in China around 500 BC, the abacus consists of beads that can be moved along rods to perform arithmetic operations. It was especially useful in trading and finance and is still used today in parts of Asia.



### One Liners: History of Computer

1. The word 'computer' originally referred to a person who performed mathematical calculations.
2. The first recorded use of the word 'computer' in English was in 1613.
3. The Mechanical Era of computing (1600-1900) involved physical devices operated without electricity.
4. Tally sticks were ancient record-keeping aids, not calculators, often used in medieval Europe for tax collection.
5. The abacus, dating to 2400 BC in Babylon, is one of the oldest calculating tools, using beads on rods.
6. Napier's Bones (1614), invented by John Napier, used inscribed rods to simplify multiplication and division.
7. The slide rule (1622), developed by William Oughtred, used logarithmic scales for complex calculations.
8. The Pascaline (1642) was a mechanical calculator created by Blaise Pascal to perform addition and subtraction.
9. Gottfried Wilhelm Leibniz designed the Stepped Reckoner (1672), capable of all four basic arithmetic operations.
10. The Arithmometer (1820) by Charles Xavier Thomas de Colmar was the first commercially successful mechanical calculator.
11. Charles Babbage, the Father of the Computer, proposed the Difference Engine and Analytical Engine.
12. The Difference Engine was designed to compute polynomial functions and print results automatically.
13. The Analytical Engine is considered the first design for a general-purpose mechanical computer.
14. Ada Lovelace wrote the first algorithm intended for the Analytical Engine, making her the first programmer.
15. Ada Lovelace suggested using binary and conceptualized machine-generated music.
16. The Scheutjian Engine (1843) was the first mechanical calculator to automatically print its results.
17. The Jacquard Loom (1881) used punch cards to control weaving patterns, inspiring future computer data input.
18. Herman Hollerith's Tabulating Machine (1890) used punched cards for data processing, starting with the U.S. Census.
19. The Tabulating Machine's innovation led to the founding of IBM.
20. The Electronic Era brought faster, smaller, more reliable machines using electricity and introduced programmability.
21. Konrad Zuse's Z1 (1936-1938) is considered the first freely programmable mechanical computer.
22. The Z1 used binary floating-point arithmetic and input via punched tape.

### Practice MCQs

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1. What was the original meaning of the word "computer"?
- An electronic calculating device
  - A person who performs mathematical calculations
  - A mechanical automation tool
  - A data storage unit

**Answer: b) A person who performs mathematical calculations**

2. The Pascaline, invented by Blaise Pascal, was primarily designed to:
- Perform multiplication and division
  - Weave complex fabric patterns
  - Assist with tax collection through addition and subtraction
  - Solve polynomial equations

**Answer: c) Assist with tax collection through addition and subtraction**

3. Which device is considered the first design for a general-purpose mechanical computer?
- Difference Engine
  - Analytical Engine
  - Stepped Reckoner
  - Arithmometer

**Answer: b) Analytical Engine**

4. Ada Lovelace is historically significant for:
- Inventing the first mechanical calculator
  - Writing the first algorithm intended for machine processing
  - Developing the stored-program concept
  - Building the first electronic computer

**Answer: b) Writing the first algorithm intended for machine processing**

5. The Tabulating Machine, which used punched cards for data processing, directly led to the founding of which company?

- Microsoft
- IBM
- Intel
- Apple

**Answer: b) IBM**

6. Konrad Zuse's Z1 is notable for being the:

- First electronic digital computer
- First computer to use vacuum tubes
- First freely programmable mechanical computer
- First commercial computer

**Answer: c) First freely programmable mechanical computer**

7. The Atanasoff-Berry Computer (ABC) introduced which of the following concepts?

- Stored-program architecture
- Use of transistors
- Binary representation and electronic calculation using vacuum tubes
- Integrated circuits

**Answer: c) Binary representation and electronic calculation using vacuum tubes**

8. What was the primary use of the Harvard Mark I during World War II?

- Code-breaking
- Ballistics calculations for the U.S. Navy
- Predicting election results
- Running business payroll

**Answer: b) Ballistics calculations for the U.S. Navy**



## Chapter 3

# Computer System: Architecture and Components

## Introduction To Computer And Its Basic Operations

In today's information age, computers are used in every walk of life. They are found in devices ranging from MP3 players and toys to industrial robots, fighter aircraft, and beyond, making life easier and more comfortable.

## Definition of a Computer

A computer is an electronic device that accepts input data and instructions via input devices, stores them until needed, processes the data, and produces output through output devices.

## Basic Operations of a Computer

All computers perform four fundamental operations to carry out any task: **Input, Processing, Output, and Storage.**

- **Input Operation:** The process of capturing or accepting data or information using input devices (e.g., keyboard, mouse).
- **Processing Operation:** The transformation of input into output. The **Central Processing Unit (CPU)** performs this task under the direction of a program.
- **Output Operation:** The result or outcome of the processing, delivered via output devices (e.g., monitor, printer, speakers).
- **Storage Operation:** The process of retaining data, information, or instructions so the user can retrieve them when required. Storage can be temporary (e.g., RAM) or permanent (e.g., Hard Disk).

## Evolution of Computing Devices

The term "computing device" refers to any machine that can perform calculations, from simple addition to managing complex systems.

- **Early Computing Devices:**
  - **Abacus (c. 3000 BC):** Considered the first computer, using a system of sliding beads for calculations.

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3. Computer System: Architecture and Components



## One Liners: Computer Systems, Architecture and components

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1. A computer is an electronic device that accepts input data and instructions, stores them, processes the data, and produces output.
  2. The four fundamental operations of a computer are Input, Processing, Output, and Storage.
  3. Input operation involves capturing or accepting data using input devices like a keyboard or mouse.
  4. The Central Processing Unit (CPU) performs the transformation of input into output, which is the processing operation.
  5. Output operation delivers the result or outcome of processing via devices like a monitor, printer, or speakers.
  6. Storage operation retains data, instructions, or information for future retrieval, and can be temporary (RAM) or permanent (Hard Disk).
  7. The Abacus (c. 3000 BC) is considered the first computing device, using sliding beads for calculations.
  8. Charles Babbage proposed the Difference Engine (1822) to solve differential equations.
  9. The Analytical Engine was Charles Babbage's later concept for a general-purpose computer.
  10. Herman Hollerith's Tabulating Machine (1889) used punched cards and was developed for the U.S. census.
  11. The Z3 (1941), developed by Konrad Zuse, was used for designing airplanes and missiles.
  12. The Harvard Mark I (1944) was an electromechanical relay computer.
  13. ENIAC (1946) was the first general-purpose electronic computer.
  14. EDVAC (1945), designed by John von Neumann, introduced the stored-program concept.
  15. UNIVAC-I (1951) was one of the first commercially available computers.
  16. Microcomputers (Personal Computers) are the smallest and least expensive class, originally for individual users.
  17. Types of microcomputers include Desktop, Notebook, Laptop, and Handheld devices (Palmtop, PDA, Smartphone).
  18. Mainframe computers are the second most powerful and expensive, used by large organizations for critical, bulk-data processing.
  19. Mainframes support many terminals simultaneously and are used for census, ERP, financial transactions, and airline reservations.
  20. Supercomputers are the most powerful and expensive, designed for intense scientific, engineering, and business applications.
  21. Supercomputers are used for weather forecasting, weapon research, space exploration, and complex simulations.
  22. Mobile Computers are devices enabling mobile computing—processing and transmitting data wirelessly.
  23. Mobile computers include laptops, smartphones, tablets, and PDAs, featuring wireless connectivity and portability.
  24. Computer hardware refers to the physical, tangible components of a computer system (e.g., monitor, keyboard, mouse, CPU).
  25. The primary function of hardware is to store and execute software.

## Practice MCQs

1. Which of the following is NOT one of the four fundamental operations performed by all computers?

- a) Input
- b) Processing
- c) Communication
- d) Storage

**Answer: c) Communication**

2. Which early computing device, considered the first computer, used a system of sliding beads for calculations?

- a) Analytical Engine
- b) Difference Engine
- c) Abacus
- d) Pascaline

**Answer: c) Abacus**

3. The concept where both program instructions and data are stored in the same memory was introduced by which computer?

- a) ENIAC
- b) Harvard Mark I
- c) EDVAC
- d) UNIVAC-I

**Answer: c) EDVAC**

4. Which type of computer is specifically designed for intense scientific applications and is the most powerful and expensive?

- a) Mainframe Computer
- b) Microcomputer
- c) Minicomputer
- d) Supercomputer

**Answer: d) Supercomputer**

5. What is the primary functional distinction between computer hardware and software?

- a) Hardware is logical, software is physical.
- b) Hardware provides instructions, software executes them.
- c) Hardware is tangible and performs physical work, software is intangible and provides instructions.
- d) Hardware is stored permanently, software is temporary.

**Answer: c) Hardware is tangible and performs physical work, software is intangible and provides instructions.**

6. Which type of software acts as an interface between the computer hardware and the application software?

- a) Utility Software
- b) System Software
- c) Firmware
- d) Customized Software

**Answer: b) System Software**

7. A software translator that converts the entire source code into machine code at once, producing an object file, is called a(n):

- a) Interpreter
- b) Assembler
- c) Compiler
- d) Linker

**Answer: c) Compiler**

8. Customized banking software developed for a specific bank is an example of which category of application software?

- a) General-Purpose Software
- b) Productivity Software
- c) Special-Purpose Software
- d) System Software

**Answer: c) Special-Purpose Software**



## Chapter 4

# Number Systems, Digital Logics and Data Basics

### Introduction to Digital Systems and Data

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Modern technology is built upon the principles of digital systems. These systems process information using discrete values—primarily the binary digits 0 and 1—as opposed to the continuous signals found in the natural world. This chapter provides a comprehensive foundation in the core concepts that bridge data representation, logical processing, and structured data management. We will explore how computers represent numbers, text, and multimedia, how they perform logical and arithmetic operations using Boolean algebra and logic gates, and how complex data is organized and managed in database systems. Mastery of these topics is essential for understanding the inner workings of all computational devices.

### Data and Number Systems

#### Data, Information, and Operations

- **Data** is a raw collection of facts, figures, and statistics related to an object. It is an organizational asset used to view past activities and make future decisions.
- **Information** is data that has been processed, manipulated, and organized into a meaningful and useful context (e.g., a student's percentage result).
- **Data Processing Operations** involve a series of actions to convert data into information:
  1. **Data Capturing:** Recording data via source documents or input devices.
  2. **Data Manipulation:** This includes:
    - **Classifying:** Organizing data into groups using codes.
    - **Calculating:** Performing arithmetic operations.
    - **Sorting:** Arranging data in a logical sequence.
    - **Summarizing:** Condensing data into a concise form.
  3. **Managing Output Results:** This involves storing, retrieving, communicating, and reproducing the processed information.

4. Number Systems, Digital Logics & Data Basics



## One Liners: Number Systems, Digital Logics and Data Basics

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1. Data is a raw collection of facts, figures, and statistics related to an object, used for viewing past activities and making future decisions.
2. Information is data that has been processed, manipulated, and organized into a meaningful and useful context.
3. The first data processing operation is Data Capturing, which involves recording data via source documents or input devices.
4. Data Manipulation includes the actions of Classifying, Calculating, Sorting, and Summarizing data.
5. The decimal number system uses a base of 10 and the digits 0-9, and is primarily for human everyday use.
6. The binary number system uses a base of 2 and the digits 0 and 1, and is used for internal computer processing.
7. The octal number system uses a base of 8 and digits 0-7, historically used for compact binary representation (3 bits/digit).
8. The hexadecimal number system uses a base of 16 and digits 0-9 and A-F, used for modern compact binary representation (4 bits/digit) and memory addressing.
9. Binary representation is used because digital circuits are built from transistors with two stable states: ON (1) and OFF (0).
10. To convert a decimal number to another base, repeatedly divide the decimal number by the target base and record remainders from bottom to top.
11. To convert binary to octal, group bits into sets of three from the right, pad with leading zeros if needed, and convert each group to its octal digit.
12. To convert binary to hexadecimal, group bits into sets of four from the right, pad with leading zeros if needed, and convert each group to its hex digit.
13. To convert octal to binary, convert each octal digit to its 3-bit binary equivalent.
14. To convert hexadecimal to binary, convert each hex digit to its 4-bit binary equivalent.
15. Whole numbers (unsigned integers) use all bits for magnitude; for n bits, the range is 0 to  $(2^n - 1)$ .
16. Signed integers use the Most Significant Bit (MSB) as a sign bit: 0 for positive, 1 for negative.
17. The Two's Complement method is used to represent negative integers: invert all bits of the positive number and add 1 to the result.
18. For an n-bit signed integer using two's complement, the range is  $-2^{n-1}$  to  $(2^{n-1} - 1)$ .
19. Real numbers (with fractions) are represented using floating-point notation: Sign  $\times$  Mantissa  $\times 2^{\text{Exponent}}$ .
20. Single-precision floating-point format uses 32 bits: 1 sign bit, 8 exponent bits, and 23 mantissa bits.
21. Double-precision floating-point format uses 64 bits: 1 sign bit, 11 exponent bits, and 52 mantissa bits.
22. To convert a fractional decimal part to binary, multiply the fraction by 2 repeatedly, recording the integer part each time.
23. Binary addition follows the rules:  $0+0=0$ ,  $0+1=1$ ,  $1+0=1$ ,  $1+1=0$  with a carry of 1.

4. Number Systems, Digital Logics & Data Basics

## Practice MCQs

1. What is the key difference between data and information?
- Data is processed, information is raw.
  - Data is meaningful, information is a collection of facts.
  - Data is raw, information is processed and meaningful.
  - Data is stored electronically, information is printed.

**Answer: c) Data is raw, information is processed and meaningful.**

2. Which of the following is NOT a step in data manipulation?

- Classifying
- Capturing
- Calculating
- Summarizing

**Answer: b) Capturing**

3. Which number system uses a base of 8 and is historically significant for representing 3 binary bits per digit?

- Decimal
- Hexadecimal
- Octal
- Binary

**Answer: c) Octal**

4. What is the primary reason computers use the binary number system internally?

- It is easy for humans to understand.
- It allows for complex mathematical operations.
- It aligns with the two stable states (ON/OFF) of transistors in digital circuits.
- It provides the most compact representation of numbers.

**Answer: c) It aligns with the two stable**

**states (ON/OFF) of transistors in digital circuits.**

5. To convert the decimal number 29 to binary, what is the correct sequence of remainders from the repeated division-by-2 process?

- 10111
- 11101
- 11011
- 11110

**Answer: b) 11101**

6. The binary number 11010101 is equivalent to which hexadecimal number?

- D5
- C5
- D4
- E5

**Answer: a) D5**

7. What is the range of values for an 8-bit unsigned integer?

- 128 to +127
- 0 to 255
- 255 to +255
- 0 to 511

**Answer: b) 0 to 255**

8. In the two's complement representation, how is the negative equivalent of a positive binary number formed?

- Invert all bits.
- Invert all bits and subtract 1.
- Invert all bits and add 1.
- Add 1 to the number.

**Answer: c) Invert all bits and add 1.**



## Chapter 5

# Operating Systems

### Introduction to Software and Operating Systems

#### What is Software?

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Software is a collection of computer programs, procedures, and associated documentation that instructs a computer on what to do and how to do it. Without software, a computer's hardware is a useless collection of electronic components.

#### Types of Software

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Software is broadly classified into two main categories:

1. **System Software:** This software is designed to manage and operate the computer hardware, providing a platform for running application software. It acts as an intermediary between the hardware and the user applications.
  - o **Examples:** Operating Systems (Windows, macOS, Linux), Device Drivers (printer, graphics card drivers), Utility Programs (antivirus, disk cleanup, backup tools).
  - o **Purpose:** To manage hardware resources and create a stable environment for other software.
2. **Application Software:** This software is designed to help users perform specific tasks or solve particular problems. These programs fulfill user needs directly.
  - o **Examples:** Word Processors (Microsoft Word, Google Docs), Web Browsers (Chrome, Firefox), Spreadsheet Software (Microsoft Excel), Graphic Design Software (Adobe Photoshop, GIMP), Games.
  - o **Purpose:** To enable users to accomplish productive, creative, or entertainment-oriented tasks.

#### Key Differences:

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- **Control:** System software controls the hardware; application software is controlled by the user to perform tasks.
- **Necessity:** A computer cannot run without system software; application software is optional and installed based on user needs.
- **Installation:** System software (especially the OS) is usually pre-installed; application software is installed by the user.

## One Liners: Operating Systems

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5. Operating Systems

1. Software is a collection of computer programs, procedures, and documentation that instructs a computer on what to do and how to do it.
2. Without software, a computer's hardware is a useless collection of electronic components.
3. System Software is designed to manage and operate computer hardware, providing a platform for running application software.
4. System Software acts as an intermediary between hardware and user applications.
5. Examples of System Software include Operating Systems, Device Drivers, and Utility Programs.
6. The purpose of System Software is to manage hardware resources and create a stable environment for other software.
7. Application Software is designed to help users perform specific tasks or solve particular problems.
8. Application Software fulfills user needs directly, such as word processing or web browsing.
9. System Software controls the hardware, whereas Application Software is controlled by the user to perform tasks.
10. A computer cannot run without System Software; Application Software is optional and installed based on user needs.
11. System Software (especially the OS) is usually pre-installed, while Application Software is installed by the user.
12. An Operating System (OS) is the most critical type of System Software, acting as an interface between the user and hardware.
13. The OS controls the execution of all programs and manages the computer's resources.
14. The primary purpose of an OS is to act as a Resource Manager for hardware and software resources (CPU, memory, disk, I/O).
15. An OS provides a User Interface, offering a stable, consistent way for users and applications to interact with hardware.
16. A Command Line Interface (CLI) is a text-based interface where users type specific commands to instruct the computer.
17. CLI is powerful and flexible but has a steep learning curve and requires command memorization.
18. DOS (Disk Operating System) was one of the first widely-installed OS for IBM-compatible PCs, using commands like DIR and COPY.
19. UNIX is a powerful, multi-user, multitasking OS developed at Bell Labs, forming the basis for Linux and macOS.
20. A Menu-Driven Interface (MDI) presents users with a series of screens with list options, requiring no command memorization.
21. MDI is simpler than CLI but less flexible, ideal for systems like ATMs and information kiosks.
22. A Graphical User Interface (GUI) uses graphics (icons, windows, buttons) and is interacted with via a pointing device like a mouse.

## Practice MCQs

1. What is the fundamental role of System Software?

- a) To help users perform specific tasks like word processing.
- b) To manage and operate computer hardware, providing a platform for application software.
- c) To provide entertainment and games for users.
- d) To connect the computer to the internet.

**Answer: b) To manage and operate computer hardware, providing a platform for application software.**

2. Which of the following is a key distinction between System Software and Application Software?

- a) System Software is optional, Application Software is essential.
- b) System Software is installed by the user, Application Software is pre-installed.
- c) A computer cannot run without System Software, but Application Software is optional.
- d) Application Software controls the hardware directly.

**Answer: c) A computer cannot run without System Software, but Application Software is optional.**

3. The most critical type of system software that acts as an interface between the user and the computer hardware is the:

- a) Device Driver
- b) Utility Program
- c) Operating System (OS)
- d) Compiler

**Answer: c) Operating System (OS)**

4. Which type of user interface is characterized by a text-based environment

where users must type specific commands?

- a) Graphical User Interface (GUI)
- b) Menu-Driven Interface (MDI)
- c) Command Line Interface (CLI)
- d) Touch Interface

**Answer: c) Command Line Interface (CLI)**

5. Which early operating system was one of the first widely-installed for IBM-compatible PCs and used commands like DIR and COPY?

- a) UNIX
- b) Windows 95
- c) DOS (Disk Operating System)
- d) macOS

**Answer: c) DOS (Disk Operating System)**

6. What is a primary advantage of a Graphical User Interface (GUI) over a Command Line Interface (CLI)?

- a) It offers more precise control over the file system.
- b) It is faster for experienced users to perform complex tasks.
- c) It is more user-friendly and easier to learn, using visual recognition.
- d) It uses fewer system resources like RAM and CPU.

**Answer: c) It is more user-friendly and easier to learn, using visual recognition.**

7. An OS that allows only one user to run multiple applications concurrently is classified as:

- a) Multi-User, Single-Tasking
- b) Single-User, Multitasking
- c) Multi-User, Multitasking



## Chapter 6

# Office Automation

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### Introduction to Office Automation

Office Automation refers to the use of computer software and systems to digitally create, collect, store, manipulate, and relay office information to accomplish core tasks. The primary applications involved are Word Processors, Spreadsheets, Database Management Systems, and Presentation Software. This chapter provides a comprehensive guide to Word Processing and Spreadsheet software, their features, interfaces, and practical operations.

### Word Processing

#### What is a Word Processor?

A Word Processor is application software used for the composition, editing, formatting, and printing of text-based documents. It goes beyond simple typing by allowing the manipulation of text, insertion of images, sounds, charts, graphics, and even video clips. Documents can be saved in various formats (.txt, .rtf, .html, .doc, .docx) and published on the web with hyperlinks. Its greatest advantage over a typewriter is the ability to make changes without retyping the entire document.

**Examples of Word Processing Software:** MS Word, WordPerfect, OpenOffice Writer, Google Docs, AbiWord, Apple iWork.

#### Categories of Word Processors

##### Text Editors (Simple Word Processors)

These support basic features only. Examples include WordPad and Notepad.

##### Basic Features:

- **Insert & Delete Text:** Add or erase characters, words, lines, or pages.
- **Cut, Copy & Paste:** Move or duplicate sections of text.
- **Page Size & Margins:** Define page layout; text readjusts automatically.
- **Search & Replace:** Find and optionally replace specific words/phrases.
- **Word Wrap:** Text automatically moves to the next line.



## One Liners: Office Automation

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1. Office Automation uses computer software to digitally create, collect, store, manipulate, and relay office information to accomplish core tasks.
2. Primary applications of office automation include Word Processors, Spreadsheets, Database Management Systems, and Presentation Software.
3. A Word Processor is application software used for the composition, editing, formatting, and printing of text-based documents.
4. A key advantage of a word processor over a typewriter is the ability to make changes without retyping the entire document.
5. Text Editors (simple word processors) support only basic features like insert, delete, cut, copy, paste, and word wrap.
6. Full-Featured Word Processors support advanced capabilities like mail merge, macros, footnotes, and table of contents generation.
7. The WYSIWYG (What You See Is What You Get) feature ensures the on-screen display matches the printed output.
8. The Title Bar in a word processor window displays the name of the active document and the application.
9. The Ribbon in modern word processors replaced menus and contains tabs grouping related commands.
10. The Quick Access Toolbar is a customizable bar for frequently used commands like Save, Undo, and Redo.
11. The Ruler shows text positioning, tabs, margins, and indents both horizontally and vertically.
12. The Document Window is the main area for creating and editing, with a blinking cursor indicating the insertion point.
13. The Status Bar shows document information such as page number, word count, and zoom level.
14. Ctrl+N is the keyboard shortcut to create a new document in most word processors.
15. Ctrl+S is the shortcut to save a document, while Ctrl+O is used to open an existing document.
16. Ctrl+P opens the Print dialog box for printing a document.
17. In Insert Mode (default), new text pushes existing text forward.
18. In Overtyping Mode, new text overwrites existing text at the cursor position.
19. Ctrl+A selects the entire document's content.
20. The Backspace key deletes characters to the left of the cursor, while the Delete key deletes characters to the right.
21. Cut (Ctrl+X), Copy (Ctrl+C), and Paste (Ctrl+V) are used to move or duplicate text via the Clipboard.
22. The Clipboard is a temporary memory space managed by the operating system for transferring data between applications.
23. Undo (Ctrl+Z) reverses the last action, and Redo (Ctrl+Y) reapplies it.
24. Font Formatting involves changing the appearance of characters, including type, size, style, and color.

## Practice MCQs

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1. What is the primary purpose of Office Automation?

- a) To replace human workers entirely
- b) To use computer software to digitally create, store, manipulate, and relay office information
- c) To design hardware for office use
- d) To provide entertainment in the workplace

**Answer: b) To use computer software to digitally create, store, manipulate, and relay office information**

2. Which of the following is NOT a primary application of office automation?

- a) Word Processor
- b) Spreadsheet
- c) Operating System
- d) Database Management System

**Answer: c) Operating System**

3. The greatest advantage of a word processor over a traditional typewriter is:

- a) It is more expensive
- b) It makes a louder sound
- c) It allows changes without retyping the entire document
- d) It uses more paper

**Answer: c) It allows changes without retyping the entire document**

4. Which word processing feature ensures that the on-screen display exactly matches the printed output?

- a) AutoCorrect
- b) WYSIWYG (What You See Is What You Get)
- c) Word Wrap
- d) Mail Merge

**Answer: b) WYSIWYG (What You See Is What You Get)**

5. In a word processor window, which component is a customizable bar for frequently used commands like Save and Undo?

- a) Title Bar
- b) Ribbon
- c) Quick Access Toolbar
- d) Status Bar

**Answer: c) Quick Access Toolbar**

6. What is the keyboard shortcut to select all text in a document?

- a) Ctrl+C
- b) Ctrl+V
- c) Ctrl+A
- d) Ctrl+X

**Answer: c) Ctrl+A**

7. Which typing mode causes new text to overwrite existing text at the cursor position?

- a) Insert Mode
- b) Overtyping Mode
- c) Replace Mode
- d) Typeover Mode

**Answer: b) Overtyping Mode**

8. The temporary memory space used by the operating system to hold cut or copied data for pasting is called the:

- a) Cache
- b) Clipboard
- c) RAM
- d) Hard Drive

**Answer: b) Clipboard**

9. Which font type has small decorative strokes at the ends of characters and is generally better for printed body text?

- a) Sans-serif
- b) Script



## Chapter 8

# Microsoft Word (MS Word)

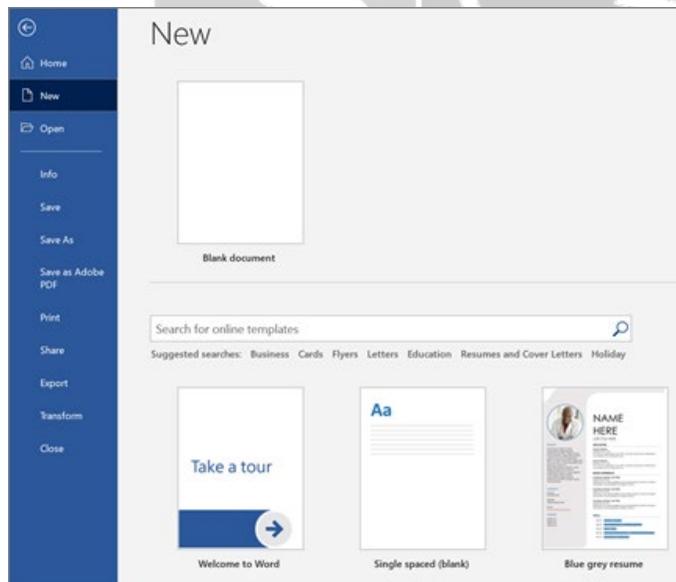
### With Word you can:

- Create a document from scratch or from a template .
- Add text, images, art, and videos.
- Research a topic and find credible sources.
- Access your documents from a computer, tablet, or phone via OneDrive.
- Share your documents and collaborate with others.
- Track and review changes.

### Create a new document

1. On the **File** tab, select **New**.
2. Select **Blank document**, or double-click a template image or type the kind of document into the **Search for online templates** box and press **Enter**.

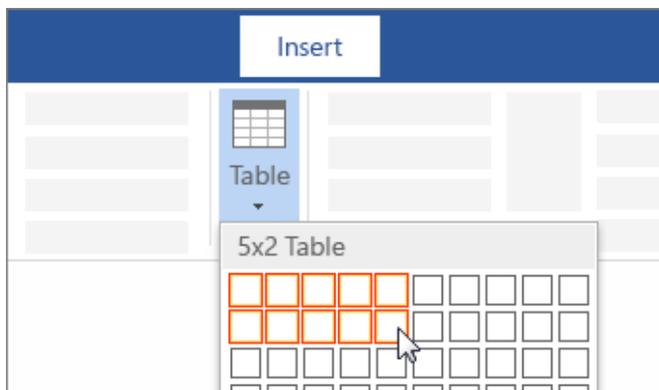
**Tip:** For practice using Word features, try a learning guide like **Welcome to Word** or **Insert your first table of contents**.



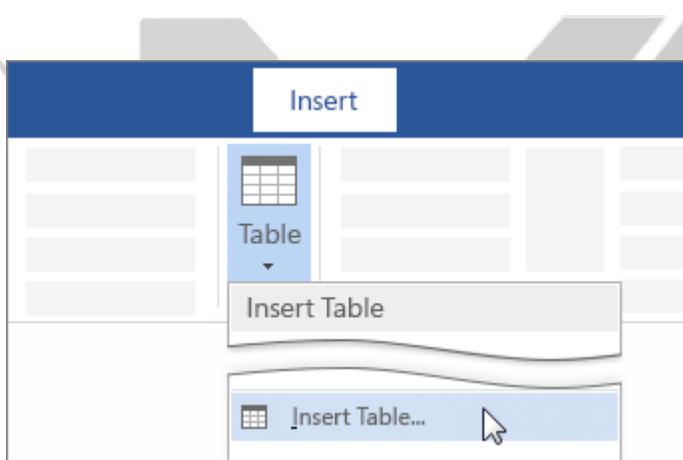
### Add and format text

1. Click on your new blank page and type some text.

For a basic table, click **Insert > Table** and move the cursor over the grid until you highlight the number of columns and rows you want.



For a larger table, or to customize a table, select **Insert > Table > Insert Table**.



### Tips:

- If you already have text separated by tabs, you can quickly convert it to a table. Select **Insert > Table**, and then select **Convert Text to Table**.
- To draw your own table, select **Insert > Table > Draw Table**

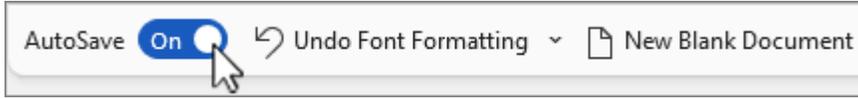
### Save a document

Save your document to OneDrive so you can get to it from anywhere – at work, at home, or on the go. Or save to another location, like your desktop.

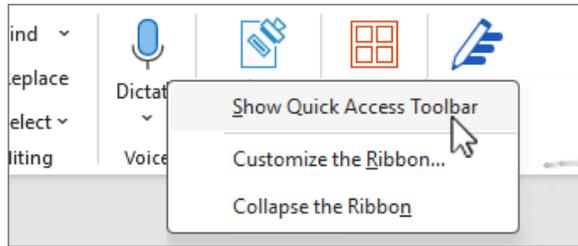
1. On the **File** tab, select **Save As** or **Save a Copy**.



When you save to OneDrive or SharePoint, all your changes are saved automatically. You can turn AutoSave on or off on the Quick Access Toolbar, either above or below your ribbon.



If you don't see the Quick Access Toolbar, right-click the ribbon, and select **Show Quick Access Toolbar**.

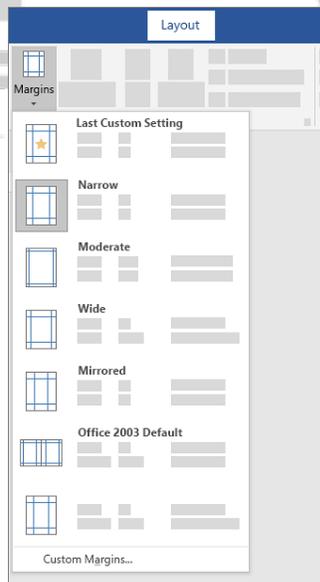


**Note:** When your document is stored in OneDrive, Word will save your changes automatically.

## Change margins

In Word, each page automatically has a one-inch margin. You can customize or choose predefined margin settings, set margins for facing pages, allow extra margin space to allow for document binding, and change how margins are measured.

1. Select **Layout > Margins**.



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### One Liners: MS Word

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1. Microsoft Word allows you to create documents from scratch or from an online template.
2. You can research topics and find credible sources directly within Microsoft Word.
3. Documents can be accessed from a computer, tablet, or phone via OneDrive.
4. Word facilitates document sharing and collaboration with others.
5. The Track and Review changes feature is available in Microsoft Word.
6. A new blank document is created from the **File** tab by selecting **New** and then **Blank document**.
7. To create a document from a template, you can double-click a template image or search in the **Search for online templates** box.
8. Learning guides like **Welcome to Word** are available for practice with Word features.
9. Text is formatted using options on the **Home** tab such as **Bold**, **Italic**, **Bullets**, and **Numbering**.
10. The **Insert** tab is used to add elements like Tables, Pictures, Shapes, SmartArt, Charts, and Screenshots.
11. A table is inserted by selecting **Insert > Table** and hovering over a grid to choose the number of rows and columns.
12. For a larger or customized table, use **Insert > Table > Insert Table**.
13. Existing text separated by tabs can be converted to a table using **Insert > Table > Convert Text to Table**.
14. You can draw a custom table using **Insert > Table > Draw Table**.
15. To add text, place the cursor at the desired location and start typing.
16. To replace text, select it and start typing; double-click selects a single word.
17. Clicking to the left of a line selects the entire line.
18. Text formatting can be applied from the pop-up toolbar or the **Home** tab's Font group.
19. The Format Painter tool copies formatting from one text selection to another.
20. Double-clicking the Format Painter allows copying formatting to multiple locations.
21. To save a document to OneDrive, use **File > Save As** or **Save a Copy** and select **OneDrive**.
22. Save personal files to **OneDrive - Personal** and work files to your company's OneDrive or SharePoint site.
23. You can also save a document to other locations like the Desktop by selecting **Browse**.
24. AutoSave automatically saves changes when a document is stored in OneDrive or SharePoint.
25. AutoSave can be toggled on or off from the Quick Access Toolbar.
26. The Quick Access Toolbar can be shown by right-clicking the ribbon and selecting **Show Quick Access Toolbar**.
27. Pictures can be inserted from your PC (**This Device**), from Stock Images, or from the web (**Online Pictures**).
28. In older Word versions, the option for online pictures may be labeled **Online Pictures** next to **Pictures**.
29. To resize a picture, select it and drag a corner handle.

## Practice MCQs

1. In Microsoft Word, where do you go to create a brand new document from a blank slate?
- Home > New
  - File > New > Blank document
  - Insert > New Document
  - View > New Window

**Answer: b) File > New > Blank document**

2. Which feature in Word allows you to automatically save changes when your document is stored on OneDrive?

- AutoRecover
- Quick Save
- AutoSave
- Background Save

**Answer: c) AutoSave**

3. To quickly convert text separated by tabs into a structured table, which command should you use?

- Insert > Table > Draw Table
- Insert > Table > Excel Spreadsheet
- Insert > Table > Convert Text to Table
- Layout > Convert > Text to Table

**Answer: c) Insert > Table > Convert Text to Table**

4. What is the primary function of the Format Painter tool in Word?

- To change the page color
- To copy formatting from one text selection to another
- To insert painterly art effects
- To adjust paragraph spacing

**Answer: b) To copy formatting from one text selection to another**

5. How do you ensure that the header on the first page of your document is different from the rest (e.g., blank)?

- Delete the header on the first page manually.
- Insert a section break after the first page.
- Check the **Different First Page** box in the Header & Footer Tools.
- Use **File > Options** to disable the first page header.

**Answer: c) Check the Different First Page box in the Header & Footer Tools.**

6. When inserting a picture, which text wrapping option places the picture within the text paragraph, causing it to move as text is edited?

- Square
- Tight
- Behind Text
- In Line with Text

**Answer: d) In Line with Text**

7. You want to start page numbering from "1" on the second page of your document. What should you set the "Start at" value to in the Page Number Format dialog?

- 1
- 0
- 2
- 1

**Answer: b) 0**

8. To create a custom watermark using your company logo, which sequence of commands do you follow?

- Design > Watermark > Custom Watermark > Picture watermark
- Insert > Picture > Set as Watermark
- Page Layout > Background > Custom Watermark
- View > Watermark > Insert Picture

**Answer: a) Design > Watermark >**

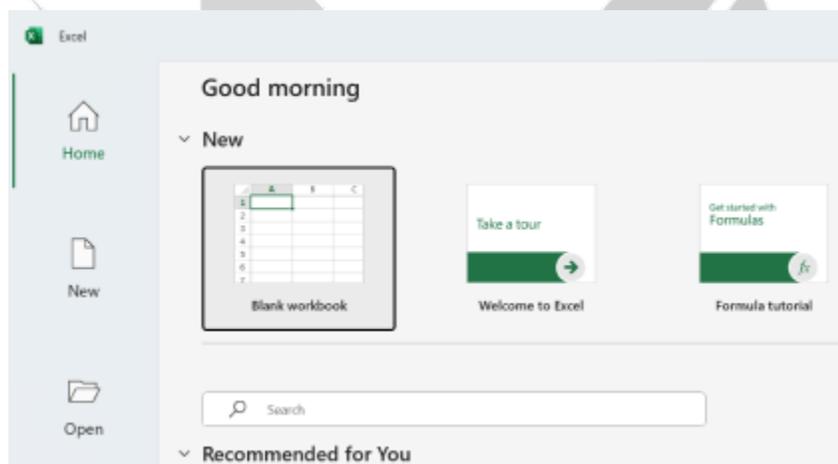
## Microsoft Excel (MS Excel)

### What is Excel?

Excel makes it easy to crunch numbers. With Excel, you can streamline data entry with AutoFill. Then, get chart recommendations based on your data, and create them with one click. Or easily spot trends and patterns with data bars, color coding, and icons.

### Create a workbook

1. Open Excel.
2. Select **Blank workbook**. Or press **Ctrl+N**.



### Enter data

To manually enter data:

1. Select an empty cell, such as A1, and then type text or a number.
2. Press **Enter** or **Tab** to move to the next cell.

To fill data in a series:

1. Enter the beginning of the series in two cells: such as Jan and Feb; or 2014 and 2015.

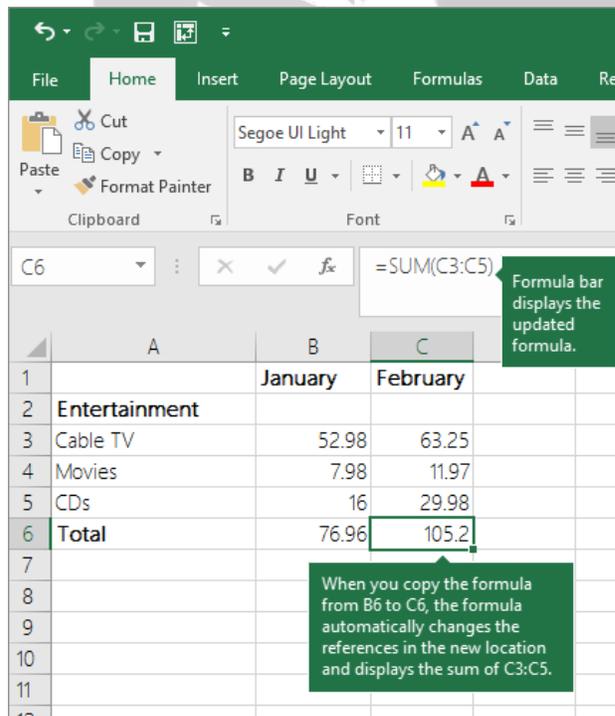
## AutoSum horizontally

1	Name	Week 1	Week 2	Total
2	Bob	\$7,894	\$6,942	=SUM(B2:C2)
3	Rishna	\$4,897	\$9,375	\$14,272
4	Sue	\$7,835	\$2,845	\$10,680
5	Mo	\$9,584	\$6,458	\$16,042
6	Total	\$30,210	\$25,620	\$40,994

## Avoid rewriting the same formula

After you create a formula, you can copy it to other cells — no need to rewrite the same formula. You can either copy the formula, or use the fill handle  to copy the formula to adjacent cells.

For example, when you copy the formula in cell B6 to C6, the formula in that cell automatically changes to update to cell references in column C.



	A	B	C
1		January	February
2	Entertainment		
3	Cable TV	52.98	63.25
4	Movies	7.98	11.97
5	CDs	16	29.98
6	Total	76.96	105.2

When you copy the formula, ensure that the cell references are correct. Cell references may change if they have relative references.

What can I use in a formula to mimic calculator keys?

Calculator key	Excel method	Description, example	Result
+ (Plus key)	+ (plus)	Use in a formula to add numbers. Example: =4+6+2	12
- (Minus key)	- (minus)	Use in a formula to subtract numbers or to signify a negative number. Example: =18-12 Example: =24*-5 (24 times negative 5)	6 -120
x (Multiply key)	* (asterisk; also called "star")	Use in a formula to multiply numbers. Example: =8*3	24
÷ (Divide key)	/ (forward slash)	Use in a formula to divide one number by another. Example: =45/5	9
% (Percent key)	% (percent)	Use in a formula with * to multiply by a percent. Example: =15%*20	3
√ (square root)	SQRT (function)	Use the SQRT function in a formula to find the square root of a number. Example: =SQRT(64)	8
1/x (reciprocal)	=1/n	Use =1/n in a formula, where <i>n</i> is the number you want to divide 1 by. Example: =1/8	0.125

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9. MS Excel

### Add a watermark in Excel

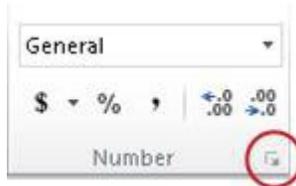
You can use an image, such as a logo, to insert as a watermark that will appear on the spreadsheet along with the displayed data.

### Create a watermark

1. Select **Insert > Header & Footer**.
2. Tap on the header and on the **Header & Footer Elements** tab on the ribbon, click **Picture**.
3. Select one of the available options to insert your image. In the header, you'll see & **[Picture]**.
4. Tap anywhere outside the header to see the watermark.

## Number formats

To see all available number formats, select the Dialog Box Launcher next to **Number** on



the **Home** tab in the **Number** group.

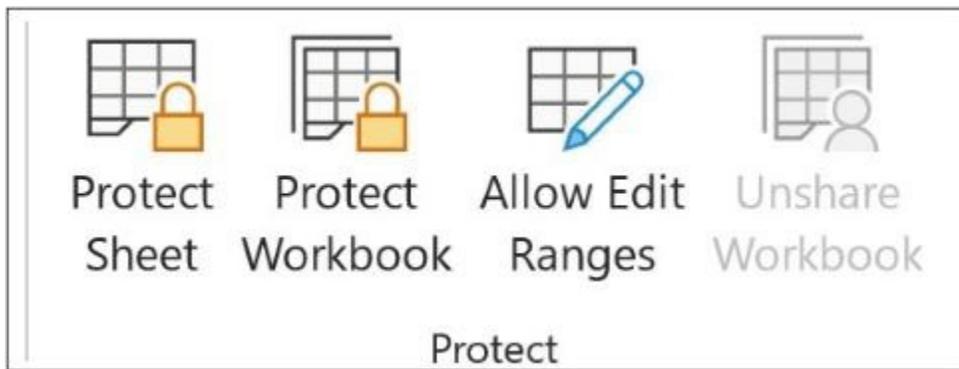
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9. MS Excel

Format	Description
General	The default number format that Excel applies when you type a number. For the most part, numbers that are formatted with the <b>General</b> format are displayed just the way you type them. However, if the cell is not wide enough to show the entire number, the <b>General</b> format rounds the numbers with decimals. The <b>General</b> number format also uses scientific (exponential) notation for large numbers (12 or more digits).
Number	Used for the general display of numbers. You can specify the number of decimal places that you want to use, whether you want to use a thousands separator, and how you want to display negative numbers.
Currency	Used for general monetary values and displays the default currency symbol with numbers. You can specify the number of decimal places that you want to use, whether you want to use a thousands separator, and how you want to display negative numbers.
Accounting	Also used for monetary values, but it aligns the currency symbols and decimal points of numbers in a column.
Date	Displays date and time serial numbers as date values, according to the type and locale (location) that you specify. Date formats that begin with an asterisk (*) respond to changes in regional date and time settings that are specified in Control Panel. Formats without an asterisk are not affected by Control Panel settings.

This unlocks all the cells on the worksheet when you protect the worksheet. Now, you can choose the cells you specifically want to lock.

5. On the worksheet, select only the cells that you want to lock.
6. Bring up the **Format Cells** popup window again (Ctrl+Shift+F).
7. This time, on the **Protection** tab, check the **Locked** box and then select **OK**.
8. On the **Review** tab, select **Protect Sheet**.



9. In the **Allow all users of this worksheet to** list, choose the elements that you want users to be able to change.

### More information about worksheet elements

Clear this check box	To prevent users from
Select locked cells	Moving the pointer to cells for which the <b>Locked</b> check box is selected on the <b>Protection</b> tab of the <b>Format Cells</b> dialog box. By default, users are allowed to select locked cells.
Select unlocked cells	Moving the pointer to cells for which the <b>Locked</b> check box is cleared on the <b>Protection</b> tab of the <b>Format Cells</b> dialog box. By default, users can select unlocked cells, and they can press the TAB key to move between the unlocked cells on a protected worksheet.



# MK PREPARATIONS



## 9. MS Excel

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	protected the worksheet, the formatting continues to change when a user enters a value that satisfies a different condition.
<b>Format columns</b>	Using any of the column formatting commands, including changing column width or hiding columns ( <b>Home &gt; Format</b> ).
<b>Format rows</b>	Using any of the row formatting commands, including changing row height or hiding rows ( <b>Home &gt; Format</b> ).
<b>Insert columns</b>	Inserting columns.
<b>Insert rows</b>	Inserting rows.
<b>Insert hyperlinks</b>	Inserting new hyperlinks, even in unlocked cells.
<b>Delete columns</b>	Deleting columns. If <b>Delete columns</b> is protected and <b>Insert columns</b> is not also protected, a user can insert columns that they cannot delete.
<b>Delete rows</b>	Deleting rows. If <b>Delete rows</b> is protected and <b>Insert rows</b> is not also protected, a user can insert rows that they cannot delete.
<b>Sort</b>	Using any commands to sort data ( <b>Data</b> tab, <b>Sort &amp; Filter</b> group). Users can't sort ranges that contain locked cells on a protected worksheet, regardless of this setting.
<b>Use AutoFilter</b>	Using the drop-down arrows to change the filter on ranges when AutoFilters are applied. Users cannot apply or remove AutoFilters on a protected worksheet, regardless of this setting.
<b>Use PivotTable reports</b>	Formatting, changing the layout, refreshing, or otherwise modifying PivotTable reports, or creating new reports.
<b>Edit objects</b>	Doing any of the following: <ul style="list-style-type: none"> <li>▪ Making changes to graphic objects including maps, embedded charts, shapes, text boxes, and controls that you did not unlock before you protected the worksheet. For example, if a worksheet has a button that runs a macro, you can click the button to run the macro, but you cannot delete the button.</li> <li>▪ Making any changes, such as formatting, to an embedded chart. The chart continues to be updated when you change its source data.</li> <li>▪ Adding or editing comments.</li> </ul>
<b>Edit scenarios</b>	Viewing scenarios that you have hidden, making changes to scenarios that you have prevented changes to, and deleting these scenarios. Users can change the values in the changing cells, if the cells are not protected, and add new scenarios.

## One Liners: MS Excel

1. Excel simplifies numerical calculations and data entry with features like AutoFill.
2. Chart recommendations based on your data can be created with a single click in Excel.
3. Trends and patterns can be easily visualized using data bars, color coding, and icons in Excel.
4. A new blank workbook is created by selecting **Blank workbook** or pressing **Ctrl+N**.
5. To enter data manually, select a cell, type, and press **Enter** or **Tab** to move to the next cell.
6. The AutoFill series is created by entering the start of the series in two cells and dragging the fill handle.
7. Excel can perform calculations using simple formulas for addition, subtraction, multiplication, and division.
8. All Excel formulas must begin with an equal sign (=).
9. The basic arithmetic operators are: plus (+) for addition, minus (-) for subtraction, asterisk (\*) for multiplication, and forward slash (/) for division.
10. There is no dedicated **SUBTRACT** function in Excel; the minus operator (-) is used within a formula.
11. The **SUM** function can incorporate negative numbers using a minus sign, e.g., =SUM(12,5,-3,8,-4).
12. The **AutoSum** feature automatically senses a contiguous range and inserts a SUM formula.
13. **AutoSum** can be applied both vertically (above/below a range) and horizontally (left/right of a range).
14. **AutoSum does not work on non-contiguous ranges** of cells.
15. The Intellisense guide for a function appears as a floating tag and provides a hyperlink to its Help topic.
16. After creating a formula, you can copy it to adjacent cells to avoid rewriting it.
17. When a formula with relative references is copied, the cell references update automatically relative to their new position.

## Practice MCQs

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- Which keyboard shortcut is used to create a new blank workbook in Excel?
  - Ctrl+B
  - Ctrl+N
  - Ctrl+W
  - Ctrl+T

**Answer: b) Ctrl+N**

- To automatically fill a series like "Jan, Feb, Mar..." what must you do first?
  - Type the entire series once.
  - Use the Fill Series dialog box.
  - Enter the beginning of the series in two cells and select them.
  - Select the cells and choose "Fill Series" from the Data tab.

**Answer: c) Enter the beginning of the series in two cells and select them.**

- What is a fundamental requirement for every Excel formula?
  - It must contain a function.
  - It must reference another cell.
  - It must begin with an equal sign (=).
  - It must be enclosed in parentheses.

**Answer: c) It must begin with an equal sign (=).**

- How does Excel handle subtraction within a formula, given there is no SUBTRACT function?
  - It uses the SUM function with negative numbers.
  - It uses the DIF function.
  - It uses the minus (-) operator.
  - Both a and c are correct.

**Answer: d) Both a and c are correct.**

- The AutoSum feature is designed to work with which type of cell ranges?
  - 3-D references
  - Non-contiguous ranges
  - Contiguous ranges
  - Array ranges

d) Array ranges

**Answer: c) Contiguous ranges**

- When you copy a formula containing a relative cell reference like =A1 to the cell one column to the right, what does it become?
  - =A1
  - =\$A\$1
  - =B1
  - =A2

a) =A1

b) =\$A\$1

c) =B1

d) =A2

**Answer: c) =B1**

- In Excel, which function is equivalent to the calculator's square root ( $\sqrt{\quad}$ ) key?
  - SQR
  - ROOT
  - SQRT
  - POWER(...,0.5)

a) SQR

b) ROOT

c) SQRT

d) POWER(...,0.5)

**Answer: c) SQRT**

- Where is a watermark picture inserted in an Excel worksheet to appear behind the data?
  - As a background from the Page Layout tab.
  - Into the header or footer via Insert > Header & Footer.
  - As an inline image on the worksheet.
  - Using the Watermark option on the Design tab.

a) As a background from the Page Layout tab.

b) Into the header or footer via Insert > Header & Footer.

c) As an inline image on the worksheet.

d) Using the Watermark option on the Design tab.

**Answer: b) Into the header or footer via Insert > Header & Footer.**

- What happens to the contents of cells B2, C2, and D2 when they are merged into one cell?
  - All contents are concatenated.
  - Only the content of the upper-left cell (B2) is kept.
  - The contents are averaged.
  - An error message appears.

a) All contents are concatenated.

b) Only the content of the upper-left cell (B2) is kept.

c) The contents are averaged.

d) An error message appears.



## Chapter 9

# Microsoft PowerPoint (MS PowerPoint)

### What is PowerPoint?

#### Overview

With PowerPoint on your PC, Mac, or mobile device, you can:

- Create presentations from scratch or a template.
- Add text, images, art, and videos.
- Select a professional design with PowerPoint Designer.
- Add transitions, animations, and cinematic motion.
- Save to OneDrive, to get to your presentations from your computer, tablet, or phone.
- Share your work and work with others, wherever they are.

#### Create a presentation in PowerPoint

Create presentations from scratch or start with a professionally designed, fully customizable template from Microsoft Create.

**Tip:** If you have Microsoft Copilot it can help you create a presentation, add slides or images, and more. To learn more see [Create a new presentation with Copilot in PowerPoint](#).

#### Create a presentation

1. Open PowerPoint.
2. In the left pane, select **New**.
3. Select an option:
  - To create a presentation from scratch, select **Blank Presentation**.
  - To use a prepared design, select one of the templates.

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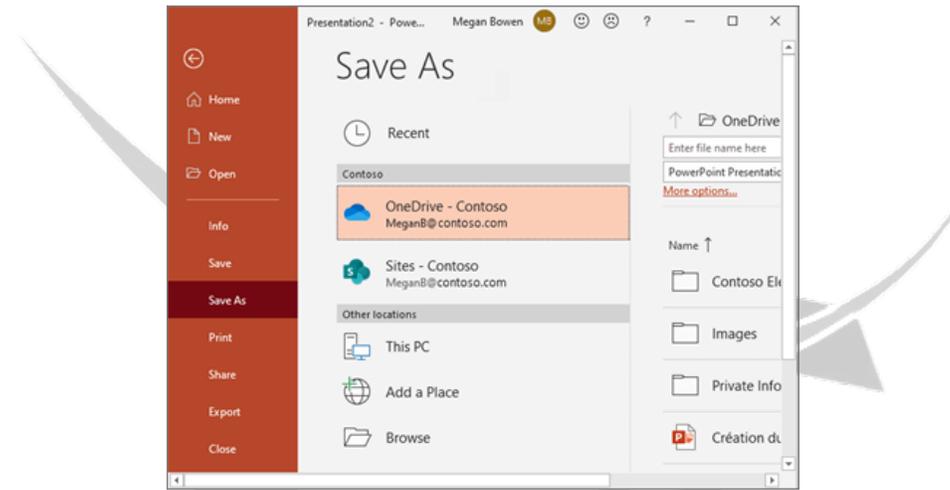
## Save in PowerPoint

### Save your presentation to OneDrive

When you save your files to the cloud, you can share and collaborate with others, and get to your files from anywhere - on your computer, tablet, or phone.

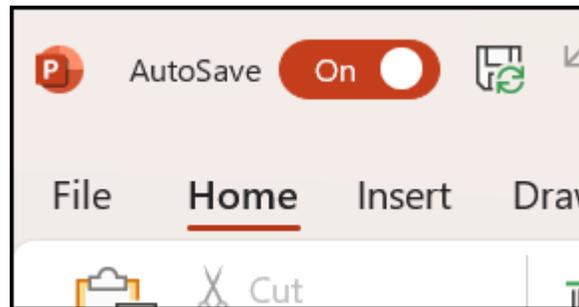
1. Select **File > Save As**.
2. Select **OneDrive**.

Save personal files to **OneDrive - Personal**, and work files to your company OneDrive. You can also save to another location, like your device.



### Offline

When you're online, AutoSave is always on and saves your changes as you work. If at any time you lose your Internet connection or turn it off, any pending changes will sync as soon as you're

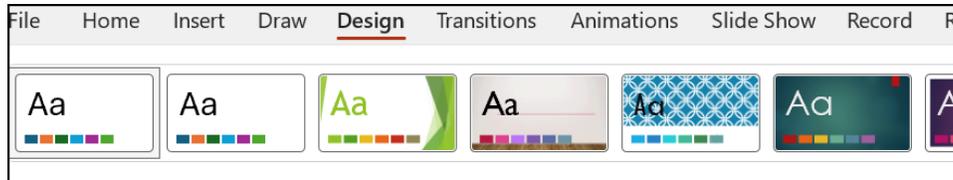


back online.



make those pre-designed themes available to you on the **Design** tab in Normal view. You can also get more [themes from templates.office.com](http://templates.office.com).

Every theme you use in your presentation includes a slide master and a related set of layouts. If you use more than one theme in your presentation, you'll have more than one slide master and multiple sets of layouts.



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## Slide Layouts

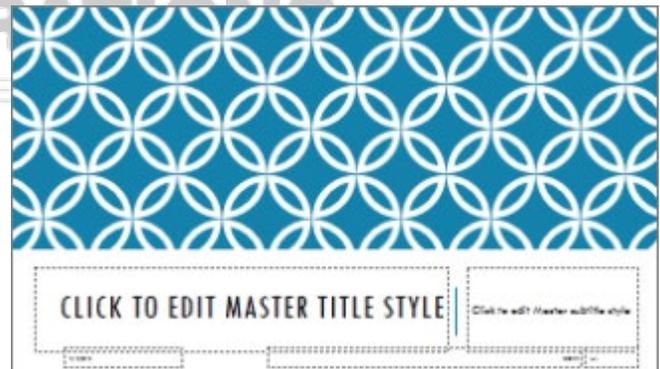
You change and manage slide layouts in Slide Master view. Every theme has a several slide layouts. You choose the layouts that best match your slide content; some are better for text and some are better for graphics.

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In Normal view, you'll apply the layouts to your slides.

Each slide layout is set up differently — with different types of placeholders in different locations on each layout.

Every slide master has a related slide layout called **Title Slide Layout**, and each theme arranges the text and other object placeholders for that layout differently, with different colors, fonts and effects. The following pictures contrast the title slide layouts for two themes: first the **Basis** theme and then the **Integral** theme.

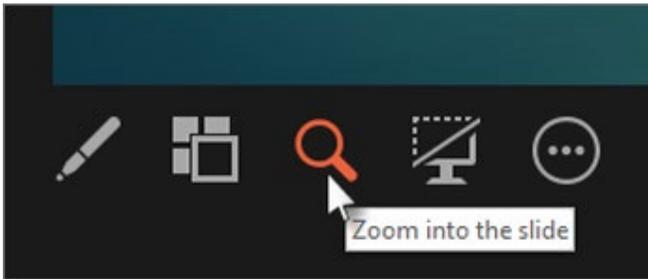


You can change anything about a layout to suit your needs. When you change a layout master and then go to Normal view, every slide you add after that time that's based on that layout will reflect the changed look of the layout. However, if there are existing slides in your presentation that are based on the prior version of the layout, you'll need to reapply the layout to those slides.

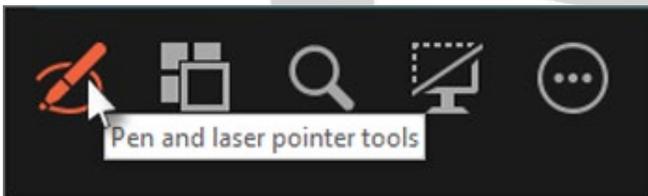
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- To view a detail in your slide up close, select **Zoom into slide**, and then point to the part you want to see.

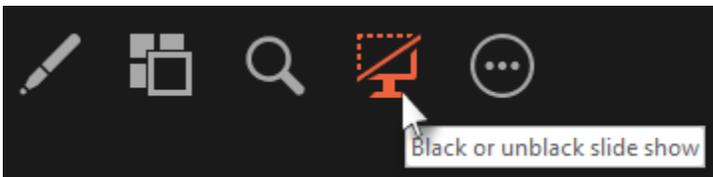


- To point to or write on your slides as you present, select **Pen and laser pointer tools**.



Press the Esc key when you want to turn off the pen, laser pointer, or highlighter.

- To hide or unhide the current slide in your presentation, select **Black or unblack slide show**.





## One Liners: MS Power Point

1. PowerPoint allows you to create presentations from scratch or from professionally designed templates.
2. With Microsoft Copilot, you can get assistance creating presentations, adding slides, images, and more.
3. To create a new presentation, open PowerPoint, select **New** in the left pane, and choose **Blank Presentation** or a template.
4. The **Take a Tour** option provides tips for using PowerPoint.
5. A new slide is added by selecting a slide in the thumbnail pane, then going to **Home > Slides > New Slide**.
6. The layout for a new slide is chosen from the **Layout** menu in the **Slides** section on the **Home** tab.
7. Text is formatted using options like **Font**, **Bold**, **Italic**, **Increase Font Size**, and **Decrease Font Size** in the **Home** tab's **Font** section.
8. Bulleted or numbered lists are created by selecting text and choosing **Bullets** or **Numbering** on the **Home** tab.
9. Pictures are inserted from the **Insert** tab, **Images** section, by selecting **Pictures** and choosing a source.
10. Illustrations such as **Shapes**, **Icons**, **3D Models**, **SmartArt**, and **Charts** are inserted from the **Illustrations** section of the **Insert** tab.
11. To save a presentation to the cloud for access and collaboration, use **File > Save As** and select **OneDrive**.
12. Save personal files to **OneDrive - Personal** and work files to your company OneDrive.
13. **AutoSave** is always on when you're online and saves changes as you work; pending changes sync when you reconnect.
14. **Themes** and their **Variants** are applied from the **Design** tab.
15. **PowerPoint Designer** suggests design ideas when you insert pictures, a list, or dates; it opens automatically.

## Practice MCQs

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- What is the primary purpose of Microsoft Copilot in PowerPoint as mentioned in the chapter?
  - To design custom animations
  - To help create presentations, add slides or images, and more
  - To automatically record narration
  - To convert presentations to video

**Answer: b) To help create presentations, add slides or images, and more**
- Where is the "Take a Tour" option located when creating a new presentation?
  - On the **Design** tab
  - In the **New** pane after selecting **Blank Presentation**
  - Under **File > Options**
  - On the **Slide Show** tab

**Answer: b) In the New pane after selecting Blank Presentation**
- To apply a professional design suggestion automatically after inserting a picture, which feature should you use?
  - Slide Master
  - Transitions
  - PowerPoint Designer
  - Animation Painter

**Answer: c) PowerPoint Designer**
- How do you access the **Presenter View** when running a slide show on a single monitor?
  - Press F5
  - Select **Slide Show > Presenter View**
  - Click the three dots (...) on the control bar in Slide Show view
  - It automatically appears if notes are

added

**Answer: c) Click the three dots (...) on the control bar in Slide Show view**

- If you want a company logo to appear on every slide in the same position, where should you place it?
  - On the first slide only
  - On the **Slide Master**
  - As a watermark from the **Design** tab
  - In the **Header & Footer** dialog

**Answer: b) On the Slide Master**
- What happens when you edit a layout master in Slide Master view?
  - Only new slides based on that layout will reflect the changes.
  - All existing slides immediately update.
  - Only the title slide changes.
  - You must manually update each slide.

**Answer: a) Only new slides based on that layout will reflect the changes.**
- Which of the following is **NOT** a standard method to delete a sequence of contiguous slides?
  - Press Shift, select the first and last slides, right-click, choose Delete Slide.
  - Press Ctrl, select each slide individually, right-click, choose Delete Slide.
  - Go to Slide Sorter view, select the slides, and press Delete.
  - The chapter does not mention using the Delete key.

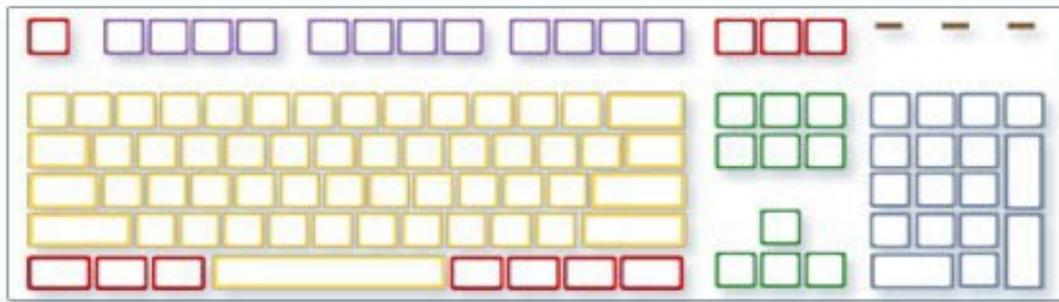
**Answer: b) Press Ctrl, select each slide individually, right-click, choose Delete Slide. (This is for non-adjacent slides)**

## Chapter 10

# Key-Board and Shortcut Keys

### What is KEYBOARD?

- A panel/plate/board of keys that operates a computer or typewriters.
- A piece of computer hardware used to input text, characters, and other commands into a computer or similar device



- |  |  |
|--|--|
|  Control keys               |  Navigation keys  |
|  Function keys              |  Numeric keypad   |
|  Typing (alphanumeric) keys |  Indicator lights |

### Types of Keys Setup on Keyboard:

#### Keyboard Shortcut keys:

1. Set of one or more keys that generates a particular command to be executed.
2. Generally executed by using **Alt** or **Ctrl** keys with some other keys
3. A **plus (+) sign** between two or more keys indicates that these keys should be pressed in combination. For example **Ctrl+Shift+A** means to press and hold **Ctrl** and **Shift** and then press **A**

## Frequently used Keys:



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## 10. Keyboard and Short Keys

Key	Function
Alt Key	<ul style="list-style-type: none"> <li>Key modifier that enables a different input</li> </ul>
Escape (esc) key	<ul style="list-style-type: none"> <li>Cancel the current operation</li> <li>Exit the currant window</li> </ul>
Space bar	<ul style="list-style-type: none"> <li>Move the curser one space forward</li> </ul>
Tab Key	<ul style="list-style-type: none"> <li>Move the cursor several space foreword</li> <li>Move to next text box on a form or on a table</li> </ul>
Control (ctrl) Key	<ul style="list-style-type: none"> <li>Modifer key</li> <li>Pressed in conjunction with another key performed a specific task</li> </ul>
Back Space Key	Move the curser one space backward
Enter Key	<ul style="list-style-type: none"> <li>Move the curser to the beginning of the next line</li> <li>In a dialogue box enable the highlighted option</li> <li>In some program start the next operation or confirm the current operation</li> </ul>

## Microsoft Power Point Shortcut Keys

Shortcut Keys	Operation
12	Save As.
Alt + F4	Close PowerPoint
Ctrl + M	Insert a new slide.
Ctrl + D	Duplicate the selected slide.
Ctrl + Shift + D	Duplicate the selected slide.
Page Up/Down	Navigate to the previous/next slide
Ctrl + G	Group objects.
Ctrl + Spacebar	Reset manual character formatting
Shift + F3	Change the case of selected text.
Alt + Q	"Tell me what you want to do".
Ctrl + T	Open the Font window.
Ctrl + K	Insert a hyperlink.
Ctrl + Tab	Switch between open presentations.
Alt + F9	Show/hide gridlines and guides
Alt + F10	Show/hide selection pane.



<b>Command + T</b>	Open a new tab in browsers.
<b>Command + L</b>	Highlight the address bar in browsers

### Famous Abbreviations:

Abbreviation	Meaning	Abbreviation	Meaning
AI	Artificial Intelligence	.exe	Executable
ASCII	American Standard Code for Information Exchange	FAX	Facsimile – Latin word meaning make similar
BINAC	Binary automatic computer	GIF	Graphic Interchange Format
BIOS	Basic input output system	GSM	Global System for Mobile Communication
CD	Compact Disk	HTTP	Hyper Text Transfer Protocol
DVD	Digital versatile Disk	HTML	Hypertext Markup Language
E-Commerce	Electronic commerce	JPEG	Joint photographic Experts Group
<b>LED</b>	<b>Light Emitting Diode</b>	<b>ROM</b>	<b>Read Only Memory</b>
MMS	Multimedia Message Service	RIP	Routing Information Protocol
MPEG	Moving Picture Experts Group	SIM	Subscriber Identification Module
PC	Personal Computer	TCP	Transmission control protocol

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10. Keyboard and Short Keys

## One Liners: Keyboard and shortcut Keys

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1. A keyboard is a panel of keys used to operate a computer or typewriter.
2. A keyboard is a piece of computer hardware used to input text, characters, and other commands.
3. Keyboard shortcut keys are a set of one or more keys that generate a particular command to be executed.
4. Shortcut keys are generally executed by using the Alt or Ctrl keys in combination with other keys.
5. A plus (+) sign between keys indicates that those keys should be pressed in combination.
6. Ctrl+Shift+A means press and hold Ctrl and Shift, then press A.
7. The Alt key is a key modifier that enables a different input.
8. The Escape (Esc) key cancels the current operation or exits the current window.
9. The Spacebar moves the cursor one space forward.
10. The Tab key moves the cursor several spaces forward or to the next text box on a form.
11. The Control (Ctrl) key is a modifier key pressed in conjunction with another key to perform a specific task.
12. The Backspace key moves the cursor one space backward.
13. The Enter key moves the cursor to the beginning of the next line.
14. The Enter key enables the highlighted option in a dialogue box.

## Practice MCQs

1. What is the primary function of a keyboard?

- a) Display visual output
- b) Input text and commands
- c) Process data
- d) Store files

**Answer: b) Input text and commands**

2. In the shortcut notation "Ctrl+Shift+A", the plus sign (+) indicates:

- a) Press keys one after the other
- b) Press keys in sequence slowly
- c) Press and hold keys in combination
- d) Press the keys only once

**Answer: c) Press and hold keys in combination**

3. Which key is used to cancel the current operation or exit a window?

- a) Tab
- b) Alt
- c) Escape (Esc)
- d) Spacebar

**Answer: c) Escape (Esc)**

4. The function of the Tab key is NOT to:

- a) Move the cursor several spaces forward
- b) Move to the next text box on a form

- c) Move the cursor one space forward
- d) Navigate within a table

**Answer: c) Move the cursor one space forward**

5. What is the role of the Ctrl key?

- a) To type uppercase letters
- b) To move the cursor backward
- c) As a modifier key pressed with another key for a task
- d) To open the Start menu

**Answer: c) As a modifier key pressed with another key for a task**

6. Pressing Shift + F10 in Windows performs which action?

- a) Opens the Run dialog
- b) Saves the document
- c) Simulates a right-click
- d) Refreshes the page

**Answer: c) Simulates a right-click**

7. In Microsoft Word, which shortcut changes text to Heading 2?

- a) Ctrl + Alt + 1
- b) Ctrl + Alt + 2
- c) Ctrl + Alt + 3
- d) Ctrl + Alt + H

**Answer: b) Ctrl + Alt + 2**

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## Chapter 11

# Data Communication and Networks

### Introduction to Data Communication

We live in an era of an electronic global village, where computers, telephones, and wireless devices are interconnected worldwide. Data communication is the electronic exchange of data between two devices via a transmission medium such as a wire cable or wireless system. It enables the transfer of information from one location to another, forming the backbone of modern connectivity, collaboration, and information sharing.

### Components of Data Communication

A data communication system consists of five fundamental components that work together to enable the transfer of information.

#### Message

The message is the information or data to be communicated. It can consist of text, numbers, pictures, sound, video, or any combination of these.

#### Sender (Transmitter/Source)

The sender is the device that originates and sends the data message. It can be a computer, workstation, telephone handset, video camera, mobile phone, or radio/TV station. The transmitter converts the message into a signal suitable for transmission over the chosen medium.

#### Receiver (Sink/Destination)

The receiver is the device that accepts the transmitted message. It can be a computer, workstation, telephone, television, printer, or fax machine. The receiver converts the received signal back into a form usable by the destination.

#### Transmission Medium (Channel)

The transmission medium is the physical path or channel through which the message travels from the sender to the receiver. It can be a **guided (wired/bounded)** medium like a cable or an **unguided (wireless/unbounded)** medium like air or space.

#### Protocol

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## Need for Standards

Standards provide common guidelines for manufacturers and vendors to ensure interoperability between different hardware and software. They define how devices identify each other, format data, and manage communication. Examples include IEEE 802 series (Ethernet, Wi-Fi), and protocols like TCP/IP.

## M K P R E P A R A T I O N S The OSI (Open Systems Interconnection) Reference Model

Developed by ISO, the OSI model is a **conceptual framework** that standardizes the functions of a telecommunication or computing system into seven distinct layers. Each layer serves the layer above it and is served by the layer below it.

Layer	Name	Function	Protocols/Devices	PDU (Protocol Data Unit)
7	Application	Provides network services directly to user applications (email, file transfer).	HTTP, FTP, SMTP, DNS, Telnet	Data/Message
6	Presentation	Translates, encrypts, and compresses data for the application layer.	SSL/TLS, JPEG, MPEG, ASCII to EBCDIC conversion	Data/Message
5	Session	Establishes, manages, and terminates connections (sessions) between applications.	NetBIOS, RPC, SIP	Data/Message



## One Liners: Data Communication and Networks

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1. Data communication is the electronic exchange of data between two devices via a transmission medium.
2. The five fundamental components of a data communication system are Message, Sender, Receiver, Transmission Medium, and Protocol.
3. A message can consist of text, numbers, pictures, sound, video, or any combination thereof.
4. The sender, or transmitter, is the device that originates and sends the data message.
5. The transmitter converts the message into a signal suitable for transmission over the chosen medium.
6. The receiver, or destination, is the device that accepts the transmitted message.
7. The receiver converts the received signal back into a form usable by the destination.
8. The transmission medium is the physical path through which the message travels from sender to receiver.
9. A protocol is a set of rules governing data communication, representing an agreement between communicating devices.
10. Protocols handle aspects like error detection, synchronization, signaling, and authentication.
11. An encoder converts digital signals into a form suitable for transmission, while a decoder converts them back.
12. The three key properties of an effective data communication system are Delivery, Accuracy, and Timeliness.
13. Delivery ensures data reaches the correct intended destination.
14. Accuracy requires that data received is identical to data sent, without alteration.
15. Timeliness for real-time data means delivery as it is produced, without significant delay or jitter.
16. Signals are electromagnetic or light waves representing data used to transfer information.
17. An analog signal is a continuous electrical wave that varies smoothly over time.
18. The key characteristics of an analog signal are Amplitude, Frequency, and Phase.

## Practice MCQs

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- Which of the following is NOT a fundamental component of a data communication system?  
a) Message  
b) Sender  
c) Router  
d) Protocol  
**Answer: c) Router**
- In data communication, what is the primary function of a protocol?  
a) To amplify the signal strength  
b) To convert analog signals to digital  
c) To govern the rules and conventions for communication  
d) To provide the physical transmission path  
**Answer: c) To govern the rules and conventions for communication**
- The property of a communication system that ensures data is delivered without alteration is called:  
a) Delivery  
b) Timeliness  
c) Accuracy  
d) Synchronization  
**Answer: c) Accuracy**
- Which characteristic of an analog signal refers to the number of cycles it completes in one second?  
a) Amplitude  
b) Wavelength  
c) Frequency  
d) Phase  
**Answer: c) Frequency**
- Unicode was developed primarily to address the limitation of ASCII in:  
a) Processing speed  
b) Representing characters from diverse world languages  
c) Error detection capabilities  
d) Signal transmission range  
**Answer: b) Representing characters from diverse world languages**
- The phenomenon where a signal loses energy and weakens as it travels over a distance is known as:  
a) Distortion  
b) Noise  
c) Attenuation  
d) Crosstalk  
**Answer: c) Attenuation**
- Which guided transmission medium operates on the principle of total internal reflection?  
a) Unshielded Twisted Pair (UTP)  
b) Coaxial Cable  
c) Shielded Twisted Pair (STP)  
d) Fiber Optic Cable  
**Answer: d) Fiber Optic Cable**
- A major disadvantage of Satellite Microwave communication is:  
a) Inability to penetrate walls  
b) High signal propagation delay  
c) Very short range  
d) Susceptibility to electromagnetic interference  
**Answer: b) High signal propagation delay**
- In which communication mode can both devices send and receive data, but not at the same time?  
a) Simplex  
b) Full-Duplex  
c) Half-Duplex



# Computational Thinking and Algorithms

## Introduction to Computational Thinking

**Computational Thinking (CT)** is a structured, problem-solving methodology that enables individuals to tackle complex problems by applying techniques and processes inspired by computer science. It is a universal skill, not limited to programming, applicable in fields such as mathematics, science, engineering, business, healthcare, and everyday life tasks like planning a trip or organizing an event. CT involves a mental framework for logical and creative problem-solving, using specific techniques to think clearly, logically, and systematically.

The primary goal is to design systematic, step-by-step solutions that can be executed by a human, a computer, or both. It prepares individuals to deconstruct complex challenges, identify patterns, focus on essentials, and design effective solutions.

## Core Components (Pillars) Of Computational Thinking

Computational thinking is built upon four fundamental, interconnected pillars.

### Decomposition

**Definition:** The process of breaking a large, complex problem into smaller, more manageable sub-problems or tasks.

**Purpose:** Makes understanding, analyzing, and solving the problem significantly easier. It simplifies the overall task and allows for focused work on individual parts.

**Examples:**

- **Everyday:** Building a birdhouse can be decomposed into: designing, gathering materials, cutting wood, assembling, painting, and installing. Preparing a meal involves steps like deciding the menu, gathering ingredients, cooking, and serving.
- **Software:** Building a mobile app is decomposed into designing the user interface, coding features (login, navigation), and implementing data storage.
- **Robotics:** Solving a maze problem for a robot can be broken down into: determining the maze size, defining start/end points, identifying allowed moves, and recognizing dead ends.

### Pattern Recognition

**Definition:** Identifying similarities, trends, or regularities within data or across different problems.

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12. Computational Thinking and Algorithms

## One Liners: Computational Thinking and Algorithm

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1. Computational Thinking is a structured problem-solving methodology inspired by computer science but applicable to all fields.
2. The four fundamental pillars of Computational Thinking are Decomposition, Pattern Recognition, Abstraction, and Algorithmic Design.
3. Decomposition is the process of breaking a large, complex problem into smaller, more manageable sub-problems.
4. Pattern Recognition involves identifying similarities, trends, or regularities within data or across different problems.
5. Abstraction is the process of filtering out irrelevant details to focus only on the essential information needed to solve a problem.
6. Algorithmic Design is the creation of a finite, precise, step-by-step sequence of instructions to solve a specific problem.
7. A core guiding principle of CT is Problem Understanding, the thorough analysis of a problem to define requirements and constraints.
8. The Problem-Solving Process involves: Identify, Define, Analyze, Plan, Test, and Select the best solution.
9. The Input-Process-Output (IPO) model is the fundamental structure for any computational solution.
10. An IPO Chart is a simple tabular tool used to visually plan a solution based on Input, Process, and Output.
11. A Simple Problem has a clear cause and straightforward solution, requiring fewer resources.
12. A Complex Problem has multiple interconnected causes, requires significant resources, and may have no guaranteed solution.
13. A Decision Problem is one where the solution is a binary "yes-or-no" (true/false) answer for a given input.
14. A Search Problem involves finding a specific item, path, or configuration that satisfies given criteria from a set of possibilities.

## Practice MCQs

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1. Which of the following is NOT one of the four core pillars of Computational Thinking?
- Decomposition
  - Pattern Recognition
  - Data Encryption
  - Algorithmic Design
- Answer: c) Data Encryption**

2. In the problem-solving process, the step that involves breaking down the problem into smaller parts to identify Facts, Input, Output, and Process is called:
- Identify the Problem
  - Define the Problem
  - Analyze the Problem
  - Plan the Solution
- Answer: c) Analyze the Problem**

3. The IPO Model in computational problem-solving stands for:
- Input, Program, Outcome
  - Instruction, Process, Output
  - Input, Process, Output
  - Initialize, Process, Operate
- Answer: c) Input, Process, Output**

4. A problem that asks, "Is this number a prime?" is best categorized as a:
- Search Problem
  - Counting Problem
  - Decision Problem
  - Optimization Problem
- Answer: c) Decision Problem**

5. If you have 5 different shirts and 4 different pairs of pants, and you want to find the total number of possible outfits (one shirt + one pant), you must apply the:
- Addition Principle

- Subtraction Principle
  - Multiplication Principle
  - Division Principle
- Answer: c) Multiplication Principle**

6. The formula  $nCr = n! / (r!(n-r)!)$  is used to calculate:
- The number of permutations of  $r$  items from  $n$
  - The number of combinations of  $r$  items from  $n$
  - The number of ways to arrange  $n$  items in a line
  - The sum of all possible selections
- Answer: b) The number of combinations of  $r$  items from  $n$**

7. The Pigeonhole Principle guarantees that if you have 15 students and only 12 lockers, then:
- Every locker will be used.
  - At least one locker will be empty.
  - At least one locker will contain more than one item.
  - The number of lockers must be increased.
- Answer: c) At least one locker will contain more than one item.**

8. Which characteristic of a good algorithm explicitly requires that it must stop after a finite number of steps?
- Definiteness
  - Finiteness
  - Feasibility
  - Generality
- Answer: b) Finiteness**

9. An algorithm that solves a problem by dividing it into independent sub-problems, solving each, and combining



## Chapter 13

# Programming Fundamentals

## The Foundations of Computing & Programming

### Introduction to Computing & Binary

**M** Computers are universal machines that process information. At their most fundamental level,  
**K** they operate on two states: ON and OFF, represented by the numbers **1** and **0**. This binary  
 foundation underpins all digital computing.

### Information Representation: The Binary System

**P** Everything a computer processes—text, images, sound, and programs—is ultimately  
**R** represented as numbers using the **binary number system**, which has a base of 2 and uses  
**E** only two digits: **0** and **1**.

- **Bit:** The smallest unit of data, short for **Binary Digit**. A single bit holds a value of either 0 or 1.
- **Byte:** A group of 8 bits. It is the standard unit for measuring data size.
- **Larger Units:** Data storage scales up using binary multiples (based on 1024, which is  $2^{10}$ ):
  - 1 Kilobyte (KB) = 1024 Bytes
  - 1 Megabyte (MB) = 1024 KB
  - 1 Gigabyte (GB) = 1024 MB
  - 1 Terabyte (TB) = 1024 GB



```
for i in range(10, 0, -2): # 10,8,6,4,2
```

```
    print(i)
```

- **Lists:** Ordered, mutable collections.

```
python
```

```
fruits = ["apple", "banana", "orange"]
```

```
fruits.append("grape") # Add item
```

```
print(len(fruits)) # Number of items
```

```
print(fruits[0]) # First item
```

- **Functions:** Defined using def.

```
python
```

```
def calculate_area(radius):
```

```
    area = 3.14159 * radius ** 2
```

```
    return area
```

## Turtle Graphics

A built-in library for creating drawings.

```
python
```

```
import turtle
```

```
turtle.forward(100)
```

```
turtle.left(90)
```

```
turtle.circle(50)
```

## Libraries and Modules

### Loops:

javascript

```
for (let i = 0; i < 5; i++) { console.log(i); } // for loop
```

```
let i = 0; while (i < 5) { console.log(i); i++; } // while loop
```

### Arrays in JavaScript

Ordered lists of elements.

javascript

```
let fruits = ["Apple", "Banana", "Orange"];
```

```
fruits.push("Grape"); // Add to end
```

```
console.log(fruits.length); // Number of elements
```

### Looping through an array:

javascript

```
for (let i = 0; i < fruits.length; i++) {
```

```
    console.log(fruits[i]);
```

```
}
```

### Functions in JavaScript

Reusable blocks of code.

javascript

```
function calculateSum(a, b) {
```

```
    return a + b;
```

```
}
```

## One Liners: Programing Fundamentals

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1. At its core, a computer processes information using two states: ON (1) and OFF (0).
2. The binary number system has a base of 2 and uses only the digits 0 and 1.
3. A Bit (Binary Digit) is the smallest unit of data, holding a value of either 0 or 1.
4. A Byte is a group of 8 bits and is the standard unit for measuring data size.
5. Data storage scales using binary multiples: 1 Kilobyte (KB) = 1024 Bytes.
6. In a binary number, the leftmost bit is the Most Significant Bit (MSB) and the rightmost is the Least Significant Bit (LSB).
7. To convert binary to decimal, use positional notation: multiply each bit by 2 raised to its position power and sum the results.
8. To convert decimal to binary, use the repeated division-by-2 method and read the remainders from the last to the first.
9. ASCII is an 8-bit code representing 128 characters, where 'a' =  $01100001_2$  ( $97_{10}$ ).
10. Unicode is an extended system capable of representing over 65,000 characters from many world languages.
11. In the RGB color model, each color component (Red, Green, Blue) is represented by an 8-bit number (0-255).
12. White in RGB is represented as (255,255,255) or  $(11111111, 11111111, 11111111)_2$ .
13. Sound is converted from analogue to digital using an Analogue-to-Digital Converter (ADC).
14. The quality of digital sound is determined by Sample Rate (samples per second) and Bit Depth (bits per sample).
15. Problem analysis involves clearly defining the problem, identifying causes, and brainstorming solutions.
16. Solution planning techniques include Abstraction, Divide and Conquer, Analogy, Brainstorming, and Research.
17. The best solution is evaluated based on Speed/Time Efficiency, Cost (resources, memory), and Complexity (number of steps).
18. An algorithm is a well-defined, step-by-step procedure that takes input, processes it, and produces an output.
19. Algorithm efficiency is measured by Time Complexity (execution speed) and Space Complexity (memory usage).
20. A flowchart is a diagrammatic representation of an algorithm using standardized symbols.
21. In a flowchart, an Oval represents the Start or End terminal.
22. In a flowchart, a Parallelogram represents an Input or Output operation.
23. In a flowchart, a Rectangle represents a Process or calculation step.
24. In a flowchart, a Diamond represents a Decision point (Yes/No, True/False).
25. Before drawing a flowchart, determine the problem's inputs, processing, decisions, and outputs.
26. A Program is a set of ordered instructions telling a computer how to perform a specific task.
27. The concept of a stored program in memory was pioneered by John von Neumann.

## Practice MCQs

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- Which of the following correctly defines the relationship between a bit and a byte?
  - A bit is a group of 8 bytes.
  - A byte is a group of 8 bits.
  - A bit represents a decimal digit, while a byte represents a binary digit.
  - A byte is always 1024 bits.

**Answer: b) A byte is a group of 8 bits.**

- In the binary number 1101, the weight of the digit '1' in the leftmost position (assuming positions start at 0 from the right) is:

- $2^0$
- $2^1$
- $2^2$
- $2^3$

**Answer: d)  $2^3$**

- Using the repeated division-by-2 method, the binary representation of the decimal number 29 is:

- 11100
- 11101
- 11011
- 10111

**Answer: b) 11101**

- In the RGB color model, the binary representation for the color Red (255, 0, 0) would be:

- (11111111, 00000000, 00000000)
- (00000000, 11111111, 00000000)
- (00000000, 00000000, 11111111)
- (11111111, 11111111, 11111111)

**Answer: a) (11111111, 00000000, 00000000)**

- When planning a software solution, the technique of creating a simplified model to focus on essential details is known as:
  - Decomposition

- Pattern Recognition
  - Abstraction
  - Algorithmic Design
- Answer: c) Abstraction**

- The primary purpose of a flowchart's diamond-shaped symbol is to represent a:

- Start or End point
- Input or Output operation
- Calculation or Process step
- Decision or Conditional branch

**Answer: d) Decision or Conditional branch**

- The von Neumann architecture is most famous for introducing the concept of:

- Binary number system
- Stored-program computers
- Graphical user interfaces
- Object-oriented programming

**Answer: b) Stored-program computers**

- A program that translates assembly language mnemonics into machine code is called a(n):

- Compiler
- Interpreter
- Assembler
- Linker

**Answer: c) Assembler**

- In programming, a construct that allows a block of code to be executed repeatedly as long as a condition remains true is a:

- Sequence
- Selection
- Loop (Repetition)
- Event

**Answer: c) Loop (Repetition)**

- In Scratch, a variable declared as "for this sprite only" has what kind of scope?



# Programming in C

## Introduction to Programming and C Language

### Computer Programs and Programming

A **computer program** is a well-defined, precise set of instructions that directs a computer to perform a specific task. The process of analyzing a problem, designing a solution, and then writing these instructions in a programming language is called **computer programming**. An individual who performs this task is a **programmer**.

### Program Syntax and Semantics

- **Syntax:** Refers to the set of grammatical rules that dictate the structure of a programming language—how symbols, keywords, and punctuation must be arranged. Violating syntax results in a compilation error.
  - *Example:* In C, `printf("Hello");` is syntactically correct, while `print("Hello")` is not.
- **Semantics:** Refers to the *meaning* or logic behind the statements—the sequence of actions the computer will execute. A program can be syntactically perfect but produce incorrect results due to semantic errors (logical errors).
  - *Example:* The statement `area = length + width;` is syntactically valid but semantically incorrect for calculating the area of a rectangle.

### Evolution and History of C

The C programming language was developed by **Dennis Ritchie** at AT&T Bell Laboratories in **1972**. It evolved from the **B** language (created by Ken Thompson) and was originally designed for implementing the UNIX operating system. Due to its power, efficiency, and flexibility, C quickly became popular for system and application programming. The language was later standardized by the **American National Standards Institute (ANSI)**, leading to **ANSI C**. C is a high-level, structured, procedural language that provides a unique balance between high-level functionality and low-level access to machine hardware.

### Categories of Programming Languages

#### Low-Level Languages

These languages are closely tied to the computer's hardware architecture.

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### Constants

A **constant** is a quantity whose value does not change during program execution.

- **Literal Constants:** Values typed directly into the code.
  - *Integer:* 100
  - *Floating-point:* 3.14159
  - *Character:* 'A'
  - *String:* "Hello"
- **Defined Constants (Macros):** Created using the `#define` preprocessor directive.
  - `#define MAX 100`
- **Constant Qualifier (const):** Uses the `const` keyword to declare a named constant variable.
  - `const float PI = 3.14159;`

### Fundamental Data Types

Data types define the type of data a variable can hold, the amount of memory it occupies, and the operations that can be performed on it.

Data Type	Keyword	Typical Size	Description & Range (Typical)
<b>Integer</b>	<code>int</code>	2 or 4 bytes	Whole numbers. e.g., -32,768 to 32,767 (2-byte) or ~-2.1 billion to ~2.1 billion (4-byte).
Long Integer	<code>long</code>	4 bytes	Larger whole numbers. e.g., -2,147,483,648 to 2,147,483,647.
<b>Floating-point</b>	<code>float</code>	4 bytes	Single-precision real numbers (6-7 decimal digits). e.g., 3.4e-38 to 3.4e+38.



An if or if-else statement placed inside another if, else, or else-if block. Used for making decisions within decisions.

c

```

if (marks >= 50) {
    if (marks >= 80) {
        printf("Grade: A");
    } else {
        printf("Grade: B");
    }
} else {
    printf("Grade: F");
}

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### The if-else if Ladder

A clean way to handle multiple, mutually exclusive conditions. Conditions are checked from top to bottom. Once a true condition is found, its block is executed, and the rest of the ladder is skipped.

c

```

if (condition1) {
    // Statements 1
} else if (condition2) {
    // Statements 2
} else if (condition3) {
    // Statements 3
} else {

```





```
fprintf(fp, "Bob 30\n");
```

```
fclose(fp);
```

```
// READING from the same file
```

```
fp = fopen("records.txt", "r");
```

```
if (fp == NULL) {
```

```
    printf("File open error for read.\n");
```

```
    exit(1);
```

```
}
```

```
printf("Contents of file:\n");
```

```
while (fscanf(fp, "%s %d", name, &age) != EOF) {
```

```
    printf("Name: %s, Age: %d\n", name, age);
```

```
}
```

```
fclose(fp);
```

```
return 0;
```

```
}
```





## One Liners: Programming in C

1. A computer program is a well-defined, precise set of instructions directing a computer to perform a specific task.
2. Programming is the process of analyzing a problem, designing a solution, and writing instructions in a programming language.
3. Syntax refers to the grammatical rules of a programming language; violating it causes a compilation error.
4. Semantics refers to the meaning or logic behind statements; semantic errors cause incorrect results despite correct syntax.
5. The C programming language was developed by Dennis Ritchie at AT&T Bell Laboratories in 1972.
6. C evolved from the B language and was designed for implementing the UNIX operating system.
7. ANSI C is the standardized version of C established by the American National Standards Institute.
8. Machine Language (1GL) is the computer's native language of binary digits (0s and 1s) executed directly by the CPU.
9. Assembly Language (2GL) uses symbolic codes called mnemonics and requires an assembler for translation into machine code.
10. High-Level Languages (HLL) use human-readable syntax, are machine-independent, and easier to learn and debug.
11. Procedural Languages (3GL) design programs as a sequence of procedures or functions operating on data; C is an example.
12. Structured Languages emphasize breaking programs into logical blocks using control structures like loops and conditionals.
13. Object-Oriented Programming (OOP) languages build programs using objects that encapsulate data and functions.

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14. Programming in C



## Practice MCQs

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1. Which of the following best describes the primary difference between syntax and semantics in programming?
  - a) Syntax deals with the meaning of code, while semantics deals with its structure.
  - b) Syntax deals with the grammatical rules, while semantics deals with the logical meaning.
  - c) Syntax errors occur during runtime, while semantic errors are caught during compilation.
  - d) Both syntax and semantics refer to the visual layout of the code.

**Answer: b) Syntax deals with the grammatical rules, while semantics deals with the logical meaning.**
2. Dennis Ritchie developed the C programming language primarily for which purpose?
  - a) Creating graphical user interfaces for Windows.
  - b) Implementing the UNIX operating system.
  - c) Developing web applications and server-side scripts.
  - d) Writing machine learning algorithms.

**Answer: b) Implementing the UNIX operating system.**

3. A language that uses mnemonics like ADD and MOV and requires an assembler for translation is classified as:
  - a) Machine Language (1GL)
  - b) Assembly Language (2GL)
  - c) High-Level Language (3GL)
  - d) Object-Oriented Language (4GL)

**Answer: b) Assembly Language (2GL)**
4. Which characteristic is NOT true of High-Level Languages (HLL)?
  - a) They are machine-independent and portable.
  - b) They require deep knowledge of the computer's internal architecture.
  - c) They are easier to learn, write, debug, and maintain than low-level languages.
  - d) They support structured and modular programming.

**Answer: b) They require deep knowledge of the computer's internal architecture.**

5. In the C program development life cycle, the step where the linker combines object files with library files to create an



## Chapter 15

# Object Oriented Programming in C++

## The Programming Environment

- **Computer Program:** A set of instructions written in a programming language to perform a specified task for a computer. It dictates what to do and in which order.
- **Software Development Life Cycle (SDLC):** A structured process for developing software, consisting of phases like Planning, Analysis, Design, Implementation, and Testing/Maintenance. Its objectives are to ensure quality, manage cost and time, and deliver a system that meets user requirements.

## Introduction to C++

- **History:** C++ was developed by Bjarne Stroustrup at Bell Labs in the early 1980s. It is a superset of the C language, adding object-oriented programming features like classes, inheritance, and operator overloading from languages like Simula and Algol.
- **Importance:** It supports both high-level and low-level programming, making it powerful for system-level coding and application development.

## Basic Structure of a C++ Program

A typical C++ program has three main components:

### 1. Preprocessor Directives:

- Instructions processed before compilation, starting with #.
- `#include <header_file.h>`: Inserts the contents of a header file (e.g., `iostream.h`, `conio.h`, `math.h`).
- `#define identifier value`: Defines symbolic constants (macros). No semicolon is used.

cpp

```
#define PI 3.14159
```

```
#define NEWLINE '\n'
```

### 2. The `main()` Function:

- The mandatory entry point where program execution begins. The function header is `int main()`.

### 3. The Body of `main()` Function:

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15. Object Oriented Programming in C++

## One Liners: Object Oriented Programming in C++

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1. Object-Oriented Programming (OOP) bundles data (attributes) and functions (methods) into single units called classes, modeling real-world objects.
2. A class is a user-defined blueprint or template that defines properties (data members) and behaviors (member functions).
3. An object is an instance of a class; memory is allocated when an object is created.
4. Access specifiers in C++ are private, public, and protected.
5. The private access specifier (default) allows access only from within other member functions of the same class or from friend functions.
6. The public access specifier allows members to be accessible from anywhere in the program where the object is visible.
7. The protected access specifier is similar to private but also accessible in derived (child) classes.
8. Data hiding is implemented using the private access specifier.
9. Class members are accessed using the dot operator (.) with the object name.
10. A constructor is a special member function automatically called when an object is created; it has the same name as the class and no return type.
11. A default constructor takes no arguments; it is provided by the compiler if no constructor is defined.
12. A parameterized constructor takes arguments to initialize an object with specific values.
13. Constructor overloading allows multiple constructors with different parameter lists in the same class.
14. A destructor is a special member function automatically called when an object is destroyed; its name is the class name preceded by a tilde (~).
15. Destructors take no arguments, have no return type, and are used for cleanup tasks like releasing memory.
16. Inheritance is a mechanism where a new class (derived/child class) is created from an existing class (base/parent class), inheriting its properties and behaviors.
17. Inheritance promotes code reusability.
18. Multiple inheritance allows a class to inherit from more than one base class.
19. Polymorphism is the ability to present the same interface for different underlying data types, meaning "many forms."
20. Examples of polymorphism include the + operator adding integers, floats, or concatenating strings.
21. Polymorphism is achieved through function overloading, operator overloading, and virtual functions.
22. Classes are defined using the keyword `class`, followed by the class name and a body enclosed in braces, and must end with a semicolon.
23. Objects are created by declaring them with the class name, e.g., `ClassName obj1, obj2;`
24. Private members of a class cannot be accessed directly from outside the class using the dot operator.
25. The public interface of a class allows interaction with the object from external code.

## Practice MCQs

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**1. What is the primary purpose of a constructor in a C++ class?**

- A) To delete the object
- B) To initialize the object's data members
- C) To perform cleanup operations
- D) To allocate memory for the class definition

**Answer: B) To initialize the object's data members**

**2. Which access specifier allows class members to be accessible only from within the same class?**

- A) public
- B) protected
- C) private
- D) friend

**Answer: C) private**

**3. In OOP, what is an 'object'?**

- A) A blueprint for creating classes
- B) An instance of a class
- C) A special type of function
- D) A memory address

**Answer: B) An instance of a class**

**4. What does the 'protected' access specifier provide that 'private' does not?**

- A) Access from anywhere in the program
- B) Access from derived classes
- C) Access from friend functions only
- D) No difference

**Answer: B) Access from derived classes**

**5. Which of the following is automatically called when an object is destroyed?**

- A) Constructor
- B) Destructor
- C) Inline function

D) Friend function

**Answer: B) Destructor**

**6. What is the term for creating multiple functions with the same name but different parameters?**

- A) Overriding
- B) Polymorphism
- C) Overloading
- D) Inheritance

**Answer: C) Overloading**

**7. Which concept allows a class to acquire the properties and behaviors of another class?**

- A) Encapsulation
- B) Polymorphism
- C) Inheritance
- D) Abstraction

**Answer: C) Inheritance**

**8. What is the default access specifier for members of a C++ class if none is specified?**

- A) public
- B) protected
- C) private
- D) friend

**Answer: C) private**

**9. How is a destructor declared in a C++ class?**

- A) Same name as the class with a ~ prefix
- B) Same name as the class with a ! prefix
- C) Name must be 'destroy'
- D) It cannot be declared explicitly

**Answer: A) Same name as the class with a ~ prefix**

**10. Which operator is used to access members of an object directly?**



# Web Development with HTML, CSS, and Java Script

## Introduction to the World Wide Web and Web Development

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The **World Wide Web (WWW, W3, or Web)** is a graphical information system on the Internet, introduced to the public on August 6, 1991, by **Tim Berners-Lee**. It allows documents to be connected via hypertext links, enabling users to search for information by moving from one document to another. It is crucial to distinguish the Web from the Internet: the **Internet** is the global network connecting computers, while the **Web** is the collection of interconnected documents (web pages) accessed via browsers.

**Web Development** is the process of creating websites and web applications. It involves using programming languages and tools to design, build, and maintain websites.

### Why Learn Web Development?

- **Digital Literacy:** Understand how websites are built and how the Internet works.
- **Career Opportunities:** Opens diverse job prospects in the IT industry (e.g., web developer, designer).
- **Problem-Solving:** Enhances logical thinking and troubleshooting skills.
- **Creativity:** Allows the creation of visually appealing and interactive websites.
- **Entrepreneurship:** Enables starting online businesses or creating web services.

- **width & height:** Specify image dimensions in pixels.
- **border:** Sets border width (deprecated; use CSS instead).

## Lists

**M** Used to group related information.

**K** • **Unordered List (<ul>):** Creates a bulleted list. Each item uses <li>.

html

**P** <ul>  
**R** <li>Item 1</li>  
**E** <li>Item 2</li>  
**P** </ul>

**A** • **Ordered List (<ol>):** Creates a numbered list. Each item uses <li>.

**R** • **Definition List (<dl>):** Creates a list of terms and definitions.

html

**T** <dl>  
**I** <dt>Term</dt>  
**O** <dd>Definition of the term.</dd>  
**N** </dl>

- **Nested List:** A list inside another list (e.g., an unordered list inside an ordered list item).

## Tables (<table>)

Display data in rows and columns.

```
.box:hover {
    background-color: yellow;
    width: 200px;
}
```

**M** • **Animations:** Define complex sequences of changes using `@keyframes`.  
**K** css

```
@keyframes example {
    from {background-color: red;}
    to {background-color: yellow;}
}
.animated-box {
    animation-name: example;
    animation-duration: 4s;
    animation-iteration-count: infinite;
}
```

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## Introduction to JavaScript

**JavaScript** is a programming language that makes web pages interactive and dynamic (e.g., animations, form validation, games). It was created by **Brendan Eich** in 1995.

## Basic Syntax and Inclusion

JavaScript code is placed within `<script>` tags, either in the `<head>` or `<body>`.

html

## One Liners: Web Development with HTML, CSS and Java script

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1. The World Wide Web (WWW) is a graphical information system on the Internet, introduced publicly on August 6, 1991, by Tim Berners-Lee.
2. The Internet is the global network connecting computers, while the Web is the collection of interconnected documents accessed via browsers.
3. Web Development is the process of creating websites and web applications using programming languages and tools.
4. Learning web development enhances digital literacy by explaining how websites are built and how the Internet works.
5. Career opportunities in web development include roles like web developer, designer, and other IT industry positions.
6. Web development improves problem-solving skills through logical thinking and troubleshooting.
7. It allows creativity by enabling the creation of visually appealing and interactive websites.
8. Web development skills support entrepreneurship by allowing the start of online businesses or web services.
9. A Web Page is a document written in HTML, viewed in a browser, and identified by a unique URL.
10. A Website is a collection of related web pages hosted on a web server and accessible via a unique address.
11. A Web Browser is software used to retrieve and display information from websites (e.g., Chrome, Firefox, Edge).
12. A Web Server is a computer that stores, processes, and delivers web pages using HTTP.
13. Any computer can become a web server by installing server software.
14. URL (Uniform Resource Locator) is the unique address for a file on the Internet, following the format: protocol://hostname/other\_information.
15. A Search Engine is a website that helps users find information by searching keywords (e.g., Google, Yahoo!).
16. The Home Page is the main or index page of a website, opening first when the site is accessed.
17. Web Hosting is the service of storing website content on a server connected to the Internet, making it accessible worldwide.
18. Web Portals are comprehensive websites offering multiple services (e.g., email, news) and often require login.
19. News Websites provide the latest news, updates, and often include videos and archives.
20. Informational Websites provide detailed information on various topics (e.g., Wikipedia).
21. Educational Websites are created for learning, offering tutorials, courses, and organized educational content.
22. Personal Websites are created by individuals for expression, portfolio, or social networking.
23. Business Websites facilitate business activities like e-commerce, banking, and reservations.
24. Entertainment Websites focus on media, games, and recreational content.

## Practice MCQs

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**1. Who introduced the World Wide Web to the public on August 6, 1991?**

- A) Brendan Eich
- B) Tim Berners-Lee
- C) Bill Gates
- D) Steve Jobs

**Answer: B) Tim Berners-Lee**

**2. What is the primary difference between the Internet and the Web?**

- A) The Internet is for emails, the Web is for browsing
- B) The Internet is the global network, the Web is the collection of interconnected documents
- C) The Internet uses HTTP, the Web uses FTP
- D) There is no difference

**Answer: B) The Internet is the global network, the Web is the collection of interconnected documents**

**3. Which of the following is NOT a reason to learn web development according to the chapter?**

- A) Digital Literacy
- B) Career Opportunities
- C) Hardware Repair Skills
- D) Creativity

**Answer: C) Hardware Repair Skills**

**4. What does URL stand for?**

- A) Uniform Resource Locator
- B) Universal Reference Link
- C) Unified Resource Locator
- D) Uniform Retrieval Link

**Answer: A) Uniform Resource Locator**

**5. Which type of website typically requires a user login and offers multiple services like email and news?**

- A) News Website
- B) Web Portal
- C) Personal Website
- D) Entertainment Website

**Answer: B) Web Portal**

**6. Which of the following is a back-end development language?**

- A) HTML
- B) CSS
- C) JavaScript
- D) PHP

**Answer: D) PHP**

**7. What does a full-stack developer handle?**

- A) Only front-end development
- B) Only back-end development
- C) Both front-end and back-end development
- D) Only database management

**Answer: C) Both front-end and back-end development**

**8. Which version of HTML introduced tags for tables, scripts, and applets?**

- A) HTML 1.0
- B) HTML 2.0
- C) HTML 3.2
- D) HTML5

**Answer: C) HTML 3.2**

**9. What is the correct file extension for an HTML document?**

- A) .txt
- B) .htm
- C) .html
- D) .web

**Answer: C) .html**



## Chapter 17

# Data Base and Data Management (DBMS)

## Data and Database Fundamentals

### Data, Information, and Knowledge

**Data** consists of raw facts and figures, such as numbers, words, measurements, observations, images, or sounds (e.g., daily temperature readings, list of student names and marks). **Information** is processed, organized, or structured data presented in a meaningful context (e.g., a weather forecast, student percentage and grade). Information is derived from data and is useful for decision-making. **Knowledge** is the actionable insight gained from understanding patterns in information. Data becomes information through processing, and information becomes knowledge through analysis and interpretation.

Aspect	Data	Information
Nature	Raw, unprocessed facts	Processed, organized, meaningful data
Role in System	Input to a computer system	Output of data processing
Usefulness	May not be meaningful on its own	Useful, valuable, supports decisions
Reproducibility	Difficult to reproduce if lost	Easier to reproduce (e.g., recalculated)
Dependence	An independent entity	Depends on data

### The Need for Databases: Evolution from File Systems

Before databases, **File Management Systems (FMS)** were used. Data was stored in independent files, each a collection of records made up of fields. This approach led to significant problems:

- **Data Redundancy:** The same data duplicated across multiple files.

## Practice MCQs

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**1. What is the primary difference between data and information?**

- A) Data is processed; information is raw
- B) Data is meaningful on its own; information requires context
- C) Data is raw facts; information is processed data in context
- D) Data is output; information is input

**Answer: C) Data is raw facts; information is processed data in context**

**2. Which of the following was a major problem with File Management Systems (FMS)?**

- A) Program-Data Independence
- B) Controlled Data Redundancy
- C) Data Inconsistency
- D) Enhanced Security

**Answer: C) Data Inconsistency**

**3. What is the key principle that data in a database is independent of the application programs called?**

- A) Data Redundancy
- B) Program-Data Dependence
- C) Data Isolation
- D) Program-Data Independence

**Answer: D) Program-Data Independence**

**4. Which database model allows a child record to have more than one parent?**

- A) Hierarchical Model
- B) Network Model
- C) Relational Model
- D) Object-Oriented Model

**Answer: B) Network Model**

**5. In the relational model, what is a two-dimensional structure of rows and columns called?**

- A) Attribute
- B) Tuple
- C) Relation/Table
- D) Key

**Answer: C) Relation/Table**

**6. Which property of a relation states that each row must be unique?**

- A) Column Atomicity
- B) Order Insignificance
- C) No Duplicate Rows
- D) NULL Allowed

**Answer: C) No Duplicate Rows**

**7. What is a set of one or more attributes that can uniquely identify all other attributes in a relation called?**

- A) Candidate Key
- B) Super Key
- C) Primary Key
- D) Foreign Key

**Answer: B) Super Key**

**8. Which key must be unique and cannot contain NULL values?**

- A) Foreign Key
- B) Alternate Key
- C) Secondary Key
- D) Primary Key

**Answer: D) Primary Key**

**9. What does a Foreign Key (FK) enforce between tables?**

- A) Entity Integrity
- B) Referential Integrity
- C) Column Atomicity
- D) Data Redundancy

**Answer: B) Referential Integrity**

**10. In an ER diagram, what does a diamond represent?**



## Chapter 18

# System Development, Troubleshooting and Maintenance

## Introduction

Systems are created to solve problems. Modern systems are often large and complex, requiring collaboration between teams of architects, analysts, programmers, testers, and users to produce the software that drives organizations. To manage this complexity and ensure structured, high-quality outcomes, a systematic process is essential. This process is known as the System Development Life Cycle (SDLC). This unit focuses on the SDLC, explaining its importance, objectives, key participants (stakeholders), and the logical phases followed to develop a software product from conception to maintenance.

## What is a System?

The term "system" originates from the Greek word "*systema*," meaning to "place together." A system can be defined as a set of interrelated components with a clearly defined boundary that work together to achieve a common set of objectives. When these components are methods, procedures, and routines applied in a proper sequence to build software, it is called a software system.

## System Development Life Cycle (SDLC) and Its Importance

The **System Development Life Cycle (SDLC)** is a conceptual model and a structured, stepwise process used in project management to guide the development of an information system. It encompasses all stages from an initial feasibility study through to the maintenance of the completed application. It is also known as information system development or application development.

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18. System Development Troubleshooting Maintenance



## One Liners: System Development Troubleshooting and Maintenance

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1. System troubleshooting is a systematic process to identify problems and find quick solutions to prevent costly downtime and system damage.
  2. The primary goal of troubleshooting is to maintain system reliability, security, and efficiency without always relying on professional help.
  3. The first step in the systematic troubleshooting process is to identify and clearly define what is not working as expected.
  4. After identifying the problem, the troubleshooter must establish a theory of probable cause based on the observed symptoms.
  5. Testing the theory to determine the cause involves performing specific checks to confirm or rule out the suspected issue.
  6. Once the cause is confirmed, the next step is to establish a detailed plan of action to resolve the problem.
  7. The implementation phase involves carrying out the planned actions to fix the identified issue.
  8. After implementing the solution, it is critical to verify full system functionality to ensure the problem is resolved.
  9. Documenting findings, actions, and outcomes creates a valuable knowledge base for future reference.
  10. Troubleshooting is crucial for preventing downtime, which can lead to lost productivity and revenue for businesses.
  11. Ensuring data integrity is a key reason for troubleshooting, as it helps identify and fix problems that could corrupt information.
  12. Effective troubleshooting can reveal security vulnerabilities and breaches, allowing for swift protective action.
  13. Troubleshooting enhances system performance by identifying causes of slowdowns, such as insufficient RAM or software conflicts.
  14. Regular troubleshooting and fixing small issues early can extend equipment life by preventing major failures.
  15. Mastering troubleshooting saves costs by reducing the need for expensive emergency repairs and prolonged downtime.
  16. A reliable, well-performing system resulting from good troubleshooting enhances the overall user experience.
  17. For an application freezing, a common solution is to use Task Manager (Ctrl+Alt+Delete) to end the unresponsive task.
  18. If an application freezing persists, reinstalling the application or checking for updates is recommended.
  19. For unresponsive peripherals, the first steps are to check physical connections and unplug/replug the device.

## Practice MCQs

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1. **What is the primary goal of system troubleshooting?**

- a) To increase software licensing costs
- b) To maintain system reliability, security, and efficiency
- c) To replace all hardware components periodically
- d) To reduce the need for user training

**Answer: b) To maintain system reliability, security, and efficiency**

2. **Which of the following is the FIRST step in the systematic troubleshooting process?**

- a) Test the theory
- b) Establish a plan of action
- c) Identify the problem
- d) Document findings

**Answer: c) Identify the problem**

3. **A laptop does not turn on. According to troubleshooting steps, what should you do immediately after identifying this problem?**

- a) Replace the motherboard
- b) Establish a theory of probable cause (e.g., dead battery)
- c) Immediately document the failure
- d) Reinstall the operating system

**Answer: b) Establish a theory of probable cause (e.g., dead battery)**

4. **Why is documenting the troubleshooting process considered important?**

- a) It increases the complexity of the solution
- b) It creates a bill for the client
- c) It creates a valuable knowledge base for future reference
- d) It is only required for auditing

purposes

**Answer: c) It creates a valuable knowledge base for future reference**

5. **Which troubleshooting benefit directly relates to minimizing financial loss for a business?**

- a) Extending equipment life
- b) Preventing downtime
- c) Enhancing user experience
- d) Improving security

**Answer: b) Preventing downtime**

6. **An application becomes unresponsive. What is the most common immediate software-based solution?**

- a) Reformat the hard drive
- b) Use Task Manager to end the task
- c) Restart the web server
- d) Update the BIOS

**Answer: b) Use Task Manager to end the task**

7. **For an unresponsive external mouse, which sequence of actions is most appropriate initially?**

- a) Update the OS, then replace the mouse
- b) Check physical connections, then unplug and replug
- c) Reinstall all device drivers, then restart
- d) Scan for viruses, then check the power supply

**Answer: b) Check physical connections, then unplug and replug**

8. **What is the primary technical reason restarting a computer often resolves software issues?**

- a) It upgrades the hardware firmware
- b) It clears memory and stops conflicting processes



# Emerging and Contemporary Technologies

## Introduction to Emerging Technologies

### Definition and Characteristics

An Emerging Technology is a new technology or a significant advancement in an existing one, capable of bringing about profound technical, institutional, and social changes. These technologies are poised to replace current systems in the near future and will be integrated into every field, from education and IT to medicine, transportation, and communication. They are distinguished by key characteristics:

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- **Innovation:** Introduces novel ideas and methods.
- **Fast Growth:** Develops and scales rapidly.
- **Consistency:** Provides reliable and repeatable performance.
- **Prominent Impact:** Creates significant changes in how tasks are performed and problems are solved.
- **Interdisciplinary Nature:** Combines knowledge and methods from multiple fields like computer science, engineering, and biology.
- **Convergence:** Merges different technologies to create new, synergistic capabilities.

### Detailed Exploration of Emerging Technologies

#### Artificial Intelligence (AI) and Machine Learning (ML)

**Artificial Intelligence (AI)** is a broad field of computer science focused on building intelligent machines and software capable of performing tasks that typically require human-like intelligence, such as reasoning, learning, problem-solving, and decision-making. The term was coined by John McCarthy in 1956. Key subfields include:

- **Machine Learning (ML):** A subset of AI that gives computers the ability to learn from data and experience without being explicitly programmed. ML algorithms build models by identifying patterns in large datasets.
  - **Supervised Learning:** The algorithm learns from a labeled dataset where the correct output is known, used for making predictions on new data (e.g., predicting prices).
  - **Unsupervised Learning:** The algorithm finds hidden patterns or intrinsic structures in unlabeled data, often through clustering (e.g., grouping customers).

## One Liners: Emerging and Contemporary Technologies

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1. An Emerging Technology is a new technology or a significant advancement in an existing one, capable of bringing profound technical, institutional, and social changes.
  2. Emerging technologies are poised to replace current systems in the near future and will be integrated into every field.
  3. Key characteristics of emerging technologies include Innovation, Fast Growth, Consistency, Prominent Impact, Interdisciplinary Nature, and Convergence.
  4. The Interdisciplinary Nature of emerging technologies combines knowledge from fields like computer science, engineering, and biology.
  5. Convergence refers to the merging of different technologies to create new, synergistic capabilities.
  6. Artificial Intelligence (AI) is a broad field of computer science focused on building intelligent machines capable of human-like tasks such as reasoning, learning, and decision-making.
  7. The term "Artificial Intelligence" was coined by John McCarthy in 1956.
  8. Machine Learning (ML) is a subset of AI that gives computers the ability to learn from data and experience without being explicitly programmed.
  9. Supervised Learning involves algorithms learning from labeled datasets where the correct output is known, used for making predictions.
  10. Unsupervised Learning involves algorithms finding hidden patterns in unlabeled data, often through clustering.
  11. Deep Learning (DL) is a specialized subset of ML that uses Neural Networks with many hidden layers.
  12. A Neural Network is inspired by the human brain and consists of interconnected nodes (neurons).
  13. The layers of a Neural Network are Input Layer, Hidden Layers, and Output Layer.
  14. Weights in a neural network represent the importance of connections between neurons.
  15. Biases are threshold adjusters in neural networks that help the model fit the data better.
  16. Activation Functions in neural networks determine whether a neuron should be activated.
  17. Loss Functions measure the difference between the predicted output and the actual target.
  18. Training a neural network involves Feedforward Propagation and Backpropagation to minimize error.
  19. Deep Learning excels at autonomously extracting complex patterns from vast amounts of unstructured data like images and text.
  20. The hierarchical relationship is:  $AI \supset ML \supset \text{Neural Networks} \supset \text{Deep Learning}$ .
  21. Natural Language Processing (NLP) enables computers to understand, interpret, and generate human language.
  22. NLP applications include language translation, spam filtering, sentiment analysis, chatbots, and voice assistants.
  23. Speech Recognition converts spoken words into text or commands (e.g., dictation software, Siri).

## Practice MCQs

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**1. Which of the following is NOT a characteristic of an emerging technology?**

- A) Innovation
- B) Slow and steady growth
- C) Interdisciplinary nature
- D) Prominent impact

**Answer: B) Slow and steady growth**

**2. Who coined the term "Artificial Intelligence"?**

- A) Alan Turing
- B) John McCarthy
- C) Marvin Minsky
- D) Claude Shannon

**Answer: B) John McCarthy**

**3. Which subset of AI gives computers the ability to learn from data without explicit programming?**

- A) Natural Language Processing
- B) Machine Learning
- C) Computer Vision
- D) Expert Systems

**Answer: B) Machine Learning**

**4. In machine learning, which type involves algorithms learning from labeled datasets?**

- A) Unsupervised Learning
- B) Reinforcement Learning
- C) Supervised Learning
- D) Deep Learning

**Answer: C) Supervised Learning**

**5. What is the hierarchical relationship between AI, ML, Neural Networks, and Deep Learning?**

- A) AI  $\supset$  Neural Networks  $\supset$  ML  $\supset$  Deep Learning
- B) AI  $\supset$  ML  $\supset$  Neural Networks  $\supset$  Deep Learning

Learning

C) ML  $\supset$  AI  $\supset$  Deep Learning  $\supset$  Neural Networks

D) Deep Learning  $\supset$  Neural Networks  $\supset$  ML  $\supset$  AI

**Answer: B) AI  $\supset$  ML  $\supset$  Neural Networks  $\supset$  Deep Learning**

**6. Which AI subfield enables computers to understand, interpret, and generate human language?**

- A) Computer Vision
- B) Robotics
- C) Natural Language Processing
- D) Speech Recognition

**Answer: C) Natural Language Processing**

**7. What is the key difference between speech recognition and voice recognition?**

- A) Speech recognition identifies a person; voice recognition converts speech to text.
- B) Speech recognition converts speech to text; voice recognition identifies a person.
- C) Both are the same.
- D) Speech recognition is for commands; voice recognition is for transcription.

**Answer: B) Speech recognition converts speech to text; voice recognition identifies a person.**

**8. Which technology creates a fully immersive, artificial three-dimensional environment?**

- A) Augmented Reality
- B) Virtual Reality
- C) Holographic Imaging
- D) 3D Printing

**Answer: B) Virtual Reality**



# Digital Citizenship, Literacy and Ethics

## Introduction: Navigating the Modern Digital World

The digital landscape is the cornerstone of modern society, transforming how we communicate, learn, work, and access entertainment. This evolution from traditional methods to a connected, technology-driven world brings immense power and convenience, but also introduces significant responsibilities, risks, and ethical dilemmas. This Master Chapter provides a complete, unified, and self-contained guide to becoming a competent, safe, responsible, and ethical participant in the digital world. It integrates foundational skills, security practices, ethical frameworks, societal impacts, and entrepreneurial thinking into a seamless professional textbook.

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## The Digital Foundation – Hardware, Software, and Systems

### Understanding Software

A computer consists of **hardware**—the physical components—and **software**, the set of instructions, data, and programs that operate the computer to perform specific tasks.

### Types of Software

1. **System Software:** The essential set of programs that acts as the primary interface between hardware and the user. Its purpose is to simplify hardware use, control operations, and optimize performance.
  - **Examples:** Operating Systems (OS), Device Drivers, Utility Programs, Language Translators.
2. **Application Software:** Programs written to carry out specific tasks for the user.
  - **Examples:** Word Processors (Microsoft Word), Spreadsheets (Excel), Presentation Software (PowerPoint), Web Browsers (Chrome), Email Clients (Gmail), Image Editors (Paint).

### System Software Deep Dive

#### The Operating System (OS)

The OS is the most critical system software that controls and manages all computer operations. A computer cannot function without it.



- Cyberterrorism, Cyberstalking, Phishing, Spoofing.

## Malicious Software (Malware)

Software designed to harm, disrupt, or gain unauthorized access.

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Type	Description	Key Characteristics
<b>Virus</b>	Attaches to a legitimate file/program and replicates when executed.	Requires user action, spreads via files, corrupts/deletes data.
<b>Worm</b>	A standalone program that self-replicates across networks.	Does not need a host file, consumes bandwidth/space.
<b>Trojan Horse</b>	Disguises as legitimate software but performs malicious actions.	Does not self-replicate; creates backdoors, steals data.
<b>Spyware</b>	Secretly collects user information (habits, passwords).	Tracks activity, changes settings, leads to identity theft.
<b>Adware</b>	Displays unwanted ads, often bundled with free software.	Slows system, tracks browsing for targeted ads.
<b>Ransomware</b>	Encrypts victim's files, demanding payment for decryption.	Makes data inaccessible, extorts money.
<b>Keylogger</b>	Records keystrokes to capture sensitive data like passwords.	A type of spyware focused on logging input.

**How Malware Spreads:** Infected removable media, pirated software, network/internet downloads, email attachments (most common).

**Symptoms of Infection:** Slow performance, frequent crashes/freezes, unwanted pop-ups/toolbars, programs opening/closing automatically, inaccessible files, unusual error messages, emails sent from your account without knowledge.

20. Digital Citizenship, Literacy and Ethics

## One Liners: Digital Citizenship, Ethics and Literacy

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1. The digital landscape is the cornerstone of modern society, transforming communication, learning, work, and entertainment.
2. A computer consists of hardware (physical components) and software (instructions, data, and programs).
3. System software acts as the primary interface between hardware and the user, simplifying hardware use, controlling operations, and optimizing performance.
4. Application software carries out specific tasks for the user (e.g., word processors, spreadsheets).
5. The Operating System (OS) is the most critical system software that controls and manages all computer operations; a computer cannot function without it.
6. OS functions include Booting, Security Management, Application Management, Memory Management, File Management, Device Management, and providing a User Interface.
7. Common OS examples are Microsoft Windows, macOS, Linux, Android, and iOS.
8. Device Drivers are specialized programs enabling hardware components to communicate with the OS.
9. Utility Programs perform management and maintenance tasks (e.g., antivirus, disk cleanup).
10. Language Translators convert human-readable programming code into machine-understandable code (Assemblers, Compilers, Interpreters).
11. The desktop is the main screen after startup, containing icons, taskbar, Start button/menu, notification area, and background/wallpaper.
12. A File is a common storage unit holding information; a Folder is a virtual container used to organize files.
13. A Shortcut is a link providing quick access to a file, folder, or program without moving the original item.
14. Essential file operations include Create, Rename, Cut/Copy/Paste, Delete & Restore, and Drag and Drop.
15. Deleted files are sent to the Recycle Bin, from which they can be restored.
16. A word processor is an application used to create, edit, format, save, and print text-based documents.
17. Key word processor interface elements include the Quick Access Toolbar, Title Bar, Ribbon, and Document Workspace.
18. Character formatting in a word processor includes changing Font Style, Size, Color, and applying Bold, Italic, Underline, and Text Alignment.
19. Page Layout adjustments involve margins, orientation (Portrait/Landscape), and size.
20. Lists can be bulleted (unordered) or numbered (sequential).
21. Headers and Footers are areas at the top and bottom of every page for titles, page numbers, and dates.
22. Spell & Grammar Check (F7) and Thesaurus are tools for error checking and finding synonyms.

## Practice MCQs

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**1. What are the two main components of a computer system?**

- A) CPU and RAM
- B) Hardware and Software
- C) Input and Output
- D) Operating System and Applications

**Answer: B) Hardware and Software**

**2. Which type of software acts as the primary interface between hardware and the user?**

- A) Application Software
- B) System Software
- C) Utility Software
- D) Programming Software

**Answer: B) System Software**

**3. Which of the following is NOT a function of an Operating System?**

- A) Booting
- B) Memory Management
- C) Word Processing
- D) File Management

**Answer: C) Word Processing**

**4. What is the purpose of a Device Driver?**

- A) To perform disk cleanup
- B) To enable hardware components to communicate with the OS
- C) To compile programming code
- D) To create documents

**Answer: B) To enable hardware components to communicate with the OS**

**5. Where are deleted files typically stored before permanent deletion?**

- A) Downloads folder
- B) Recycle Bin
- C) Temp folder

D) Desktop

**Answer: B) Recycle Bin**

**6. Which keyboard shortcut is used to copy selected text or files?**

- A) Ctrl+X
- B) Ctrl+C
- C) Ctrl+V
- D) Ctrl+A

**Answer: B) Ctrl+C**

**7. In a word processor, which tab is used to adjust page margins and orientation?**

- A) Home
- B) Insert
- C) Layout
- D) Review

**Answer: C) Layout**

**8. What does Bcc stand for in an email?**

- A) Basic Carbon Copy
- B) Blind Carbon Copy
- C) Broad Copy Control
- D) Binary Copy Code

**Answer: B) Blind Carbon Copy**

**9. Which email protocol downloads emails from the server to a single device and typically removes them from the server?**

- A) SMTP
- B) IMAP
- C) POP
- D) HTTP

**Answer: C) POP**

**10. What is the ability to effectively find, create, evaluate, communicate, and share content in a digital**

**20. Digital Citizenship, Literacy and Ethics**



## Chapter 21

# Entrepreneurship in the Digital Age

### Introduction

Entrepreneurship is the dynamic process of identifying a market opportunity, conceptualizing a solution, and undertaking the risk of launching and managing a new business venture to bring new products, services, or processes to life. It is the engine of innovation, job creation, and economic growth. In the contemporary world, this traditional process has been fundamentally transformed by digital technologies. The fusion of classic business acumen with tools like the internet, social media, cloud computing, and data analytics has created unprecedented opportunities while reshaping the entrepreneurial landscape. This Master Chapter provides a comprehensive, unified guide to understanding the complete journey of entrepreneurship—from its core principles and initial idea validation to building, launching, and scaling a venture in the digital era. It is designed to be a self-contained, professional resource for students and aspiring entrepreneurs.

### The Foundation of Entrepreneurship

#### Definition and Core Concepts

- **Entrepreneur:** An individual who organizes, manages, and assumes the financial risks of a new business venture. An entrepreneur is commonly seen as an **innovator**, a source of new ideas, goods, services, and business procedures. The term originates from the French word meaning "to undertake."
- **Entrepreneurship:** The process of designing, launching, and running this new business venture. It involves identifying a market need, taking calculated risks under conditions of uncertainty, and making strategic decisions to achieve business objectives and create value.

#### Significance and Impact

Entrepreneurship is a vital catalyst for any economy due to its multi-faceted role:

- **Economic Growth:** Creates new jobs and introduces new products and services, stimulating economic activity.
- **Innovation and Progress:** Drives groundbreaking ideas that transform lifestyles and industries (e.g., smartphones, digital platforms).
- **Job Creation:** Generates employment opportunities directly and indirectly.

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21. Entrepreneurship in the Digital Age



## One Liners: Entrepreneurship in Digital Age

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1. Entrepreneurship is the dynamic process of identifying a market opportunity and undertaking the risk of launching a new business venture.
2. An entrepreneur is an individual who organizes, manages, and assumes the financial risks of a new business venture.
3. The term "entrepreneur" originates from the French word meaning "to undertake."
4. Entrepreneurship is commonly seen as a source of innovation, introducing new ideas, goods, services, and business procedures.
5. The process of entrepreneurship involves identifying a market need, taking calculated risks, and making strategic decisions to create value.
6. Entrepreneurship acts as a vital catalyst for economic growth by creating new jobs.
7. It drives economic growth by introducing new products and services that stimulate economic activity.
8. Entrepreneurship is a primary driver of groundbreaking innovation that transforms lifestyles and industries.
9. A major impact of entrepreneurship is job creation, generating employment opportunities both directly and indirectly.
10. By introducing fresh ideas and competition, entrepreneurship leads to better products, services, and prices for consumers.
11. Social entrepreneurship specifically addresses pressing societal and environmental challenges.
12. A key characteristic of successful entrepreneurs is innovation and creativity.
13. Entrepreneurs exhibit calculated risk-taking, understanding that failure is possible but great rewards can follow.
14. Successful entrepreneurs are moderate risk-takers, not gamblers.
15. Persistence and resilience are essential attributes for overcoming inevitable challenges and setbacks.

## Practice MCQs

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1. **What is the core definition of an entrepreneur?**
  - a) An employee who follows company procedures
  - b) An individual who organizes, manages, and assumes the financial risks of a new business venture
  - c) A government official who regulates markets
  - d) A consumer who buys innovative products

**Answer: b) An individual who organizes, manages, and assumes the financial risks of a new business venture**
2. **The term "entrepreneur" originates from which language?**
  - a) Latin
  - b) Greek
  - c) French
  - d) German

**Answer: c) French**
3. **Which of the following is NOT a primary impact of entrepreneurship on an economy?**
  - a) Job Creation
  - b) Economic Stagnation
  - c) Innovation and Progress
  - d) Increased Competition

**Answer: b) Economic Stagnation**
4. **A successful entrepreneur who takes financial risks with an understanding of potential failure, but not recklessly, is best described as a:**
  - a) Gambler
  - b) Calculated risk-taker
  - c) Avoider of all risk
  - d) Follower of trends

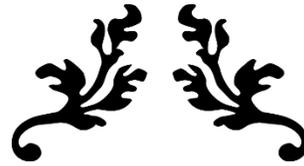
**Answer: b) Calculated risk-taker**
5. **Which characteristic involves the ability to pivot strategies based on market feedback?**
  - a) Persistence
  - b) Confidence
  - c) Flexibility and Adaptability
  - d) Future Orientation

**Answer: c) Flexibility and Adaptability**
6. **What is a significant drawback of entrepreneurship?**
  - a) Unlimited profit potential
  - b) Gaining control over one's career
  - c) Uncertainty and variability of income
  - d) Doing personally enjoyable work

**Answer: c) Uncertainty and variability of income**
7. **A local grocery store that supports a family lifestyle without seeking venture capital is an example of:**
  - a) Scalable Startup
  - b) Social Entrepreneurship
  - c) Small Business Entrepreneurship
  - d) Buyer Entrepreneurship

**Answer: c) Small Business Entrepreneurship**
8. **Which type of entrepreneurship aims primarily for social good rather than profit maximization?**
  - a) Innovative Entrepreneurship
  - b) Social Entrepreneurship
  - c) Hustler Entrepreneurship
  - d) Imitator Entrepreneurship

**Answer: b) Social Entrepreneurship**



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# **MISC. INFORMATION**

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## **QUICK REVISION NOTES**



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## Chapter 22

# Miscellaneous Information: Quick Revision Notes

## 1. Most Common Keyboard Shortcuts

### Windows

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- **Ctrl + C** → Copy selected item → Used to copy text/files.
  - **Ctrl + X** → Cut selected item → Removes and copies text/files.
  - **Ctrl + V** → Paste copied/cut item → Inserts clipboard content.
  - **Ctrl + Z** → Undo last action → Reverses previous operation.
  - **Ctrl + Y / Ctrl + Shift + Z** → Redo action → Reapplies undone action.
  - **Ctrl + A** → Select all items → Highlights all content in a window.
  - **Ctrl + S** → Save current document → Saves file in active application.
  - **Ctrl + F** → Open find/search box → Searches for text on a page.
  - **Ctrl + P** → Print current page/document → Opens print dialog.
  - **Ctrl + N** → Open new window/document → Creates new instance.
  - **Ctrl + W** → Close current window/tab → Shuts active tab/window.
  - **Ctrl + T** → Open new browser tab → Creates tab in browsers.
  - **Ctrl + Shift + T** → Reopen closed tab → Restores recently closed tab.
  - **Alt + Tab** → Switch between open apps → Toggles running applications.
  - **Alt + F4** → Close active application → Quits current program.
  - **Windows Key + D** → Show/hide desktop → Minimizes all windows.
  - **Windows Key + E** → Open File Explorer → Launches file manager.
  - **Windows Key + L** → Lock computer → Locks screen quickly.
  - **Windows Key + R** → Open Run dialog → Executes commands.



- **Country of Origin:** Pakistan
- **Headquarters:** Karachi, Pakistan
- **Current CEO:** Bjarke Mikkelsen
- **Major Services:** Online marketplace in South Asia (Pakistan, Bangladesh, Sri Lanka, Nepal, Myanmar).
- **Launch Year:** 2012
- **Key Fact:** Alibaba-owned leading online shopping platform in South Asia.
- **Walmart** ([Walmart.com](https://www.walmart.com))
  - **Founder:** Sam Walton
  - **Country of Origin:** USA
  - **Headquarters:** Bentonville, Arkansas, USA
  - **Current CEO:** Doug McMillon
  - **Major Services:** Online retail, grocery delivery, in-store pickup, Walmart+ membership.
  - **Launch Year:** 2000 (online)
  - **Key Fact:** World's largest retailer by revenue, with massive omnichannel e-commerce presence.
- **Rakuten**
  - **Founder:** Hiroshi Mikitani
  - **Country of Origin:** Japan
  - **Headquarters:** Tokyo, Japan
  - **Current CEO:** Hiroshi Mikitani
  - **Major Services:** E-commerce, fintech, digital content, communications, investing.
  - **Launch Year:** 1997
  - **Key Fact:** Japan's largest e-commerce site, operates as an ecosystem of services.
- **Mercado Libre**



- **Owner/Parent:** Hugging Face, Inc.
- **CEO:** Clément Delangue
- **Launch Year:** 2016
- **Key Feature:** Central repository for open-source AI models and transformers library.

## 4. Core Computer Science Concepts

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- **Operating System (OS):** Software that manages computer hardware and provides services for applications.

- **Kernel:** Core component of OS that manages CPU, memory, and system calls.

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- **Process:** An instance of a program in execution, with its own memory space.

R

- **Thread:** The smallest unit of processing that can be scheduled within a process.

E

- **Deadlock:** A situation where two or more processes are unable to proceed because each is waiting for the other.

P

- **Virtual Memory:** Memory management technique that uses disk space to extend RAM.

A

- **File System:** Method for storing, organizing, and retrieving files on a storage device.

R

- **Database Management System (DBMS):** Software for creating, managing, and interacting with databases.

A

- **Relational Database:** Database structured with tables, rows, and columns, using SQL.

T

- **NoSQL Database:** Non-relational database designed for scalability and flexible data models.

I

- **ACID Properties:** Atomicity, Consistency, Isolation, Durability – guarantees for database transactions.

O

- **SQL:** Structured Query Language used to communicate with relational databases.

N

- **Primary Key:** Unique identifier for a record in a database table.

S

- **Foreign Key:** Field in a table that links to the primary key of another table.

- **Normalization:** Process of organizing data to reduce redundancy and improve integrity.

- **Indexing:** Database optimization technique to speed up data retrieval.



- **Web3:** Idea for a decentralized internet built on blockchain technology. (Example: Using Ethereum-based dApps without centralized control.)
- **Low-Code/No-Code Platforms:** Development environments allowing creation of apps with minimal hand-coding. (Example: Building a business app using drag-and-drop in [Bubble.io](https://bubble.io).)

## 6. General High-Value IT and Tech Facts

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- **Microsoft** was founded by Bill Gates and Paul Allen in 1975.
- **Apple** was founded by Steve Jobs, Steve Wozniak, and Ronald Wayne in 1976.
- **Google** was founded by Larry Page and Sergey Brin in 1998.
- **Amazon** was founded by Jeff Bezos in 1994, originally as an online bookstore.
- **Facebook (Meta)** was founded by Mark Zuckerberg in 2004.
- **Linux** is an open-source kernel created by Linus Torvalds in 1991.
- **Windows** is a family of proprietary operating systems developed by Microsoft.
- **macOS** is the proprietary Unix-based operating system for Apple Mac computers.
- **Android** is a mobile OS based on a modified Linux kernel, developed by Google.
- **iOS** is Apple's mobile operating system for iPhone and iPad.
- **Google Chrome** is a web browser developed by Google (parent: Alphabet).
- **Mozilla Firefox** is an open-source browser developed by Mozilla Foundation.
- **Microsoft Edge** is a browser developed by Microsoft, based on Chromium.
- **Safari** is a browser developed by Apple for its devices.
- **C programming language** was created by Dennis Ritchie at Bell Labs (1972).
- **C++** was created by Bjarne Stroustrup as an extension of C (1985).
- **Java** was created by James Gosling at Sun Microsystems (1995, now owned by Oracle).
- **Python** was created by Guido van Rossum and released in 1991.
- **JavaScript** was created by Brendan Eich at Netscape in 1995.



- **MP3** is a coding format for digital audio using lossy compression.
- **JPEG** is a commonly used method of lossy compression for digital images.
- **PNG** is a raster-graphics file format supporting lossless data compression.
- **MP4** is a digital multimedia container format for video, audio, and subtitles.
- **Elon Musk** is the CEO of Tesla and SpaceX, and founded Neuralink and The Boring Company.
- **Satya Nadella** is the Chairman and CEO of Microsoft.
- **Tim Cook** is the CEO of Apple.
- **Sundar Pichai** is the CEO of Alphabet (Google's parent company).
- **Jensen Huang** is the co-founder and CEO of NVIDIA.
- **The first programmable computer** was the Z3 by Konrad Zuse (1941).
- **The first electronic general-purpose computer** was ENIAC, completed in 1945.
- **The World Wide Web (WWW)** was invented by Tim Berners-Lee in 1989.
- **The first website** was [info.cern.ch](http://info.cern.ch), launched in 1991.
- **ARPANET**, the precursor to the internet, became operational in 1969.
- **The first email** was sent by Ray Tomlinson in 1971, using the "@" symbol.
- **The first iPhone** was announced by Steve Jobs in 2007.
- **The first domain name ever registered** was [symbolics.com](http://symbolics.com) (March 15, 1985).
- **As of 2024, the most valuable public company** is Microsoft (by market cap).
- **The most downloaded app of all time** is WhatsApp.
- **The most popular programming language** (as per various 2024 indices) is Python.
- **The largest data center in the world** is the China Telecom Data Center in Hohhot, China.
- **The first 1 GB hard drive** (IBM 3380) weighed 550 pounds and cost \$40,000 in 1980.



## M K P R E P A R A T I O N S

- **AI:** Artificial Intelligence - Intelligence demonstrated by machines.
- **ML:** Machine Learning - AI subset where systems learn from data.
- **IoT:** Internet of Things - Network of interconnected physical devices.
- **ISP:** Internet Service Provider - Company providing internet access.
- **SMTP:** Simple Mail Transfer Protocol - Protocol for sending email messages.
- **FTP:** File Transfer Protocol - Standard network protocol for transferring files.
- **OS:** Operating System - System software that manages computer hardware and software resources.
- **BIOS:** Basic Input/Output System - Firmware used to perform hardware initialization during booting.
- **POST:** Power-On Self-Test - Diagnostic testing sequence performed by firmware/BIOS on boot.
- **CMOS:** Complementary Metal-Oxide-Semiconductor - Battery-powered chip storing BIOS settings.
- **IP:** Internet Protocol - Principal communications protocol for relaying datagrams across networks.
- **MAC:** Media Access Control Address - Unique hardware identifier for network interfaces.
- **LAN:** Local Area Network - Network covering a small geographic area like a home or office.
- **WAN:** Wide Area Network - Network covering a broad area (e.g., internet).
- **MAN:** Metropolitan Area Network - Network covering a city or campus.
- **PAN:** Personal Area Network - Network for communication among devices close to a person.
- **5G:** 5th Generation - Latest standard for cellular networks, high speed and low latency.
- **LTE:** Long-Term Evolution - Standard for high-speed wireless communication.
- **PDF:** Portable Document Format - File format for presenting documents.
- **DOCX:** Microsoft Word Open XML Document - Default format for Microsoft Word documents.



- **CMS:** Content Management System - Software application for creating and managing digital content.
- **ERP:** Enterprise Resource Planning - Integrated management of main business processes.
- **CRM:** Customer Relationship Management - System for managing company interactions with customers.
- **SCM:** Supply Chain Management - Management of flow of goods and services.
- **BI:** Business Intelligence - Technologies/applications for analyzing business information.
- **ETL:** Extract, Transform, Load - Process in data warehousing for preparing data for analysis.
- **OLAP:** Online Analytical Processing - Approach to answer multi-dimensional analytical queries.
- **OLTP:** Online Transaction Processing - Class of systems facilitating transaction-oriented applications.
- **NoSQL:** Not only SQL - Broad class of database management systems differing from relational databases.
- **MongoDB:** A popular document-oriented NoSQL database.
- **Hadoop:** Open-source framework for distributed storage/processing of big data.
- **Spark:** Apache Spark - Unified analytics engine for large-scale data processing.
- **Kafka:** Apache Kafka - Distributed event streaming platform.
- **DevOps:** Development and Operations - Culture/practice combining software development and IT operations.
- **CI/CD:** Continuous Integration/Continuous Deployment - Automating software delivery pipeline.
- **Agile:** Iterative approach to project management and software development.
- **Scrum:** Framework within which people can address complex adaptive problems in Agile.
- **Kanban:** Visual system for managing work as it moves through a process in Agile.
- **JVM:** Java Virtual Machine - Virtual machine enabling computer to run Java programs.



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# **PAST PAPER QUESTIONS**

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## Past Papers Questions

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**1. How many rows in MS Excel Sheet?**

- A) 86340
  - B) 1048576
  - C) 86400
  - D) None of these
- Answer: B) 1048576**

**2. Which Pane is not available in PowerPoint?**

- A) WordArt
  - B) Insert
  - C) Animation
  - D) None of these
- Answer: A) WordArt**

**3. Deleted Items in file directly go to the:**

- A) Recycle Bin
  - B) Desktop
  - C) Windows Folder
  - D) None of these
- Answer: A) Recycle Bin**

**4. Crop function is used to crop:**

- A) Videos
  - B) Images
  - C) Files
  - D) None of these
- Answer: B) Images**

**5. Which key is used to move the cursor to end of the line?**

- A) End
  - B) Home
  - C) Shift+ tab
  - D) None of these
- Answer: A) End**

**6. In MS-DOS, DOS stands for:**

- A) Disk Operating System
- B) Device Operating System
- C) Driver Operating System

D) None of these

**Answer: A) Disk Operating System**

**7. HTML stands for hypertext markup language is used for creating:**

- A) Web pages
- B) Web server
- C) Client server
- D) None of these

**Answer: A) Web pages**

**8. Gmail, Hotmail and Yahoo are:**

- A) Email Server
- B) Client Server
- C) Email Programmer
- D) None of these

**Answer: D) None of these**

**9. Windows 9 and Windows 10 are known as:**

- A) Operating system
- B) System software
- C) Application software
- D) None of these

**Answer: A) Operating system**

**10. In PowerPoint the header and footer button can be found on the:**

- A) Home tab
- B) Insert tab
- C) Draw tab
- D) None of these

**Answer: B) Insert tab**

**11. Which of the following are word processing software?**

- A) Browser
- B) PowerPoint
- C) MS Word
- D) None of these

**Answer: C) MS Word**



12. The first computers were programmed using:

- A) Assembly language
- B) Machine language
- C) Object code
- D) None of these

Answer: B) Machine language

13. The computer cannot boot if it cannot load the:

- A) Loader
- B) Operating system
- C) Assembler
- D) None of these

Answer: B) Operating system

14. BIOS stands for:

- A) Basic Input Output System
- B) Binary Input Output System
- C) Broad Input Output System
- D) None of these

Answer: A) Basic Input Output System

15. LCD stands for:

- A) Light Clear Display
- B) Liquid Crystal Display
- C) Light Crystal Display
- D) None of these

Answer: B) Liquid Crystal Display

16. Which function in Excel returns the remainder of division?

- A) Divide
- B) MOD
- C) ACOT
- D) None of these

Answer: B) MOD

17. Which template provides design concept, fonts and color scheme?

- A) Design template
- B) Color template
- C) Animation template
- D) None of these

Answer: A) Design template

18. Which key is used to minimize an Excel Worksheet?

- A) CTRL+F5
- B) CTRL+F9
- C) CTRL+F11
- D) None of these

Answer: B) CTRL+F9

19. Videos, documents and files can be shown in:

- A) WhatsApp
- B) YouTube
- C) Skype
- D) None of these

Answer: D) None of these

20. The extension of a PowerPoint file is:

- A) XLS
- B) PPT
- C) TXT
- D) All of these

Answer: B) PPT

21. In MS Word, Header and Footer are inserted in:

- A) Front page
- B) Last page
- C) On every page
- D) None of these

Answer: C) On every page

22. Which button do you click to add up a series of numbers?

- A) Auto sum
- B) Formula button
- C) Total Button
- D) None of these

Answer: A) Auto sum

23. When you insert an Excel file into a Word document, the data are:

- A) Embedded
- B) Linked
- C) Hyperlink placed in word table

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- B) Printed parts
- C) Program
- D) None of these

**Answer:** A) Physical parts

**116. An element of an array is mentioned by its:**

- A) Array
- B) Subscript
- C) Superscript
- D) None of these

**Answer:** B) Subscript

**117. What is the main difference between a mainframe and a supercomputer?**

- A) Supercomputer is much larger than mainframe computer
- B) Supercomputers are much smaller than mainframe computers
- C) Supercomputers are focused to execute a few programs as fast as possible while the mainframe used its power to execute as many programs concurrently
- D) None of these

**Answer:** C) Supercomputers are focused to execute a few programs as fast as possible while the mainframe used its power to execute as many programs concurrently

**118. Is it necessary for an algorithm to solve a problem with an infinite number of steps?**

- A) No
- B) Yes
- C) Error
- D) None of these

**Answer:** B) Yes

**119. Arithmetic Operations are performed by:**

- A) LU
- B) ALU
- C) CU
- D) None of these

**Answer:** B) ALU

**120. A processor is also known as:**

- A) CPU
- B) UPS
- C) PUS
- D) None of these

**Answer:** A) CPU

**121. Which part of the CPU controls the sequence of instructions?**

- A) AU
- B) CU
- C) ALU
- D) None of these

**Answer:** B) CU

**122. RAM stands for:**

- A) Random Access Memory
- B) Random Analysis
- C) Read Able Memory
- D) None of these

**Answer:** A) Random Access Memory

**123. ROM stores data:**

- A) Permanently
- B) Partially
- C) Temporary
- D) None of these

**Answer:** A) Permanently

**124. Which of the following is the highest speed slot?**

- A) ISA
- B) AGP
- C) AGC
- D) None of these

**Answer:** B) AGP

**125. A video game is played by using \_\_\_\_\_ card.**

- A) Sound
- B) Modem
- C) Graphics
- D) None of these

**Answer:** C) Graphics

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