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DEPARTMENT OF MATH AND SCIENCE

COMPUTER & AI

Lecture Notes 2026-27

Classroom Lecture Notes on

Unit-1 Basic organisation of Computer

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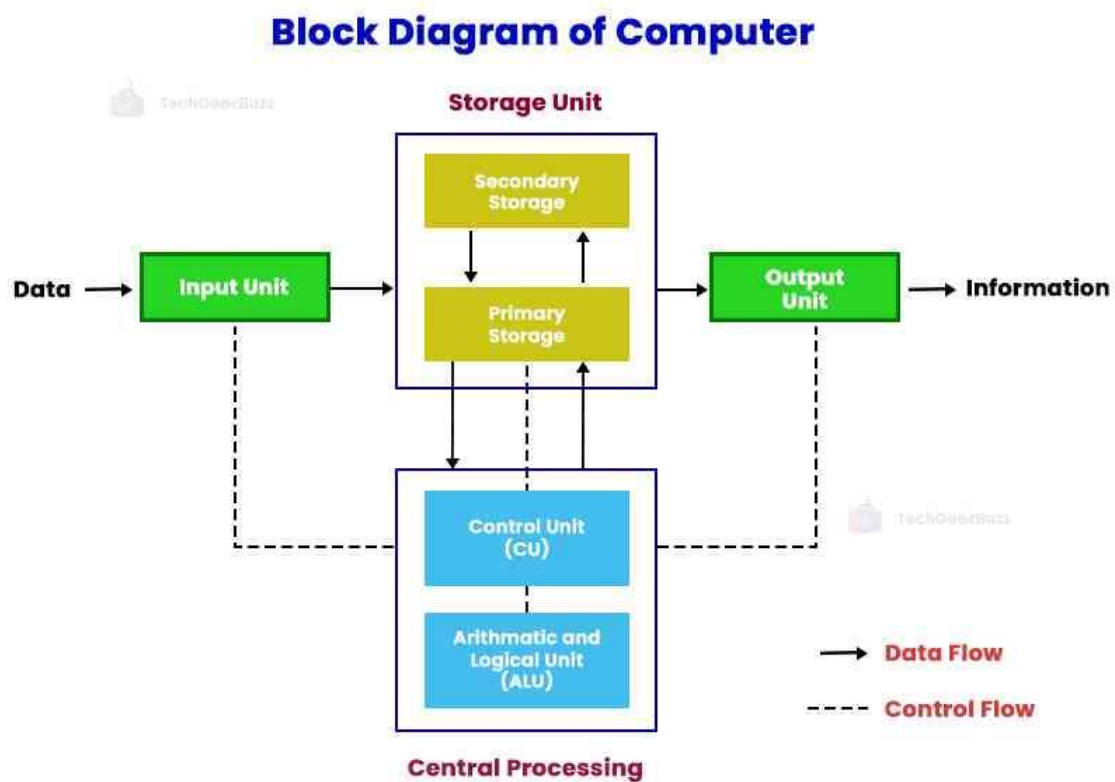
1. Computer System Overview

Computers are available in different sizes and have different processing capabilities and configurations. Each hardware component has its own specific functionality and is attached in a coordinated manner to form a computer system.

Definition of a Computer

A **computer** is an electronic device that can be programmed to accept data (input), process it, and generate results (output).

2. Block Diagram & Architecture of a Computer



- **Data Flow:** Moves data from input devices to memory, through the CPU for processing, and out to output devices.
- **Control Flow:** Transmits command and control signals from the Control Unit to manage all system operations.

3. Central Processing Unit (CPU)

The **CPU** (often called the processor or central processor) is the brain of the computer. It processes most of the data, turning raw input into output, thereby driving system performance. It is used in desktops, laptops, tablets, smartphones, and televisions, with major manufacturers being Intel and AMD.

The CPU consists of three primary internal components:

A. Arithmetic and Logical Unit (ALU)

- A combinational digital circuit designed to perform all arithmetic calculations (addition, subtraction, etc.) and logical operations (comparison, complement, bitwise shifts).
- As operations become more complex, the ALU design consumes more space and becomes more expensive.
- 3 Key Sub-components of ALU:
 1. **Adder:** Performs actual arithmetic calculations.
 2. **Registers:** Stores data and instructions temporarily during execution.
 3. **Accumulator:** Stores intermediate results produced during arithmetic/logical calculations.

B. Control Unit (CU)

- Regulates and integrates all operations across the computer system.
- Functions:
 - Fetches instructions from programs stored in main memory.
 - Decodes instructions into micro-commands.
 - Sends control signals over system buses to memory, I/O devices, and the ALU to execute operations.

C. Internal CPU Registers

- Ultra-fast temporary storage locations inside the processor used to hold instructions, memory addresses, and data currently being manipulated.

4. Input Devices

A. Keyboard

The primary text-input device (similar to an electronic typewriter) consisting of buttons used to enter letters, numbers, symbols, and system commands. It connects

via USB cable or wireless signals. Some keyboards include multimedia buttons, power/sleep keys, or trackballs.

- **Types:** QWERTY (general purpose), Gaming, Virtual (software), Ergonomic (physiological/comfort design), and Multimedia.
- Key Classifications:
 1. **Function Keys (F1–F12):** Located on the top row; assigned specific system commands or customizable application shortcuts.
 2. **Character Keys:** Alphabets (A-Z, a-z), numbers (0-9), Tab, and Caps Lock for general typing.
 3. **Modifier Keys:** Modifies the output of other keys when pressed together (e.g., Ctrl, Alt, Shift, AltGr).
 4. **Navigation / Cursor Control Keys:** Arrow keys (Up, Down, Left, Right), Home, End, Page Up, Page Down.
 5. **Numeric Keypad:** Dedicated number pad (0-9, math operators, NumLock, Del) for fast numeric entry.
 6. System Command Keys:
 - **PrtSc (Print Screen):** Captures the current screen view to the clipboard.
 - **Break / Pause:** Used to terminate or pause program execution.
 - **Esc (Escape):** Cancels commands, closes dialog boxes, or acts as a stop signal.
 - **Enter:** Ends a paragraph in text editors or executes typed commands in a CLI.
 - **Shift:** Accesses upper-case letters and top-row symbols.
 - **Windows Key:** Opens the OS Start menu.
 - **Space Bar:** Inserts blank spaces between characters.
 - **Backspace:** Erases characters to the left of the cursor.

B. Mouse

A handheld pointing device that translates physical hand movements into digital signals to control a graphical cursor in a GUI.

- Core Mouse Actions:
 - **Point:** Positioning the cursor over an item on screen.
 - **Click:** Pressing the left mouse button once to select an item or trigger a control.
 - **Right-Click:** Pressing the right button to display contextual pop-up menus (Copy, Paste, Properties).
 - **Double-Click:** Pressing the left button twice rapidly to open files, folders, or execute applications.
 - **Drag and Drop:** Holding the left button over an item, moving it across the screen, and releasing to relocate it.
 - **Scrolling:** Rotating the central scroll wheel to navigate vertically through documents or webpages.
- Types of Mice:
 1. **Mechanical Mouse:** Uses a hard rubber ball that rotates internal rollers/sensors to track motion. Prone to mechanical wear and dust accumulation over time.
 2. **Optical & Laser Mouse:** Employs LED lights (Optical) or Laser beams paired with photodiode arrays to track surface movement. Offers high precision with no moving parts, though optical units struggle on glass/reflective surfaces.

C. Scanners

Electrical devices used for direct data entry that scan physical document images and translate text, photos, or diagrams into digital bitstream files.

- Types of Scanners:
 - **Drum Scanner:** Rotates the document around a drum. Uses Photomultiplier Tubes (PMTs) instead of CCD sensors, offering extreme light sensitivity and ultra-high image resolution.
 - **Flatbed Scanner:** The most common scanner. Documents lie flat on a glass sheet under a flip cover. Easy to use for books, images, and single sheets; often equipped with wireless capabilities or Auto-Document Feeders (ADF).

- **Sheetfed Scanner:** Specifically designed for handling loose sheets of paper through a feed tray. Compact and fast (measured in pages per minute), making them ideal for high-volume office use.
- **Handheld Scanner:** Portable devices dragged manually across physical pages or items. Highly flexible and common in retail or warehouses for scanning barcodes.

D. Joystick

An input device featuring a stick that pivots on a base, primarily used to control virtual objects, characters, or vehicles in video games and simulations.

- Types of Joysticks:
 - **Analogue Joystick:** Combines digital and continuous positional detection for precise movement handling.
 - **Paddle Controller Joystick:** One of the earliest joystick types, consisting of a single rotating knob and a fire button.
 - **PC Analogue Joystick:** Popularized via standard IBM PC interfaces and modern USB ports, offering multiple buttons and rapid response times.

5. Output Devices

A. Monitor (Display Screen)

The primary visual output device that receives processed video data from the computer's graphics card to display text, images, and video. Desktop displays connect via cables (HDMI/VGA), whereas laptops/tablets integrate displays directly.

- Types of Monitors:
 1. **CRT (Cathode Ray Tube):** Legacy technology using electron beams directed at a phosphorescent screen. Bulky and heavy, but offers excellent color rendering and fast response times.
 2. **LCD (Liquid Crystal Display):** Uses liquid crystal layers trapped between glass plates that block or pass light generated by a CCFL backlight when electrified. Slim, lightweight, energy-efficient, and affordable.
 3. **LED (Light Emitting Diode):** An advanced LCD variant using LED backlighting. Provides better brightness, higher contrast ratios, improved color accuracy, and lower power consumption.

4. **OLED (Organic LED):** Features organic molecules that emit their own light per pixel (no separate backlight required). Delivers true black levels, infinite contrast, super-fast response times, and energy savings.
5. **Touchscreen Monitors:** Integrates capacitive or resistive touch layers over the display to enable direct finger/stylus input. Widely used in kiosks, tablets, and interactive tools.
6. **Curved Monitors:** Designed with a subtle screen curvature that wraps around the user's field of view to reduce distortion and glare while improving immersion.

B. Printers

Output devices that produce hard copies (physical prints on paper) of electronic documents containing text, images, or graphics.

- **Impact Printers:** Characters are formed via direct physical contact between an impact mechanism (pins/typebars) and an inked ribbon onto paper.
 - **Daisy-Wheel Printer:** Uses a rotating wheel with character spokes. Produces letter-quality text slowly (25–50 characters per second).
 - **Dot-Matrix Printer:** Uses 9-pin or 24-pin print heads to strike ribbons and create text/graphics from dot patterns. Inexpensive, with speeds from 100 to 550 cps.
 - **Line Printer:** Prints an entire line of text at once using chain or drum mechanisms. Extremely fast (1,000 to 6,000 lines per minute).
- **Non-Impact Printers:** Prints without physically striking paper. They operate quietly and require less physical maintenance.
 - **Inkjet Printer:** Sprays tiny drops of liquid ink onto paper. Excellent for photo-realistic color printing; compact and versatile, but has a higher per-page cost and slower output.
 - **Laser Printer:** Uses a laser beam, static electricity, and a photosensitive drum to melt dry toner powder onto paper. Very fast, cost-effective for high volumes, expandable with extra paper trays, but requires higher initial power and space.
 - **LED Printer:** Operates similarly to a laser printer, but uses a solid-state LED array instead of a laser/mirror assembly. Highly efficient, reliable, and compact.

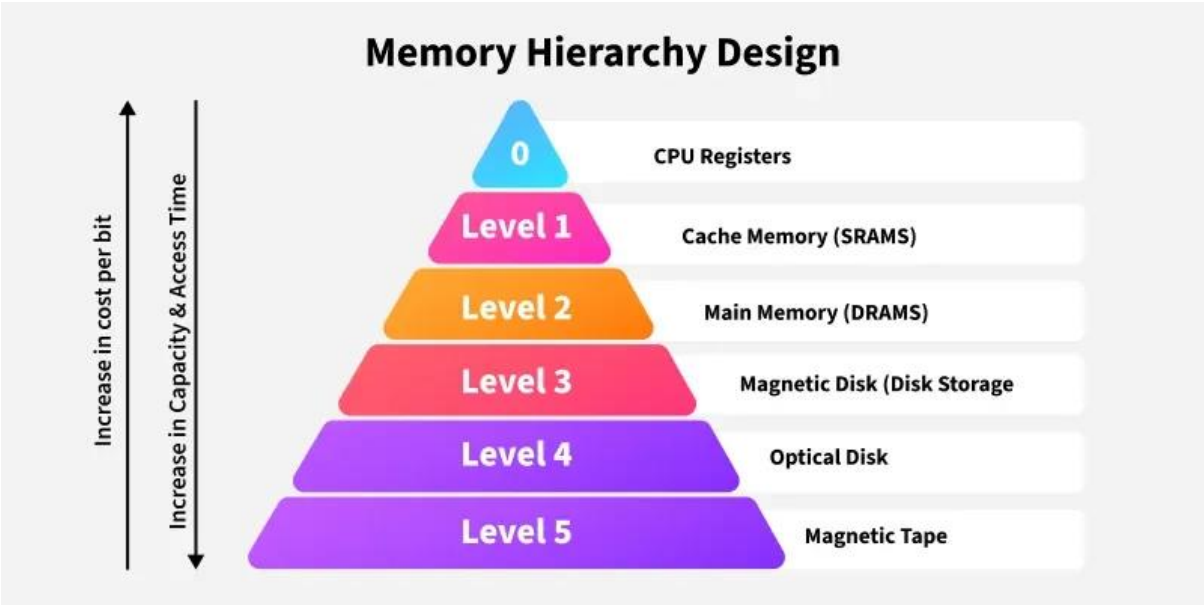
C. Speakers

Hardware transducers that convert digital sound signals processed by the computer's sound card into audible sound waves. Available as built-in laptop/desktop units or external systems.

- Types of Speakers:
 - **Soundbar Speakers:** Compact horizontal units delivering wide audio profiles in home or desk setups.
 - **Subwoofers / Bass Speakers:** Designed exclusively to reproduce deep, low-frequency sounds.
 - **Bookshelf Speakers:** Medium-sized units configured for optimized sound in small-to-mid rooms.
 - **Tower Speakers:** Large floor-standing units providing full-range, high-clarity sound.
 - **In-Ceiling / Wall Speakers:** Flush-mounted architectural speakers providing space-saving room illumination.
 - **Portable Speakers:** Compact, battery-powered units with Bluetooth connectivity for audio on the go.
 - **Tweeters:** Specialized small drivers handling high-frequency treble sounds.
 - **Squawkers (Mid-range):** Specialized drivers tuned to reproduce middle frequencies (250 Hz to 2000 Hz).

6. Computer Memory & Hierarchy

Memory stores programs, instructions, and data. The smallest fundamental unit of memory is a **Bit** (Binary Digit, holding a value of 0 or 1).



Memory Hierarchy Comparison Table

Level	Memory Type	Access Speed	Capacity	Cost per Bit
Level 0	CPU Registers	Fastest	Smallest	Extremely High
Level 1–3	Cache (SRAM)	Very Fast	Very Small	Very High
Level 4	Main Memory (DRAM)	Fast	Medium	Moderate
Level 5	Secondary Storage (SSD/HDD)	Moderate/Slow	Large	Low
Level 6	Auxiliary Storage (Tape/Optical)	Slowest	Huge	Lowest

A. Primary Memory (Main Memory)

Internal semiconductor memory directly accessible by the CPU to execute programs and store temporary calculation results.

1. RAM (Random Access Memory)

- Volatile memory: Data is lost when the computer's power is turned off.
- Called "Random Access" because access time is identical regardless of where data resides physically.
- **Static RAM (SRAM):** Uses transistor flip-flops; retains data without needing refreshing as long as power is supplied. Extremely fast and used primarily for internal CPU **Cache Memory**.
- **Dynamic RAM (DRAM):** Uses tiny capacitor-transistor pairs that leak charge and require periodic refreshing. Dense, cheaper, and generates less heat; used for **Main System RAM**.

2. ROM (Read-Only Memory)

- Non-volatile memory: Data persists permanently even when power is turned off. Contains critical system code such as firmware and system bootloaders.
- **PROM (Programmable ROM):** Blank memory chip written once by a user using a special PROM programmer device. Cannot be altered afterward.
- **EPROM (Erasable Programmable ROM):** Contents can be completely erased by exposing the chip to high-intensity Ultraviolet (UV) light, allowing it to be reprogrammed.
- **EEPROM (Electrically Erasable Programmable ROM):** Can be erased and rewritten electrically byte-by-byte up to tens of thousands of times. Erase cycles take 10^4 ms.
- **Flash Memory:** An advanced form of EEPROM that erases and writes data in blocks rather than single bytes, making it much faster.

B. Secondary Memory (Auxiliary Storage)

External non-volatile storage used to permanently store operating systems, programs, and user files. Data must be transferred to primary memory before the CPU can process it.

1. Hard Disk Drive (HDD)

- Stores digital data magnetically on rotating circular plates called **platters**.
- Core Components:
 - **Platters:** Circular magnetic disks that record 1s and 0s.

- **Spindle:** Motorized spindle that holds and spins platters at high RPMs.
- **Read/Write Head & Arm:** Reads and writes magnetic patterns on platters.
- **Actuator:** Controls the precise movement of the read/write arm across platter tracks.

2. Solid State Drive (SSD)

- Modern storage solution that replaces traditional mechanical HDDs.
- Uses flash memory chips arranged in a grid to store data electronically without moving parts.

HDD vs. SSD Comparison

Feature	Hard Disk Drive (HDD)	Solid State Drive (SSD)
Technology	Magnetic spinning platters & moving arms	Non-volatile flash memory microchips
Speed	Lower read/write speed	Ultra-high read/write speed
Durability	Vulnerable to mechanical failure/shocks	Highly durable with no moving parts
Noise & Heat	Produces operational hum and higher heat	Completely silent with minimal heat output
Cost	Very low cost per gigabyte	Higher cost per gigabyte

3. Magnetic Tape & Optical Disks

- **Magnetic Tape:** Thin plastic film coated with magnetic material. Used primarily for long-term offsite backups due to slow sequential data access times.
- **Optical Disks:** Uses laser beams to read and write data on reflective discs (CDs, DVDs, Blu-ray).