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CUET · COMPUTER SCIENCE · CLASS XI · CODE 308

Computer System

CUET unit: Computer System

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Snapshot

- A computer system has a clear architecture: hardware components (CPU, memory, I/O devices), their interconnections via buses, and the software stack that drives them.
- Computing evolved from the Abacus (500 BC) to modern multicore microprocessors and IoT devices; technology kept changing the computer's physical form.
- The memory hierarchy (registers → cache → RAM → secondary storage) determines speed and volatility, and is tested frequently in CUET.
- Software is classified into system software, programming tools, and application software; language translators (assembler, compiler, interpreter) sit within programming tools.
- The Operating System (§1.8) — resource management, user interfaces, and the four OS functions — is a recurring CUET topic.

Detailed Notes

2.1 Core concepts

- A **computer** is an electronic device that can be programmed to accept data (input), process it and generate output. A computer together with additional hardware and software is called a **computer system**. A computer system primarily comprises a CPU, memory, input/output devices, and storage devices. (NCERT §1.1, p. 1)
- The **Central Processing Unit (CPU)** is the electronic circuitry that carries out actual processing; it is commonly called the processor or microprocessor. Physically, it is placed on one or more microchips called integrated circuits (ICs) made of semiconductor materials. The CPU has two main components: the **Arithmetic Logic Unit (ALU)**, which performs arithmetic and logic operations, and the **Control Unit (CU)**, which controls sequential instruction execution, interprets instructions, and guides data flow through memory, ALU, and I/O devices. During processing, the CPU stores data and instructions in local memory called **registers**. (NCERT §1.1.1, p. 1–2)
- **Input devices** convert input data into a digital form acceptable to the computer system. Examples include keyboard, mouse, scanner, touch screen, and braille

- keyboard for the visually impaired. Data entered through input devices is temporarily stored in the main memory (RAM). (NCERT §1.1.2, p. 2)
- **Output devices** receive data from the computer and convert digital information into human-understandable form. Examples include monitor, projector, speaker, printer, and 3D printer. A 3D printer builds physical replicas of digital 3D designs and is used in manufacturing and the medical field. A braille display monitor helps visually challenged users. (NCERT §1.1.3, p. 2–3)
 - The **evolution of computers** (Figure 1.4) spans key milestones: Abacus (~500 BC, simple arithmetic), Pascaline (1642, mechanical calculator by Blaise Pascal), Analytical Engine (1834, Charles Babbage, basis of modern computers), Tabulating Machine (1890, Herman Hollerith, first step towards programming using punched cards), Turing Machine (1937, general purpose programmable concept), Transistor (1947, replaced vacuum tubes, developed at Bell Labs), EDVAC/ENIAC (1945, stored program concept by John Von Neumann), Integrated Circuit (1970, silicon chip with complete electronic circuit), leading to microprocessors, PCs (IBM 1981, Apple Macintosh 1984), GUI-based OS, WWW (1990s), laptops, smartphones, and now wearables and IoT. (NCERT §1.2, p. 3–5)
 - **Von Neumann architecture** (Figure 1.5) consists of a CPU for processing arithmetic and logical instructions, a memory to store data and programs, input and output devices, and communication channels. ENIAC is the first binary programmable computer based on this architecture. During the 1970s, Large Scale Integration (LSI) allowed a complete CPU on a single chip (microprocessor). **Moore's Law** (Gordon Moore, 1965) predicted the number of transistors on a chip would double every two years while costs would halve. The 1980s saw VLSI (~3 million components); current technology uses SLSI (~ 10^6 components). (NCERT §1.2, p. 4–5)
 - **Computer memory** is needed to store data and instructions for processing. The memory hierarchy from fastest/smallest to slowest/largest is: registers → cache → primary memory (RAM/ROM) → secondary memory. (NCERT §1.3, p. 5)
 - **Units of memory:** The basic unit is a **bit** (binary digit, 0 or 1). Four bits form a **nibble** (e.g., 1001). Eight bits form a **byte** (e.g., 01000110). Larger units follow multiples of 1024: 1 KB = 1024 bytes, 1 MB = 1024 KB, 1 GB = 1024 MB, 1 TB = 1024 GB, 1 PB = 1024 TB, 1 EB = 1024 PB, 1 ZB = 1024 EB, 1 YB = 1024 ZB (Table 1.1, p. 6). (NCERT §1.3.1, p. 5–6)
 - **Primary memory** is directly accessed by the CPU for read/write operations. It has two types: (i) **RAM (Random Access Memory)** — volatile; data is lost when power is off; used to store data and programs during processing; also called main memory. (ii) **ROM (Read Only Memory)** — non-volatile; retains contents even when power is off; used to store the startup program (boot loader). (NCERT §1.3.2(A), p. 6)
 - **Cache memory** is a very high-speed memory placed between CPU and primary memory to reduce average data-access time. It stores copies of frequently accessed

primary memory locations. When the CPU needs data, it checks cache first; if not found, primary memory is accessed. (NCERT §1.3.2(B), p. 6–7)

- **Secondary memory** is non-volatile, has larger storage capacity, and is slower and cheaper than primary memory. It cannot be accessed directly by the CPU — contents must first be brought into main memory. Examples: Hard Disk Drive (HDD), CD/DVD, Memory Card, Tape Drive, and Solid State Drive (SSD). SSDs support very fast data transfer speeds compared to HDDs. (NCERT §1.3.2(C), p. 7)
- **Data transfer between memory and CPU** uses physical wires called a **bus**. The **system bus** comprises three types: (i) **Data bus** — transfers data between components (bidirectional); (ii) **Address bus** — transfers memory addresses from CPU to memory (unidirectional); (iii) **Control bus** — communicates control signals (unidirectional). The **memory controller** manages data flow into and out of main memory. (NCERT §1.4, p. 7–8)
- A **microprocessor** is a CPU implemented on a single microchip. It performs arithmetic and logical operations and is built over an IC comprising millions of small components like resistors, transistors, and diodes. The generations of microprocessors are characterised by chip type (LSI → VLSI → SLSI), word size (4/8 bit → 64 bit), clock speed, and cores (Table 1.2, p. 9). The 5th generation (1995–present) uses SLSI, 64-bit word size, up to 64 GB memory, multicore processors (e.g., Pentium, Celeron, Xeon). (NCERT §1.5, p. 8–9)
- **Microprocessor specifications:** (A) **Word size** — maximum bits processed at once (currently 16–64 bit); (B) **Memory size** — RAM size depends on word size (64-bit allows up to 16 Exabytes); (C) **Clock speed** — pulses generated per second by internal clock, measured in GHz (billions of pulses per second), indicates instruction execution speed; (D) **Cores** — basic computation unit; multicore processors (dual-core = 2, quad-core = 4, octa-core = 8) allow simultaneous task execution. (NCERT §1.5.1, p. 9–10)
- A **microcontroller** is a small computing device with a CPU, fixed amount of RAM, ROM and other peripherals all on a single chip. Unlike a microprocessor (which has only a CPU on chip), a microcontroller is a complete system. It is embedded in devices for specific tasks (e.g., controlling the washing cycle in a washing machine). Examples: keyboard, mouse, digital camera, pen drive, remote controller, microwave. (NCERT §1.5.2, p. 10)
- **Data and Information:** A computer processes data. Data can be raw, unorganised facts; when processed, they become meaningful **information**. Data types include structured (strict record format, e.g., attendance table — easily sorted), unstructured (no predefined format, e.g., audio/video files, social media posts, text documents), and semi-structured (no well-defined structure but uses internal tags, e.g., CSV files, HTML pages). (NCERT §1.6, §1.6.1, p. 10–12)
- **Data lifecycle:** (A) **Data Capturing** — gathering data from various sources in digital form (e.g., keyboard, barcode reader, satellite sensors); (B) **Data Storage** — storing captured data for future processing (storage requirements keep increasing;

- large organisations use data servers); (C) **Data Retrieval** — fetching data from storage for processing as per user requirement. (NCERT §1.6.2, p. 13)
- **Data Deletion and Recovery:** Deleting data marks its address as free without actually removing the bits immediately. **Data recovery** is the process of retrieving deleted, corrupted, or lost data from secondary storage — possible only if the marked space has not been overwritten. Security concerns include unauthorised deletion (mitigated by passwords/encryption) and unauthorised recovery (mitigated by data shredding before device disposal). (NCERT §1.6.3, p. 13–14)
 - **Software** is a set of instructions and data that makes hardware functional. Hardware alone is of no use; software acts as an interface between human users and hardware. It is classified into three categories: (i) System software, (ii) Programming tools, (iii) Application software (Figure 1.13, p. 16). (NCERT §1.7, p. 14–15)
 - **System software** provides basic functionality to operate a computer by interacting directly with hardware. It includes: (A) **Operating System** — manages other application programs and provides access/security; (B) **System Utilities** — maintenance and configuration tools (e.g., disk defragmentation, antivirus, disk compression); (C) **Device Drivers** — act as interface between a specific hardware device and the OS, hiding hardware-level details. (NCERT §1.7.2, p. 15–16)
 - **Programming tools** include: (A) Programming languages — low-level (machine language: 1s and 0s, directly executed; assembly language: English-like mnemonics, computer-specific) and high-level (machine-independent, uses English-like sentences, e.g., C++, Java, Python); (B) Language translators — assembler (assembly → machine language), compiler (entire source code → machine code at once; not needed again after translation), interpreter (one line at a time; always needed during execution); (C) Program development tools — text editors, IDEs (Integrated Development Environment: editor + build tools + debugger; e.g., Python IDLE, Netbeans, Eclipse, Atom, Lazarus), and debugger. (NCERT §1.7.3, p. 16–18)
 - **Application software** works on top of system software and caters to specific end-user needs. Two broad categories: (A) **General purpose software** — designed for generic applications for a broad audience (e.g., LibreOffice Calc, Adobe Photoshop, GIMP, Mozilla Firefox); (B) **Customised software** — tailor-made for a specific organisation or individual (e.g., school management software, accounting software, websites). (NCERT §1.7.4, p. 19)
 - **Proprietary vs. Free/Open Source Software: FOSS (Free and Open Source Software)** — source code freely available; anyone can improve or add functionality (e.g., Ubuntu, Python, LibreOffice, Mozilla Firefox). **Freeware** — free to use but source code not available (e.g., Skype, Adobe Reader). **Proprietary software** — must be purchased; source code not available (e.g., Microsoft Windows, Tally, Quickheal). (NCERT §1.7.5, p. 19–20)
 - An **Operating System (OS)** is a resource manager that manages all resources of a computer — CPU, RAM, Disk, Network, I/O devices, application software, and device

drivers. It has two primary objectives: (1) provide services for building and running application programs; (2) provide a user interface for human-computer interaction. (NCERT §1.8, p. 20)

- **OS User Interfaces** (Figure 1.15, p. 20): (A) **Command-based Interface** — user types commands (e.g., MS-DOS, Unix); less interactive, usually one program at a time; (B) **Graphical User Interface (GUI)** — icons, menus, windows; mouse and keyboard as input (e.g., Windows, Ubuntu, Fedora, Macintosh); (C) **Touch-based Interface** — touchscreen input (e.g., Android, iOS, Windows 8.1/10); (D) **Voice-based Interface** — voice commands (e.g., Siri/iOS, Google Now/Android, Cortana/Windows 10); (E) **Gesture-based Interface** — waving, tilting, eye motion (evolving; applications in gaming and medicine). (NCERT §1.8.1, p. 20–22)
- **Functions of Operating System** (§1.8.2): (A) **Process Management** — manages multiple running processes, allocates CPU, exchanges information among processes (a task in execution = process; managed via Ctrl+Alt+Delete system monitor); (B) **Memory Management** — dynamically allocates and frees main memory for running processes, tracks each location as free or occupied; (C) **File Management** — creation, updation, deletion and protection of files in secondary storage; manages access control; (D) **Device Management** — manages I/O devices through interaction with device drivers; configures devices; restricts device access to authorised users/software only. (NCERT §1.8.2, p. 22–23)

2.2 Definitions to memorise

Term	Definition	Page
Computer system	An electronic device (computer) together with additional hardware and software that accepts input, processes it, and generates output	1
CPU (Central Processing Unit)	Electronic circuitry that carries out actual processing; commonly called processor or microprocessor	1
ALU (Arithmetic Logic Unit)	Component of CPU that performs all arithmetic and logic operations	2
Control Unit (CU)	Component of CPU that controls sequential instruction execution, interprets instructions and guides data flow	2
Register	Local memory within the CPU chip used to store data, instructions, or intermediate results during processing	2
Input device	A device that sends control signals to a computer and converts input data into digital form acceptable by the computer system	2
Output device	A device that receives data from a computer and converts digital information into human-understandable form	2–3
Bit	The basic unit of memory; a binary digit — 0 or 1	5

Term	Definition	Page
Nibble	A group of 4 bits	5
Byte	A group of 8 bits (two nibbles)	5
RAM (Random Access Memory)	Volatile primary memory; data is lost when power is switched off; stores data and programs during processing	6
ROM (Read Only Memory)	Non-volatile primary memory; retains contents when power is off; stores startup program (boot loader)	6
Cache memory	Very high-speed memory between CPU and primary memory; stores copies of frequently accessed data to reduce average access time	6–7
Secondary memory	Non-volatile, larger capacity, slower memory used to store data permanently; cannot be directly accessed by CPU	7
Bus	Physical wires used to transfer data between components of a computer system	7
Data bus	Bidirectional bus that transfers data between different components	8
Address bus	Unidirectional bus that transfers memory addresses from CPU to memory	8
Control bus	Unidirectional bus that communicates control signals between components	8
Microprocessor	A CPU implemented on a single microchip	8
Microcontroller	A small computing device with CPU, fixed RAM, ROM, and peripherals all on a single chip; designed for specific tasks	10
Moore's Law	Prediction (Gordon Moore, 1965) that the number of transistors on a chip doubles every two years while costs halve	4
Data	Raw, unorganised facts that are processed to get meaningful information	10–11
Structured data	Data that follows a strict record structure in tabular format; easy to comprehend and sort	11
Unstructured data	Data not organised in a predefined record format (e.g., audio, video, social media posts)	12
Semi-structured data	Data with no well-defined structure but uses internal tags/ markings to separate data elements (e.g., CSV, HTML)	12
Data recovery	Process of retrieving deleted, corrupted, or lost data from secondary storage	14
Software	A set of instructions and data that makes computer hardware functional; cannot be touched or viewed physically	14–15

Term	Definition	Page
System software	Software that provides basic functionality to operate a computer by interacting directly with hardware	15
Device driver	Software that acts as interface between a specific hardware device and the OS	16
Assembler	Language translator that converts assembly language code to machine language	18
Compiler	Language translator that converts the entire source code (high-level) to machine code at once	18
Interpreter	Language translator that translates and executes one line of source code at a time	18
IDE (Integrated Development Environment)	Software consisting of text editor, building tools, and debugger for program development	18
FOSS	Free and Open Source Software — source code freely available for anyone to use, modify, and distribute	19
Freeware	Software free to use but source code is not available	20
Proprietary software	Software that must be purchased; source code not available to the public	20
Operating System	System software that acts as a resource manager, managing all hardware and software resources of a computer	20
Process	A task in execution on a computer system	22
GUI (Graphical User Interface)	OS user interface that lets users interact via icons, menus, and windows	21

2.3 Diagrams / processes to remember

- **Figure 1.1 (p. 1):** Block diagram of a computer system showing Secondary Storage Devices → Primary Memory → Control Unit (CU) and ALU (together forming CPU) → Output Device, with Input Device feeding into CU. Directed lines show data/signal flow.
- **Figure 1.4 (p. 3):** Timeline of key inventions in computing technology (500 BC to 1970+) — shows Abacus, Pascaline (1642), Analytical Engine (1834), Tabulating Machine (1890), Turing Machine (1937), EDVAC/ENIAC (1945), Transistor (1947), Integrated Circuit (1970).
- **Figure 1.5 (p. 4):** Von Neumann architecture — Input → Central Processing Unit + Memory → Output, showing stored-program concept.
- **Figure 1.6 (p. 4):** Exponential growth of transistors per IC over time (Intel microprocessor generations from 4004 to Core i7), illustrating Moore's Law.

- **Figure 1.8 (p. 8):** Data transfer between CPU, Memory, and Input/Output through Control bus, Address bus, and Data bus — all forming the System bus.
- **Figure 1.9 (p. 10):** Structure of microcontroller — Clock → CPU → Memory, with Bus System connecting I/O ports (Input and Output).
- **Figure 1.13 (p. 16):** Categorisation of software — User → User Interface → Application software / Programming tools → System Utilities → Operating System → Device Drivers → Hardware; with Proprietary Software and FOSS classification on the sides.
- **Figure 1.14 (p. 18):** Language translator process — Source Code (high-level) → Language Translator → Object Code (machine language).
- **Figure 1.15 (p. 20):** Types of user interfaces of OS — Command-based, GUI, Touch-based, Voice-based, Gesture-based.

2.4 Common confusions / NTA trap points

- **RAM vs. ROM volatility (NCERT § 1.3.2(A), p. 6).** RAM is volatile (data lost on power off); ROM is non-volatile. NTA may present options with these swapped. Remember: RAM = temporary working memory; ROM = permanent boot memory storing the bootloader.
- **Compiler vs. Interpreter (NCERT § 1.7.3, p. 18).** A compiler translates the entire program at once and the translated code can run without the compiler again; an interpreter translates one line at a time and is always needed during execution. NTA frequently asks which translator is needed repeatedly vs. only once.
- **Microprocessor vs. Microcontroller (NCERT § 1.5.2, p. 10).** A microprocessor has only a CPU on the chip; a microcontroller has CPU + RAM + ROM + peripherals on a single chip. Smart home appliances use microcontrollers (not microprocessors) because they need a complete embedded system for specific tasks.
- **Data bus is bidirectional; address bus and control bus are unidirectional (NCERT § 1.4, p. 8).** NTA traps students by stating the opposite. Only the data bus is bidirectional (CPU reads from and writes to memory). Address and control buses move in one direction only.
- **FOSS vs. Freeware (NCERT § 1.7.5, p. 19-20).** FOSS has source code freely available and can be modified (e.g., Ubuntu, Python). Freeware is free to use but source code is not available (e.g., Skype, Adobe Reader). Students wrongly treat them as synonymous; NTA tests this distinction.
- **Cache is NOT secondary memory (NCERT § 1.3.2(B), p. 6).** Cache is a high-speed primary-side buffer between CPU and RAM; it is faster than RAM, not slower. NTA traps confuse cache with secondary storage like SSD/HDD.
- **CPU cannot directly access secondary memory (NCERT § 1.3.2(C), p. 7).** Data on HDD/SSD must first be moved to RAM before the CPU can read or write it. NTA distractors may claim "CPU directly executes instructions from HDD."

- **Memory unit conversions use 1024, not 1000 (NCERT § 1.3.1, Table 1.1, p. 6).** 1 KB = 1024 bytes, not 1000 bytes. NTA exploits the SI-vs-binary confusion (decimal kilo = 1000 but computing kilobyte = 1024).
- **ENIAC vs. EDVAC (NCERT § 1.2, p. 4).** ENIAC is the first binary programmable computer based on Von Neumann architecture, while the stored program concept itself is attributed to John Von Neumann. NTA may confuse the two as identical milestones.
- **Word size ≠ clock speed (NCERT § 1.5.1, p. 9-10).** Word size is the number of bits processed at once; clock speed is the number of pulses per second (GHz). They are independent specifications — a 64-bit CPU can be slower (in GHz) than a 32-bit CPU.
- **Microcontroller examples (NCERT § 1.5.2, p. 10).** Pen drive, keyboard, mouse, digital camera, microwave, washing machine controller all use microcontrollers — not microprocessors. A common NTA trap: claiming a desktop CPU is a microcontroller.
- **System utilities are part of system software (NCERT § 1.7.2(B), p. 15).** Antivirus, disk defragmenter, and disk compression are system utilities — under system software — not application software. NTA may classify antivirus as "application software" to mislead.

Practice MCQs

Q1. Which of the following correctly describes the function of the Control Unit (CU) in a CPU?

- A.** It performs all arithmetic and logic operations on data as per program instructions.
- B.** It stores data, instructions, and intermediate results during processing.
- C.** It controls sequential instruction execution, interprets instructions, and guides data flow through memory, ALU, and I/O devices.
- D.** It acts as a very high-speed buffer between the CPU and primary memory.

Q2. Consider the following statements about types of memory: 1. RAM is non-volatile and retains data even when power is switched off. 2. ROM stores the startup program (boot loader) that loads the operating system into primary memory. 3. Cache memory is placed between the CPU and primary memory to reduce average data-access time. Which of the statements given above is/are correct?

- A. 1 and 2 only
- B. 2 and 3 only
- C. 1 and 3 only
- D. 1, 2, and 3

Q3. Match the following language translators with their correct descriptions: | Translator | Description | |---|---| | (i) Assembler | (P) Translates entire high-level source code to machine code at once; not needed again after translation | | (ii) Compiler | (Q) Translates one line of source code at a time; always needed during execution | | (iii) Interpreter | (R) Converts assembly language code to machine language |

- A. (i)–R, (ii)–P, (iii)–Q
- B. (i)–P, (ii)–Q, (iii)–R
- C. (i)–Q, (ii)–R, (iii)–P
- D. (i)–R, (ii)–Q, (iii)–P

 **12 more MCQs + answer key**

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PYQ Alignment

Computer System fundamentals form the foundation of CUET Computer Science and appear consistently across years, particularly through questions on memory types (RAM vs. ROM), software classification, language translators, and OS functions. NTA typically tests definitional precision — especially the volatile/non-volatile distinction, compiler vs. interpreter behaviour, and the microprocessor vs. microcontroller difference — making this one of the highest-yield chapters in the subject. Review all 15 MCQs and cross-link with the consolidated [PYQ archive for Computer Science](#) for further practice.