

Year	Subject Title	Sem	Sub Code
2018 -19 Onwards	Core: COMPUTER FUNDAMENTALS AND C PROGRAMMING	I	18BIT13C

Objectives:

- To enable the students to know about the fundamentals of computer types of software and operating system.
- To learn about of the programming language.
- To enable the students to learn the C programs using Arrays, Strings, Functions, Structures, Pointers and files.

UNIT I: Fundamentals of Computers: Introduction – History of Computers-Generations of Computers - Classification of Computers-Basic Anatomy of a Computer System-Input Devices Processor-Output Devices-Memory Management – Types of Software- Overview of Operating System- Programming Languages-Translator Programs-Problem Solving Techniques.

UNIT II: Overview of C: Introduction - Character set - C tokens - keyword & Identifiers -Constants - Variables - Data types - Declaration of variables - Assigning values to variables -Defining Symbolic Constants - Reading & Writing a character - Formatted input and output - Arithmetic, Relational, Logical, Assignment, Increment and Decrement operators, Conditional, Bitwise, Special Operators - Arithmetic Expressions - Evaluation of expressions -precedence of arithmetic operators - Type conversion in expressions – operator precedence &associatively - Mathematical functions.

UNIT III: Decision Making and Branching: Introduction – If, If...Else, nesting of If ...Else statements- Else If ladder – The Switch statement, The?: Operator – The Go to Statement. Decision Making and Looping: Introduction- the While statement- the do statement – the for statement-jumps in loops. Arrays - Character Arrays and Strings.

UNIT IV: User-Defined Functions: Introduction – Need and Elements of User-Defined Functions- Definition Return Values and their types - Function Calls – Function Declaration– Category of Functions- Nesting of Functions - Recursion – Passing Arrays and Strings to Functions - Structures and Unions.

UNIT V: Pointers: Understanding pointers - Accessing the address of a variable - Declaring and initializing pointers - Accessing a variable through its pointer - Pointer

expressions -Pointers and arrays -Pointers and character strings - Pointers to functions - Pointers and structures.

File Management in C- Defining and opening a file -Closing a file - Input/Output operations on files - Error handling during I/O operations -Random access to files - Command line arguments.

TEXT BOOK

1. E Balagurusamy, ” Computing Fundamentals & C Programming” - TataMcGraw-Hill, Second Reprint 2008, ISBN 978-0-07-066909-3.

REFERENCE BOOK:

1. Ashok N Kamthane: Programming with ANSI and Turbo C, Pearson Edition Publ, 2002.

2. Henry Mullish&HuubertL.Cooper: The Spirit of C, Jaico Pub. House, 1996.

UNITI: Fundamentals of Computers: Introduction – History of Computers-Generations of Computers - Classification of Computers-Basic Anatomy of a Computer System-Input Devices Processor-Output Devices-Memory Management – Types of Software- Overview of Operating System- Programming Languages-Translator Programs-Problem Solving Techniques.

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History of Computers

The computer was born not for entertainment or email but out of a need to solve a serious number-crunching crisis. By 1880, the U.S. population had grown so large that it took more than seven years to tabulate the U.S. Census results. The government sought a faster way to get the job done, giving rise to punch-card based computers that took up entire rooms.

Today, we carry more computing power on our smartphones than was available in these early models. The following brief history of computing is a timeline of how computers evolved from their humble beginnings to the machines of today that surf the Internet, play games and stream multimedia in addition to crunching numbers.

1801: In France, Joseph Marie Jacquard invents a loom that uses punched wooden cards to automatically weave fabric designs. Early computers would use similar punch cards.

1822: English mathematician Charles Babbage conceives of a steam-driven calculating machine that would be able to compute tables of numbers. The project, funded by the English government, is a failure. More than a century later, however, the world's first computer was actually built.

1890: Herman Hollerith designs a punch card system to calculate the 1880 census, accomplishing the task in just three years and saving the government \$5 million. He establishes a company that would ultimately become IBM.

1936: Alan Turing presents the notion of a universal machine, later called the Turing machine, capable of computing anything that is computable. The central concept of the modern computer was based on his ideas.

1937: J.V. Atanasoff, a professor of physics and mathematics at Iowa State University, attempts to build the first computer without gears, cams, belts or shafts.

1939: Hewlett-Packard is founded by David Packard and Bill Hewlett in a Palo Alto, California, garage, according to the Computer History Museum.

1941: Atanasoff and his graduate student, Clifford Berry, design a computer that can solve 29 equations simultaneously. This marks the first time a computer is able to store information on its main memory.

1943-1944: Two University of Pennsylvania professors, John Mauchly and J. Presper Eckert, build the Electronic Numerical Integrator and Calculator (ENIAC). Considered the grandfather of digital computers, it fills a 20-foot by 40-foot room and has 18,000 vacuum tubes.

1946: Mauchly and Presper leave the University of Pennsylvania and receive funding from the Census Bureau to build the UNIVAC, the first commercial computer for business and government applications.

1947: William Shockley, John Bardeen and Walter Brattain of Bell Laboratories invent the transistor. They discovered how to make an electric switch with solid materials and no need for a vacuum.

1953: Grace Hopper develops the first computer language, which eventually becomes known as COBOL. Thomas Johnson Watson Jr., son of IBM CEO Thomas Johnson Watson Sr., conceives the IBM 701 EDPM to help the United Nations keep tabs on Korea during the war.

1954: The FORTRAN programming language, an acronym for FORmula TRANslation, is developed by a team of programmers at IBM led by John Backus, according to the University of Michigan.

1958: Jack Kilby and Robert Noyce unveil the integrated circuit, known as the computer chip. Kilby was awarded the Nobel Prize in Physics in 2000 for his work.

1964: Douglas Engelbart shows a prototype of the modern computer, with a mouse and a graphical user interface (GUI). This marks the evolution of the computer from a specialized machine for scientists and mathematicians to technology that is more accessible to the general public.

1969: A group of developers at Bell Labs produce UNIX, an operating system that addressed compatibility issues. Written in the C programming language, UNIX was portable across multiple platforms and became the operating system of choice among mainframes at large companies and government entities. Due to the slow nature of the system, it never quite gained traction among home PC users.

1970: The newly formed Intel unveils the Intel 1103, the first Dynamic Access Memory (DRAM) chip.

1971: Alan Shugart leads a team of IBM engineers who invent the "floppy disk," allowing data to be shared among computers.

1973: Robert Metcalfe, a member of the research staff for Xerox, develops Ethernet for connecting multiple computers and other hardware.

1974-1977: A number of personal computers hit the market, including Scelbi & Mark-8 Altair, IBM 5100, Radio Shack's TRS-80 — affectionately known as the "Trash 80" — and the Commodore PET.

1975: The January issue of Popular Electronics magazine features the Altair 8080, described as the "world's first minicomputer kit to rival commercial models." Two "computer geeks," Paul Allen and Bill Gates, offer to write software for the Altair,

using the new BASIC language. On April 4, after the success of this first endeavor, the two childhood friends form their own software company, Microsoft.

1976: Steve Jobs and Steve Wozniak start Apple Computers on April Fool's Day and roll out the Apple I, the first computer with a single-circuit board, according to Stanford University.

1977: Radio Shack's initial production run of the TRS-80 was just 3,000. It sold like crazy. For the first time, non-geeks could write programs and make a computer do what they wished.

1977: Jobs and Wozniak incorporate Apple and show the Apple II at the first West Coast Computer Faire. It offers color graphics and incorporates an audio cassette drive for storage.

1978: Accountants rejoice at the introduction of VisiCalc, the first computerized spreadsheet program.

1979: Word processing becomes a reality as MicroPro International releases WordStar. "The defining change was to add margins and word wrap," said creator Rob Barnaby in email to Mike Petrie in 2000. "Additional changes included getting rid of command mode and adding a print function. I was the technical brains — I figured out how to do it, and did it, and documented it. "

1981: The first IBM personal computer, code-named "Acorn," is introduced. It uses Microsoft's MS-DOS operating system. It has an Intel chip, two floppy disks and an optional color monitor. Sears & Roebuck and Computerland sell the machines, marking the first time a computer is available through outside distributors. It also popularizes the term PC.

1983: Apple's Lisa is the first personal computer with a GUI. It also features a drop-down menu and icons. It flops but eventually evolves into the Macintosh. The Gavilan SC is the first portable computer with the familiar flip form factor and the first to be marketed as a "laptop."

1985: Microsoft announces Windows, according to [Encyclopedia Britannica](#). This was the company's response to Apple's GUI. Commodore unveils the Amiga 1000, which features advanced audio and video capabilities.

1985: The first dot-com domain name is registered on March 15, years before the World Wide Web would mark the formal beginning of [Internet history](#). The Symbolics Computer Company, a small Massachusetts computer manufacturer, registers Symbolics.com. More than two years later, only 100 dot-coms had been registered.

1986: Compaq brings the Deskpro 386 to market. Its 32-bit architecture provides as speed comparable to mainframes.

1990: Tim Berners-Lee, a researcher at CERN, the high-energy physics laboratory in Geneva, develops HyperText Markup Language (HTML), giving rise to the World Wide Web.

1993: The Pentium microprocessor advances the use of graphics and music on PCs.

1994: PCs become gaming machines as "Command & Conquer," "Alone in the Dark 2," "Theme Park," "Magic Carpet," "Descent" and "Little Big Adventure" are among the games to hit the market.

1996: Sergey Brin and Larry Page develop the Google search engine at Stanford University.

1997: Microsoft invests \$150 million in Apple, which was struggling at the time, ending Apple's court case against Microsoft in which it alleged that Microsoft copied the "look and feel" of its operating system.

1999: The term Wi-Fi becomes part of the computing language and users begin connecting to the Internet without wires.

2001: Apple unveils the Mac OS X operating system, which provides protected memory architecture and pre-emptive multi-tasking, among other benefits. Not to be outdone, Microsoft rolls out Windows XP, which has a significantly redesigned GUI.

2003: The first 64-bit processor, AMD's Athlon 64, becomes available to the consumer market.

2004: Mozilla's Firefox 1.0 challenges Microsoft's Internet Explorer, the dominant Web browser. Facebook, a social networking site, launches.

2005: YouTube, a video sharing service, is founded. Google acquires Android, a Linux-based mobile phone operating system.

2006: Apple introduces the MacBook Pro, its first Intel-based, dual-core mobile computer, as well as an Intel-based iMac. Nintendo's Wii game console hits the market.

2007: The iPhone brings many computer functions to the smartphone.

2009: Microsoft launches Windows 7, which offers the ability to pin applications to the taskbar and advances in touch and handwriting recognition, among other features.

2010: Apple unveils the iPad, changing the way consumers view media and jumpstarting the dormant tablet computer segment.

2011: Google releases the Chromebook, a laptop that runs the Google Chrome OS.

2012: Facebook gains 1 billion users on October 4.

2015: Apple releases the Apple Watch. Microsoft releases Windows 10.

2016: The [first reprogrammable quantum computer](#) was created. "Until now, there hasn't been any quantum-computing platform that had the capability to program new algorithms into their system. They're usually each tailored to attack a particular algorithm," said study lead author Shantanu Debnath, a quantum physicist and optical engineer at the University of Maryland, College Park.

2017: The Defense Advanced Research Projects Agency (DARPA) is developing a new "Molecular Informatics" program that uses molecules as computers. "Chemistry offers a rich set of properties that we may be able to harness for rapid, scalable information storage and processing," Anne Fischer, program manager in DARPA's Defense Sciences Office, said in a statement. "Millions of molecules exist, and each molecule has a unique three-dimensional atomic structure as well as variables such as shape, size, or even color. This richness provides a vast design space for exploring novel and multi-value ways to encode and process data beyond the 0s and 1s of current logic-based, digital architectures."

Generation of Computers

S.No	Generation & Description
1	First Generation The period of first generation: 1946-1959. Vacuum tube based.
2	Second Generation The period of second generation: 1959-1965. Transistor based.
3	Third Generation The period of third generation: 1965-1971. Integrated Circuit based.
4	Fourth Generation The period of fourth generation: 1971-1980. VLSI microprocessor based.
5	Fifth Generation The period of fifth generation: 1980-onwards. ULSI microprocessor based.

First Generation

The period of first generation was from 1946-1959. The computers of first generation used vacuum tubes as the basic components for memory and circuitry for CPU (Central Processing Unit). These tubes, like electric bulbs, produced a lot of heat and the installations used to fuse frequently. Therefore, they were very expensive and only large organizations were able to afford it.

In this generation, mainly batch processing operating system was used. Punch cards, paper tape, and magnetic tape was used as input and output devices. The computers in this generation used machine code as the programming language.

The main features of the first generation are –

- Vacuum tube technology
- Unreliable
- Supported machine language only
- Very costly
- Generated a lot of heat
- Slow input and output devices
- Huge size
- Need of AC
- Non-portable
- Consumed a lot of electricity

Some computers of this generation were –

- ENIAC
- EDVAC
- UNIVAC
- IBM-701
- IBM-650

Second Generation

The period of second generation was from 1959-1965. In this generation, transistors were used that were cheaper, consumed less power, more compact in size, more reliable and faster than the first generation machines made of vacuum tubes. In this generation, magnetic cores were used as the primary memory and magnetic tape and magnetic disks as secondary storage devices.

In this generation, assembly language and high-level programming languages like FORTRAN, COBOL were used. The computers used batch processing and multiprogramming operating system.

The main features of second generation are –

- Use of transistors
- Reliable in comparison to first generation computers
- Smaller size as compared to first generation computers
- Generated less heat as compared to first generation computers
- Consumed less electricity as compared to first generation computers
- Faster than first generation computers
- Still very costly
- AC required
- Supported machine and assembly languages

Some computers of this generation were –

- IBM 1620
- IBM 7094
- CDC 1604
- CDC 3600
- UNIVAC 1108

Third Generation

The period of third generation was from 1965-1971. The computers of third generation used Integrated Circuits (ICs) in place of transistors. A single IC has many transistors, resistors, and capacitors along with the associated circuitry.

The IC was invented by Jack Kilby. This development made computers smaller in size, reliable, and efficient. In this generation remote processing, time-sharing, multiprogramming operating system were used. High-level languages (FORTRAN-II TO IV, COBOL, PASCAL PL/1, BASIC, ALGOL-68 etc.) were used during this generation.

The main features of third generation are –

- IC used
- More reliable in comparison to previous two generations
- Smaller size
- Generated less heat

- Faster
- Lesser maintenance
- Costly
- AC required
- Consumed lesser electricity
- Supported high-level language

Some computers of this generation were –

- IBM-360 series
- Honeywell-6000 series
- PDP (Personal Data Processor)
- IBM-370/168
- TDC-316

Fourth Generation

The period of fourth generation was from 1971-1980. Computers of fourth generation used Very Large Scale Integrated (VLSI) circuits. VLSI circuits having about 5000 transistors and other circuit elements with their associated circuits on a single chip made it possible to have microcomputers of fourth generation.

Fourth generation computers became more powerful, compact, reliable, and affordable. As a result, it gave rise to Personal Computer (PC) revolution. In this generation, time sharing, real time networks, distributed operating system were used. All the high-level languages like C, C++, DBASE etc., were used in this generation.

The main features of fourth generation are –

- VLSI technology used
- Very cheap
- Portable and reliable
- Use of PCs
- Very small size
- Pipeline processing

- No AC required
- Concept of internet was introduced
- Great developments in the fields of networks
- Computers became easily available

Some computers of this generation were –

- DEC 10
- STAR 1000
- PDP 11
- CRAY-1(Super Computer)
- CRAY-X-MP(Super Computer)

Fifth Generation

The period of fifth generation is 1980-till date. In the fifth generation, VLSI technology became ULSI (Ultra Large Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components.

This generation is based on parallel processing hardware and AI (Artificial Intelligence) software. AI is an emerging branch in computer science, which interprets the means and method of making computers think like human beings. All the high-level languages like C and C++, Java, .Net etc., are used in this generation.

AI includes –

- Robotics
- Neural Networks
- Game Playing
- Development of expert systems to make decisions in real-life situations
- Natural language understanding and generation

The main features of fifth generation are –

- ULSI technology
- Development of true artificial intelligence

- Development of Natural language processing
- Advancement in Parallel Processing
- Advancement in Superconductor technology
- More user-friendly interfaces with multimedia features
- Availability of very powerful and compact computers at cheaper rates

Some computer types of this generation are –

- Desktop
- Laptop
- NoteBook
- UltraBook
- ChromeBook

Classification of Computers

Sr.No.	Type	Specifications
1	PC (Personal Computer) or Micro-Computers	It is a single user computer system having a moderately powerful microprocessor. It is termed as a computer that is equipped microprocessor as its CPU.
2	Workstation	It is also a single user computer system, similar to the personal computer, however, has a more powerful microprocessor.
3	Mini-Computer	It is a multi-user computer system, capable of supporting hundreds of users simultaneously.

Sr.No.	Type	Specifications
4	Main Frame	It is a multi-user computer system, capable of supporting hundreds of users simultaneously. Software technology is different from minicomputer.
5	Super-Computer	It is an extremely fast computer, which can execute hundreds of millions of instructions per second.

PC (Personal Computer)

A PC can be defined as a small, relatively inexpensive computer designed for an individual user. PCs are based on the microprocessor technology that enables manufacturers to put an entire CPU on one chip. Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications. At home, the most popular use for personal computers is playing games and surfing the Internet.

Although personal computers are designed as single-user systems, these systems are normally linked together to form a network. In terms of power, nowadays high-end models of the Macintosh and PC offer the same computing power and graphics capability as low-end workstations by Sun Microsystems, Hewlett-Packard, and Dell.

Workstation

The workstation is a computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other such types of applications which require a moderate amount of computing power and relatively high-quality graphics capabilities.

Workstations generally come with a large, high-resolution graphics screen, a large amount of RAM, inbuilt network support, and a graphical user interface. Most workstations also have mass storage device such as a disk drive, but a special type of workstation, called diskless workstations, comes without a disk drive.

Common operating systems for workstations are UNIX and Windows NT. Like PC, workstations are also single-user computers like PC but are typically linked together to form a local area network, although they can also be used as stand-alone systems.

Minicomputer

It is a midsize multi-processing system capable of supporting up to 250 users simultaneously.

Mainframe

The mainframe is very large in size and is an expensive computer capable of supporting hundreds or even thousands of users simultaneously. Mainframe executes many programs concurrently and supports much simultaneous execution of programs.

Supercomputer

Supercomputers are one of the fastest computers currently available. Supercomputers are very expensive and are employed for specialized applications that require an immense amount of mathematical calculations (number-crunching).

For example, weather forecasting, scientific simulations, (animated)graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting).

Anatomy Of A Computer

A computer can accept input, process or store data, and produce output according to a set of instructions which are fed into it. A computer system can be divided into two components which are responsible for providing the mechanisms to input and output data, to manipulate and process data, and to electronically control the various input, output, and their storage. They are known as hardware and software. The *hardware* is the tangible parts of the computer. Whereas, the *software* is the intangible set of instructions that control the hardware and make it perform specific tasks. Without software, a computer is effectively useless.

1. Hardware

Hardware is the physical components of a computer that includes all mechanical, electrical, electronic and magnetic parts attached to it. A computer consists of the following major hardware components:

- Input and output devices
- Central processing unit (CPU)
- Memory unit and storage devices
- Interface unit

Input devices

- The data and instructions are typed, submitted, or transmitted to a computer through input devices. Input devices are electronic or electro-mechanical equipment that provide a means of communicating with the computer system for feeding input data and instructions. Most common input devices are briefly described below.
- **Keyboard** Keyboard is like a type-writer. A keyboard, normally, consists of 104 keys. These keys are classified into different categories which are briefly described below.
- **Character keys** These keys include letters, numbers, and punctuation marks. On pressing any character key, the corresponding character is displayed on the screen.
- **Function keys** There are 12 functional keys above the key board which are used to perform certain functions depending on the operating system or the software currently being executed. These keys are placed at the top of the key board and can easily be identified with the letter F followed by a number ranging from 1 to 12.
- **Control keys** Alt, Ctrl, Shift, Insert, Delete, Home, End, PgUp, PgDn, Esc and Arrow keys are control keys.
- **Navigation keys** These include four arrows, Page Up and Page Down, Home and End. These keys are normally used to navigate around a document or screen.
- **Toggle keys** Scroll Lock, Num lock, Caps Lock are three toggle keys. The toggle state is indicated by three LEDs at the right-top side of the keyboard. For example, on pressing caps lock, letters typed by the user will appear in upper case. On pressing again, letters are typed on the screen in lower case.
- **Mouse** A mouse is the pointing device attached to a computer. It is used to move the cursor around the screen and to point to an object (such as icon, menu, command button etc.) on the computer video screen for the purpose of selecting or activating objects on graphical interface provided by the operating system or the software currently being executed and executing various tasks. It has two or three buttons for clicking. The mouse tracks the

motion of the mouse pointer and senses the clicks and sends them to the computer so it can respond appropriately. The mouse can be connected to the system either through a USB connector or wirelessly through infrared radiation. A wireless mouse needs to be powered through batteries.

- **Scanner** A scanner is a device that captures pictures or documents so that they can be stored in storage devices, seen on the video screen, modified suitably, transported to other computers, or printed on a printer. A personal computer with a scanner and printer can function as a photocopier.

Output devices

- Output devices mirror the input data, or show the output results of the operations on the input data or print the data. The most common output device is monitor or visual display unit. The printer is used to print the result. A hard copy refers to a printout showing the information. On the other hand soft copy means information stored on a storage device.
- **Monitor** Computer display devices are commonly known as Visual Display Unit (VDU) or monitor. It operates on a principle similar to that of a normal television set. Various technologies have been used for computer monitors. They are also of different sizes. CRT (Cathode-ray tube) and LCD (liquid crystal display) monitors are the two common types which are widely used. The CRT is composed of a vacuum glass tube which is narrower at one end. One electron gun is placed at this end which fires electrons. The electron gun is made up of cathode (negatively charged) and one anode (positively charged). On the other side it has a wide screen, coated with phosphor. The beam of electron strikes on the surface of screen and produces an image by photo luminance process. There is some vertical and horizontal coil to deflect the electron beam in any position of the screen. An image is formed by constantly scanning the screen. To send an image to the screen, the computer first assembles it in a memory area called a video buffer. The graphics are stored as an array of memory locations that represent the colors of the individual screen dots, or pixels. The video card then sends this data through a Digital To Analog Converter (DAC), which converts the data to a series of voltage levels that are fed to the monitor. CRT monitors are too bulky and consume high power. Apart from these, users are very much concerned about potentially damaging non-ionizing radiation from CRT monitor.

- **Printer** The printer is a device that prints any data, report, document, picture, diagrams, etc. Printers are categorized based on the physical contact of the print head with the paper to produce a text or an image. An *impact printer* is one where the print head will be in physical contact with the paper. In a *non-impact printer*, on the other hand the print head will have no physical contact with the paper.
- **Central processing unit (CPU)** Central Processing Unit or CPU can be thought of as the brain of the computer. Most of the processing takes place in CPU. During processing, it locates and executes the program instructions. It also fetches data from memory and input/output devices and sends data back.
- Physically, it is an integrated circuit (IC) silicon chip, mounted on a small square plastic slab, surrounded by metal pins. In the world of personal computers, the term microprocessor and CPU are used interchangeably. It is more accurate to describe it as a CPU on a chip because it contains the circuitry that performs processing. The CPU itself can be divided into different functional units which are described below-
- **Registers** These are high-speed storage devices. In most CPUs, some registers are reserved for special purposes. For example, the Instruction Register (IR) holds the current instruction being executed. The Program Counter (PC) is a register that holds the address of the next instruction to be executed. In addition to such and other special-purpose registers, it also contains a set of general-purpose registers that are used for temporary storage of data values as needed during processing.
- **Arithmetic logic unit (ALU)** It is the part of the CPU that performs arithmetic operations, such as addition and subtraction as well as logical operations, such as comparing two numbers to see if they are the equal or greater or less.

Control unit (CU) The control unit coordinates the processing by controlling the transfer of data and instructions between main memory and the registers in the CPU. It also coordinates the execution of the arithmetic logic unit (ALU) to perform operations on data stored in particular registers. It consists of

- an *instruction decoding circuit* that interprets what action should be performed.

- a *control and timing circuit* directs all the other parts of the computer by producing the respective control signals.

Nowadays, a high-speed memory, called *cache memory*, is embedded with the CPU chip. This improves the computer performance by minimizing the processor need to read data from the slow main memory. The CPU's processing power is measured in terms of the number of instructions that it can execute per unit time. Every computer comprises of an internal clock, which emits electronic pulses at a constant rate. These pulses are used to control and synchronize the pace of operations. Each pulse is called a *clock cycle* which resembles a rectangular wave with a rising half of the signal and a falling half. In other words, a full clock cycle is the amount of time that elapses between pulses of the oscillating signal. Each instruction takes one or more clock cycles to execute. The higher the clock speed, the more instructions are executed in a given period of time. Hertz (Hz) is the basic unit of computer clock frequency which is equal to one cycle per second. CPU speed has been improved continuously. It is typically measured in megahertz (MHz) or gigahertz (GHz). One megahertz is equal to one million cycles per second, while one gigahertz equals one billion cycles per second. Nowadays, multiple processors are embedded together on a single integrated-circuit chip, known as multi-core processor e.g. a *dual-core processor* has two CPUs and a *quad core processor* has four CPUs.

- ***Memory unit***

Components such as the input device, output device, and CPU are not sufficient for the working of a computer. A storage area is needed in a computer to store instructions and data, either temporarily or permanently, so that subsequent retrieval of the instructions and data can be possible on demand. Data are stored in memory as binary digits, called *bits*. Data of various types, such as numbers, characters, are encoded as series of bits and stored in consecutive memory locations. Each memory location comprises of a single byte which is equal to eight bits and has a unique address so that the contents of the desired memory locations can be accessed independently by referring to its' address. A single data item is stored in one or more consecutive bytes of memory. The address of the first byte is used as the address of the entire memory location. CPU uses registers exclusively to store and manipulate data and instructions during the processing. Apart from registers,

there are mainly two types of memory that are used in a computer system. One is called *primary memory* and the other *secondary memory*.

Primary memory Primary memory is the area where data and programs are stored while the program is being executed along with the data. This memory space, also known as *main memory*, forms the working area of the program. This memory is accessed directly by the processor. A memory module consists of a large bank of flip-flops arranged together with data traffic control circuitry such that data can be stored or read out on or from a set of flip-flops. A flip-flop can store a binary digit. These flip-flops are grouped to form a unit memory of fixed length and each of which is identified by a sequence number known as a memory address. These type are called Random Access Memory, or RAM, where any location can be accessed directly, and its stored contents get destroyed the moment power to this module is switched off. Hence, these are volatile in nature. Primary memory devices are expensive. They are limited in size, consume very low power, and are faster as compared to secondary memory devices. There is another kind of primary memory increasingly being used in modern computers. It is called *cache memory* (pronounced as “cash”). It is a type of high speed memory that allows the processor to access data more rapidly than from memory located elsewhere on the system. It stores or caches some of the contents of the main memory that is currently in use by the processor. It takes a fraction of the time, compared to main memory, to access cache memory. The management of data stored in the cache memory ensures that for 20 per cent of the total time, during which the cache is searched, the data needed is found to be stored in cache. As a result the performance of the computer improves in terms of speed of processing.

Secondary memory Secondary memory provides large, non-volatile, and inexpensive storage for programs and data. However, the access time in secondary memory is much larger than in primary memory. Secondary storage permits the storage of computer instructions and data for long periods of time. Moreover, secondary memory, which is also known as *auxiliary memory*, stores a huge number of data bytes at a lesser cost than primary memory devices.

Note:

- The memory unit is composed of an ordered sequence of storage cells, each capable of storing one byte of data. Each memory cell has a distinct address which is used to refer while storing data into it or retrieving data from it.

- Both RAM and cache memory are referred to as primary memory. Primary memory is comparatively expensive, and loses all its data when the power is turned off. Secondary memory provides less expensive storage that is used to store data and instructions on a permanent basis.

Memory operations

There are some operations common to both primary and secondary memory devices. These are as follows.

Read During this operation, data is retrieved from memory.

Write In this operation, data is stored in the memory. Using read and write operations, many other memory-related functions such as copy and delete are carried out.

Unit of memory The memory's interface circuit is designed to logically access a byte or a multiple of a byte of data from the memory during each access. The smallest block of memory is considered to be a byte, which comprises eight bits. The total memory space is measured in terms of bytes. Thus, the unit of memory is a byte. The capacity of memory is the maximum amount of information it is capable of storing. Since the unit of memory is a byte, the memory's capacity is expressed in number of bytes. Some units used to express the memory capacity are as follows:

- Kilobyte (KB) = 1024 bytes
- Megabyte (MB) = 1024 Kilobytes
- Gigabyte (GB) = 1024 Megabytes
- Terabyte (TB) = 1024 Gigabytes
- Petabyte (PB) = 1024 Terabytes
- Exabyte (EB) = 1024 Petabytes
- Zettabyte (ZB) = 1024 Exabytes
- Yottabyte (YB) = 1024 Zettabytes

The size of the register is one of the important considerations in determining the processing capabilities of the CPU. *Word size* refers to the number of bits that a CPU can manipulate at one time. Word size is based on the size of registers in the ALU and the capacity of circuits that lead to those registers. A processor with a 32-bit word size, for example, has 32-bit registers, processes 32 bits at a time, and is referred to as a 32-bit processor. Processor's word size is a factor that leads to

increased computer performance. Today's personal computers typically contain 32-bit or 64-bit processors.

Memory hierarchy (Memory management)

The various types of memory used in a computer system differ in speed, cost, size, and volatility (permanence of storage). They can be organized in a hierarchy. The memory hierarchy in the computer system is depicted as:

Registers

Cache

Main Memory

Secondary Memory

It shows that on moving down the hierarchy, the cost per bit of storage decreases but access times increases (i.e., devices are slow). In other words, from top to bottom, the speed decreases while the capacity increases and the prices become much lower. Of the various memories specified in the hierarchy, those above the secondary memory are volatile and the rest are non-volatile. While designing a computer system, there must always be a balance on all of the above factors, namely speed, cost, volatility, etc. at each level in the hierarchy. The devices in a computer system other than the CPU and main memory are called **peripherals**. Popular peripheral devices include printers, digital cameras, scanners, joysticks, and speakers.

Interface unit

The interface unit interconnects the CPU with memory and also with the various input/output (I/O) devices. The instructions and data move between the CPU and other hardware components through interface unit. It is a set of parallel wires or lines which connects all the internal computer components to the CPU and main memory. Depending on the type of data transmitted, a bus can be classified into the following three types:

Data bus The bus used to carry actual data.

Address bus memory or Input/output device Addresses travel via the address bus.

Control bus This bus carries control information between the CPU and other devices within the computer. The control information entails signals that report the status of various devices, or ask devices to take specific actions

- ***Motherboard***

All the components in the computer system are mounted and connected together by an electronic circuit board called motherboard or main board. To make all these things work together the motherboard provides some kind of physical connection among them.

Types of Software

Software

Software provides the instructions that tell the hardware exactly what is to be performed and in what order. This set of instructions is sequenced and organized in a computer program. Therefore, a program is a series of instructions which is intended to direct a computer to perform certain functions and is executed by the processor. In a broader sense, software can be described as a set of related programs. But software is more than a collection of programs. It refers to a set of computer programs, which provide desired functions and performance, the data which the programs use, data structures that facilitate the programs to efficiently manipulate data and documents that describe the operation and use of the programs. A comparison between computer program and software is listed below (Table below).

Table Comparison between computer program and software

Computer Program	Software
Programs are developed by individuals. A single developer is involved.	A large number of developed are involved.
Small in size and have limited functionality.	Extremely large in size and has enormous functionality.
The user interface may not be very important, because the programmer is the sole user.	For a software product, user interface must be carefully designed and implemented because developers of that products and users of that product are totlly different.

Nowadays, most of the software must be installed prior to their use. Installation involves copying several files to computer memory or requires a series of steps and configurations depending on the operating system and the software itself so that it can be run or executed when required. Software is generally categorized as system software or application software or utility software.

System software

System software is designed to facilitate and coordinate the use of the computer by making hardware operational. It interacts with the computer system at low level. Examples of such software include language translator, operating system, loader, linker, etc. However, the most important system software is the *operating system* which is a set of programs designed to control the input and output operations of the computer, provide communication interface to the user, and manage the resources of the computer system, such as memory, processor, input/output devices etc. and schedule their operations with minimum manual intervention. Other programs (system and application) rely on facilities provided by the operating system to gain access to computer system resources. The *loader* is the system software which copies a executable program from secondary storage device into main memory and prepares this program for execution and initializes the execution. Hardware devices, other than the CPU and main memory, have to be registered with the operating system by providing a software, known as *device driver*, for communication between the device and other parts of the computer. This type of system software is used by printers, monitors, graphics cards, sound cards, network cards, modems, storage devices, mouse, scanners, etc. Once installed, a device driver automatically responds when it is needed or may run in the

background. Modern operating system recognizes almost all connected hardware devices and immediately begins the installation process. Such a device, for which the operating system automatically starts the installation process, is called a *plug and-play* device. However, there are few hardware devices for which the user has to manually initiate the installation process.

Application software

Application software is designed to perform specific usages of the users. Microsoft Word, Microsoft Excel, Microsoft Power Point, Microsoft Access, Page Maker, Coral Draw, Photoshop, Tally, AutoCAD, Acrobat, WinAmp, Micro Media Flash, iLeap, Xing MP3 Player etc. are some of the examples of application software. There are two categories of application software, *custom software* and *pre-written software packages*. Software that is developed for a specific user or organization in accordance with the user's needs is known as *custom software*. A *pre-written software package* is bought off the shelf and has predefined generic specifications that may or may not cater to any specific user's requirements. The most important categories of software packages available are as follows:

- Database management software, e.g. Oracle, DB2, Microsoft SQL server, etc.
- Spreadsheet software, e.g. Microsoft Excel.
- Word processing, e.g. Microsoft Word, Corel Word perfect and desktop publishing (DTP), e.g. Page maker.
- Graphics software, e.g. Corel Draw.
- Statistical, e.g. SPSS and operation research software, e.g. Tora.

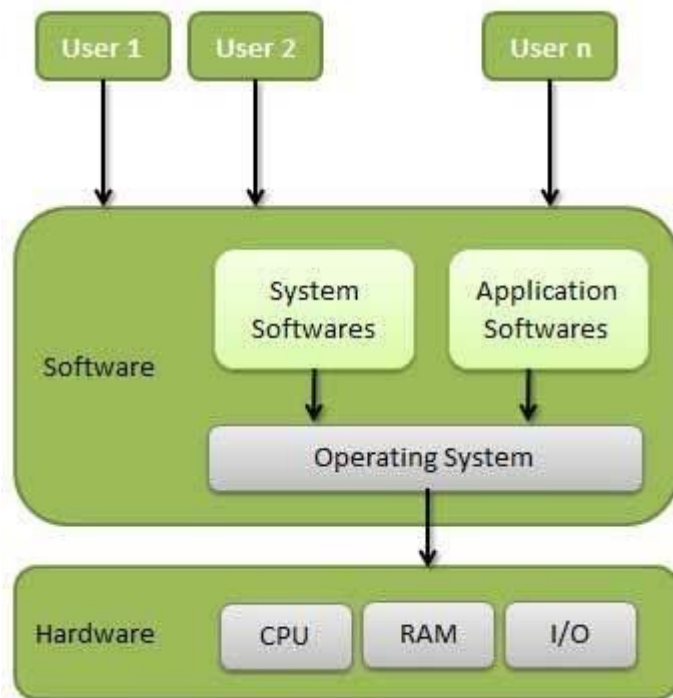
Operating System

An Operating System (OS) is an interface between a computer user and computer hardware. An operating system is a software which performs all the basic tasks like file management, memory management, process management, handling input and output, and controlling peripheral devices such as disk drives and printers.

Some popular Operating Systems include Linux Operating System, Windows Operating System, VMS, OS/400, AIX, z/OS, etc.

Definition

An operating system is a program that acts as an interface between the user and the computer hardware and controls the execution of all kinds of programs.



Following are some of important functions of an operating System.

- Memory Management
- Processor Management
- Device Management
- File Management
- Security
- Control over system performance
- Job accounting
- Error detecting aids
- Coordination between other software and users

Programming Languages

A programming language is a set of commands, instructions, and other syntax use to create a software program. Languages that programmers use to write code are called "high-level languages." This code can be compiled into a "low-level language," which is recognized directly by the computer hardware.

High-level languages are designed to be easy to read and understand. This allows programmers to write source code in a natural fashion, using logical words and symbols. For example, reserved words like function, while, if, and else are used in most major programming languages. Symbols like <, >, ==, and != are common operators. Many high-level languages are similar enough that programmers can easily understand source code written in multiple languages.

Examples of high-level languages include C++, Java, Perl, and PHP. Languages like C++ and Java are called "compiled languages" since the source code must first be compiled in order to run. Languages like Perl and PHP are called "interpreted languages" since the source code can be run through an interpreter without being compiled. Generally, compiled languages are used to create software applications, while interpreted languages are used for running scripts, such as those used to generate content for dynamic websites.

Low-level languages include assembly and machine languages. An assembly language contains a list of basic instructions and is much more difficult to read than a high-level language. In rare cases, a programmer may decide to code a basic program in an assembly language to ensure it operates as efficiently as possible. An assembler can be used to translate the assembly code into machine code. The machine code, or machine language, contains a series of binary codes that are understood directly by a computer's CPU. Needless to say, machine language is not designed to be human readable.

Translator Programs

A **translator** or **programming language processor** is a generic term that can refer to anything that converts code from one computer language into another. A program written in high-level language is called source program. These include translations between high-level and human-readable computer languages such as C++ and Java, intermediate-level languages such as Java byte code, low-level languages such as the assembly language and machine code, and between similar levels of language on different computing platforms, as well as from any of the above to another.

Different types of translators

Compiler

A compiler is a translator used to convert high-level programming language to low-level programming language. It converts the whole program in one session and reports errors detected after the conversion. The compiler takes time to do its work as it translates high-level code to lower-level code all at once and then saves it to memory. A compiler is processor-dependent and platform-dependent. It has been addressed by alternate names as the following: special compiler, cross-compiler and, source-to-source compiler

Interpreter

The interpreter is similar to a compiler, it is a translator used to convert high-level programming language to low-level programming language. The difference is that it converts the program one line of code at a time and reports errors when detected, while also doing the conversion. An interpreter is faster than a compiler as it immediately executes the code upon reading the code. It is often used as a debugging tool for software development as it can execute a single line of code at a time. An interpreter is also more portable than a compiler as it is processor-independent, you can work between different hardware architectures

Assembler

An assembler is a translator used to translate assembly language into machine language. It has the same function as a compiler for the assembly language but works like an interpreter. Assembly language is difficult to understand as it is a low-level programming language. An assembler translates a low-level language, such as an assembly language to an even lower-level language, such as the machine code

Problem Solving Techniques

Computer Programmers are problem solvers. In order to solve a problem on a computer you must:

1. Know how to **represent** the information (data) describing the problem.
2. Determine the steps to **transform** the information from one representation into another.

Information Representation

A computer, at heart, is really dumb. It can only really know about a few things... numbers, characters, booleans, and lists (called arrays) of these items. (See Data Types). Everything else must be "approximated" by combinations of these data types.

A good programmer will "encode" all the "facts" necessary to represent a problem in variables (See Variables). Further, there are "good ways" and "bad ways" to encode information. Good ways allow the computer to easily "compute" new information.

Algorithm

An algorithm (see Algorithm) is a set of specific steps to solve a problem. Think of it this way: if you were to tell your 3 year old niece to play your favorite song on the piano (assuming the niece has never played a piano), you would have to tell her where the piano was, and how to sit on the bench, and how to open the cover, and which keys to press, and which order to press them in, etc, etc, etc.

The core of what good programmers do is being able to define the steps necessary to accomplish a goal. Unfortunately, a computer, only knows a very restricted and limited set of possible steps. For example a computer can add two numbers. But if you want to find the average of two numbers, this is beyond the basic capabilities of a computer. To find the average, you must:

1. First: Add the two numbers and save this result in a variable
2. Then: Divide this new number the number two, and save this result in a variable.
3. Finally: provide this number to the rest of the program (or print it for the user).