SPI 2102 COMPUTER SYSTEMS AND ORGANIZATION

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COURSE DESCRIPTION

Classification of computers: size, types and generations. Fundamentals of PCs: Hardware, Central processing unit (CPU), motherboards, hard disc and floppy disk: types, track, sector, cluster, access mode: sequential, random, indexed and access methods. Memories: types and classification; random access memory (RAM), read only memory (ROM), cache, virtual storage, memory capacity. Peripheral devices: printer, monitor, keyboard. Software: operating systems, ROM BIOS, Role of ROM BIOS. Software utilities. Information and data; bits and byte. Data representation: character codes, binary, octal and hexadecimal numbers.

Learning outcomes/objectives

- Describe the fundamentals of computer organization and its relevance to classical and modern problems of computer design.
- Describe where, and how enhancements of computer performance can be accomplished.
- Apply concepts of computer organization in real-life settings using various PC performance improvements.

Assessment

- Two CATs – 4th week and 10th week. One sit in and one take away (30%)
- End of semester exams (70%)

Ground rules

- Mobile phones should be switched off during lectures
- No moving in and out of lecture hall during lectures
- Punctuality to lectures should be observed

Classification of computers

Computers can be classified according to the following factors:

1. Physical size & processing power.
2. Purpose for which they are designed.
3. Functionality (operating principles).

A. CLASSIFICATION ACCORDING TO PHYSICAL SIZE.

Computers can be classified into 4 main groups according to their size as:

- Supercomputers.
- Mainframe computers.
- Minicomputers.
- Microcomputers.

Supercomputers.

Supercomputers are the fastest, largest, most expensive & also the most powerful computers available. They are very fast in processing. They can perform many complex calculations in a fraction of a second. Most Supercomputers use multiple processors. In this case, a single task is split among the processors for faster execution. However, all the processors are controlled by a single central processor.

Supercomputers generate a lot of heat, & therefore require special cooling systems. Sometimes, the whole CPU is deeped in a tank containing **liquid Fluorocarbon** to provide cooling. Supercomputers are very large & heavy, and are usually kept under special environmental conditions (i.e., in a special room). They are operated by computer specialists. A Supercomputer can be operated by over 500 users at the same time.

Areas where supercomputers are used:

Supercomputers are mainly used for complex scientific applications that involve many calculations & require a lot of computational power. Some of the applications that use supercomputers include;

- ✔ Weather forecasting.
- ✔ Petroleum research.
- ✔ Defence and weapon analysis.
- ✔ Aerodynamic design and simulation.

Note. These tasks use large amounts of data, which need to be manipulated within a very short time.

Examples of Supercomputers:

- CRAY T3D, NEC-500.

Mainframe computers.

Mainframes are less powerful & less expensive than supercomputers. They are big in size but smaller compared to Supercomputers. Are powerful computers with very high capacities of Main storage. They also have a large backing storage capacity. Have a very high processing speed, i.e., can process large amounts of data very quickly. They can support a large number of peripherals of different types (can support between 5–300 terminals). They can handle hundreds of users at the same time, e.g., they can be operated by 200 users at a time. Mainframe computers are general-purpose, and can handle all kinds of problems whether scientific or commercial.

Areas where mainframe computers are used:

Mainframe computers are mostly found in government departments, big organizations and companies which have large information processing needs, e.g., they are used;

- ✔ In Banks & Hospitals for preparing bills, Payrolls, etc.
- ✔ In communication networks such as the **Internet** where they act as Servers.
- ✔ By Airline reservation systems where information of all the flights is stored.

Examples of Mainframes:

- IBM 4381.
- ICL 39 Series.
- CDC Cyber series.

Minicomputers.

A Minicomputer is physically smaller than a mainframe. However, it can support the same peripheral devices supported by a mainframe.

A Minicomputer can support several users at a time, e.g., can be operated by 6 users at a time. Several workstations/ terminals are connected to one central minicomputer so that the users connected can share its resources (C.P.U time, storage, etc).

Minicomputers are easier to manufacture & maintain compared to mainframes.

Minicomputers are cheaper than the mainframes, but more costly than the microcomputers.

They handle small amounts of data, are less powerful, & have less memory than the mainframes. Minicomputers are slow compared to mainframe computers.

Areas where minicomputers are used:

Minicomputers are used mainly in:

- ✔ Scientific laboratories & research institutions.
- ✔ Engineering plants/factories to control chemical or mechanical processes.
- ✔ Space industry.
- ✔ Insurance companies & Banks for accounting purposes.
- ✔ Smaller organizations as Network **Servers**.

Example of Minicomputer:

- ♦ PDP-8 built in 1965 by **D**igital **E**quipment **C**orporation in U.S.

Microcomputers.

Microcomputers are the PCs mostly found today in homes, schools & many small offices. They are called ***Personal Computers*** (***PCs***) because they are designed to be used by one person at a time. They consist of very few connected units, i.e. can support very few peripheral devices (usually 1 or 2). The data processing in microcomputers is done by a **Microprocessor** (a single chip containing the Arithmetic Logic unit & Control unit).

Microcomputers are smaller in size & also cheaper than minicomputers. Their design is based on **Very Large Scale Integration** (VLSI) that confines several physical components into an IC. They are less powerful than minicomputers & their internal memory is smaller than that of minicomputers.

Areas where microcomputers are used:

Microcomputers are commonly used in:

- ✔ Training and learning institutions such as schools.
- ✔ Small business enterprises, and
- ✔ Communication centres as terminals.

Microcomputers have become very popular because of the following reasons:

1) Are cheaper than both mini & mainframe computers.
2) Are very fast (i.e. have high processing speeds).
3) Small in size, hence they occupy less space in an office.
4) Are more energy efficient (i.e., consume less power).
5) Are more reliable than the early Mainframe computers.

Examples:

- IBM PCs such as Apple Macintosh, Dells, Compaq, etc.

Laptops & Notebooks.

A Laptop is a PC sufficiently small & light such that a user can use it comfortably on his/her lap. It is designed to be used by placing it on the lap.

- Laptops are very small in size & are portable. They are small enough to fit inside a briefcase; still leaving room for other items.
- A Laptop computer operates mainly on electricity or by rechargeable batteries
- Laptops normally have in-built disk drives & Flat screens (*Liquid Crystal Displays*).
- Can only support a limited number of peripheral devices.

- Have limited storage capacities.

Note. The smaller computers like Laptops tend to be more expensive than Desktop computers because of the following reasons:

1) The technology of producing smaller devices is expensive.
2) They are convenient because they are portable.
3) They have advanced power management capabilities (they consume less power since a laptop can operate on rechargeable batteries).

Palmtops.

Palmtops are small enough to fit in the pocket, and can be held in the palm when being used.

- Have limited storage capacities.
- Palmtops are mainly used as Personal Organizers, with some minimal programs for calculations, Word processing, Spreadsheets, & E-mail.

Example of a Palmtop; *Personal Digital Assistant* (*PDA*).

Desktop computer.

This is the name given to any computer designed to be used when placed on a desk in an office environment.

- They are not portable.

Examples of desktop computers:

1) **Home computer.**

   This is a low-cost microcomputer of limited capability designed for domestic use. It has programs that are used typically for computer games or controlling family finances.

2) **Personal computer (PC).**

   This is a microcomputer designed for independent use by an individual at work or in the home mainly for business purposes.

   - A PC can support only 1 user at a time.

   - PCs are mostly used in offices, schools, business premises, and at home for various applications like computer literacy, Games, Database management, Accounting, Word processing, Telecommunications, etc.

   - A PC can be connected to a mini & mainframe computer so as to enable the user access the facilities offered by the larger machines.

3) **Workstation.**

   A *workstation* is usually a desktop computer with all the facilities but interlinked to a network.

   A typical workstation works in a similar way to a Personal computer. However, it is more advanced than a typical PC in the following ways:

   i). It is larger & more powerful than a PC. E.g., workstations use 32-bit microprocessors, while PCs use 16-bit microprocessors.

ii). It has in-built capabilities for its interconnection & operation with other computers, i.e., it is fully connected to a computer network as any other computer on the network in its own right.

iii). It has high resolution graphics.

iv). It has a Multi-tasking operating system, i.e. it is able to run multiple applications at the same time.

An Embedded computer.

This is a computer that is within another device or system but is not accessed directly. E.g., there are embedded computers operating within Petrol pumps, Watches, Cameras & Video recorders.

B. CLASSIFICATION ACCORDING TO PURPOSE.

Digital computers can be classified further according to the tasks they perform either as:

- General-purpose.
- Special purpose
- Dedicated computers.

General-purpose computers.

General-purpose computers are designed to perform a wide variety of tasks. They use specifically written instructions (programs) to carry out the desired processing tasks.

Example;

A single computer can be used to process documents, perform calculations, process the Payroll, simulate the loading on a bridge, process Insurance policies, and play games, among others.

The programs used in a general-purpose computer are exchangeable. This means that, to perform a particular task, the appropriate set of instructions required to perform that particular task are loaded into the computer memory.

E.g., if you want to play a game, the appropriate program is loaded into the computer's memory & the computer is instructed to execute the instructions which make up the game.

Examples of general-purpose computers: Mainframes, Minicomputers, Microcomputers & Laptops used in most offices & schools.

Special-purpose computer.

A special-purpose computer is designed to handle/accomplish a particular specific task only.

Such computers cannot perform any other task except the one they were meant to do. Therefore, the programs which are used in a special-purpose computer are fixed (hard-wired) at the time of manufacture.

For example;

In a computer Network, the **Front End Processor** (**FEP**) is only used to control the communication of information between the various workstations and the host computer.

A Special-purpose computer is dedicated to a single task; hence it can perform it quickly & very efficiently.

Examples of special-purpose computers:

- Robots used in a manufacturing industry for production only.
- Mobile phones used for communication only.
- Calculators that carry out calculations only.
- Computers used in Digital watches.
- Computers used in Petrol pumps.
- Computers used in Washing machines.
- An Automatic pilot – a computer dedicated to the task of operating an aircraft.
- A Word processor – a special-purpose computer used in the production of office documents, letters, etc.

Reasons why a Mobile phone is regarded to be a computer.

- ✔ It is electronic.
- ✔ Has a screen.
- ✔ It has a Keypad.
- ✔ Has a Memory.
- ✔ It is programmable.

Dedicated computer.

A **Dedicated computer** is a general-purpose computer that is committed to some processing task; though capable of performing a variety of tasks in different application environments.

E.g., the computer can be dedicated to carrying out Word processing tasks only.

C. CLASSIFICATION ACCORDING TO FUNCTIONALITY (operating principles)

Usually, there are two forms of data; **Digital data**, and **Analogue data**. Computers can be classified according to the type of data they can process as either:

- Digital computers.
- Analogue computers
- Hybrid computers.

Digital computers.

This is the most commonly used type of computers.

A **Digital computer** is a computer that operates on discrete data only. It can process both numeric & alphabetic data within the computer, e.g., 0, 1, 2, 3…, A,B,C….

Their operation is based on 2 states, "ON" & "OFF" or on digits "1" & "0". Therefore, any data to be manipulated by a digital computer must first be converted to digital form.

Their output is usually in form of numbers, alphabets, & symbols.

Digital computers are usually general-purpose computers; hence, they are widely used in different areas for data processing.

Most of the devices found at homes today are digital in nature.

Digital computers are less accurate, i.e. may not solve all your problems since the facilities provided are generalized.

Examples:

- A Television with a button which is pressed to increase or decrease the volume.
- Digital watches.
- Calculators.
- Microcomputers. They are said to be digital because they posses the ALU.

Analogue computers.

An **Analogue computer** is a computer that operates on continuous data.

They carry out their data processing by measuring the amount of change that occurs in physical attributes/quantities, such as changes in electrical voltage, speed, currents, pressure, length, temperature, humidity, etc.

An Analogue computer is usually a special-purpose device that is dedicated to a single task. For example, they are used in specialized areas such as in:

- Scientific or engineering experiments,
- Military weapons,
- Controlling manufacturing processes like monitoring & regulating furnace temperatures and pressures.
- Weather stations to record & process physical quantities, e.g., wind, cloud speed, temperature, etc.

The output from analogue computers is in form of smooth graphs produced by a plotting pen or a trace on a Cathode Ray Tube (CRT) from which the information can be read.

Note: Analogue computers usually use one characteristic, e.g. a length, to give information about another physical characteristic, such as weight.

Analogue computers are very accurate & efficient since they are dedicated to a single task. They are very fast since most of them use multiple processors.

Examples of analogue devices:

- **The computer used to control a flight simulator for training pilots.**

  The computer responds to the Cockpit simulator control movements made by the pilot to physically change the environment so that the pilot feels as if he were controlling an actual aeroplane.

- **A Bathroom scale.**

  It uses the weight of a person to move a pointer smoothly/continuously over calibrated scale, which shows the person's weight.

- **Thermometer.**

  It uses a volume of Mercury to show temperature. The Thermometer is calibrated to give an exact temperature reading.

- **Speedometer.**

In Speedometer, the rotation of the wheel is converted to a voltage, which causes a pointer to rotate over a dial calibrated in Km/h or Miles/h.

- A **Petrol pump** measures the rate of flow of Gasoline (petrol) & converts the volume delivered to 2 readings; one showing the volume & the other showing the cost.
- A **Post-office scale** converts the weight of a parcel delivered into a charge for posting.

- A Monitor with knobs that are rotated to increase brightness.
- A Television with knobs that are rotated to increase or decrease the volume.

- A Radio with a knob that slides in a slot to increase volume.

Hybrid computers.

Hybrid computers are designed to process both analogue & digital data. They combine both the functional capabilities of the digital and analogue computers.

Hybrid computers are designed by interconnecting the elements of a digital computer & analogue computer directly into one processor, using a suitable interfacing circuitry.

Hybrid computers are more expensive.

Example;

In a hospital **Intensive Care Unit**, an analogue device may be used to measure the functioning of a patient's heart, temperature and other vital signs. These measurements may then be converted into numbers and sent to a digital device, which may send an immediate signal to the nurses' station if any abnormal readings are detected.

Computer generations

Generation is a fundamental change/shift in technology

Generation	Period	technology
First	1946-1959	Vacuum tube
Second	1959-1965	transistor
Third	1965-1971	Integrated circuit
Fourth	1971-1980	VLSI microprocessor
Fifth	1980 – onwards	ULSI microprocessor

First generation

The computers of first generation used vacuum tubes as the basic components for memory and circuitry for central processing unit (CPU). These tubes produced a lot of heat and were prone

to frequent breakdown. Computers of this generation were very expensive and could be afforded only by very large organizations. In this generation mainly batch processing operating system were used. Punched cards, paper tape, and magnetic tape were used as input and output devices. The computers in this generation used machine code as programming language.

Main features of first generation:

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

Some computers of this generation: ENIAC,EDVAC, UNIVAC, IBM-701, IBM-650

Second generation

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 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.

Main features of second generation

- Use of transistors
- Reliable in comparison to first generation computers
- Smaller in size 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
- Were still costly
- Supported machine and assembly language

Some examples of second-generation computers: IBM 360, IBM 7094, CDC 1604, UNIVAC 1108

Third generation

The computers of third generation used integrated circuits (IC's) in place of transistors. A single IC had many transistors, resistors and capacitors along with 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, multi-programming operating systems were used. High level languages (FORTRAN, COBOL, PASCAL, BASIC, ALGOL) were used to program computers

The main features of third generation:

- IC used
- More reliable in comparison to previous two generations
- Smaller in size
- Generated less heat
- Faster processing
- Lesser maintenance
- Less costly
- Consumed less electricity
- A.C needed
- Supported high-level language

Some examples of third generation computers: IBM-360 series, Honeywell-6000 series

Fourth generation

The computers of fourth generation used Very Large Scale Integrated (VLSI) circuits. VLSI circuits having about 5000 transistors and other circuit elements and 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 computers (PC) revolution. In this generation time sharing, real time, networks, distributed operating system were used. High level languages like C, C++, DBASE were used to write programs.

Main features of fourth generation:

- VLSI technology used
- Very cheap
- Portable and reliable
- Use of PC's
- Very small size
- Pipeline processing
- No A.C needed
- Concept of internet was introduced
- Great developments in the fields of networks
- Computers became easily available

Examples of fourth generation computers: DEC 10, STAR 1000, CRAY-1 (super computer)

Fifth generation

In the fifth generation, the 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 a branch of computer science, which interprets means and method of making computers think like human beings. all high-level languages are applicable in this generation. AI includes robotics, neural networks, game playing, expert systems and natural language processing

Main features of fifth generation

- 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