University of Diyala

College of Engineering

Department of Computer Engineering

Computer Science

1st stage

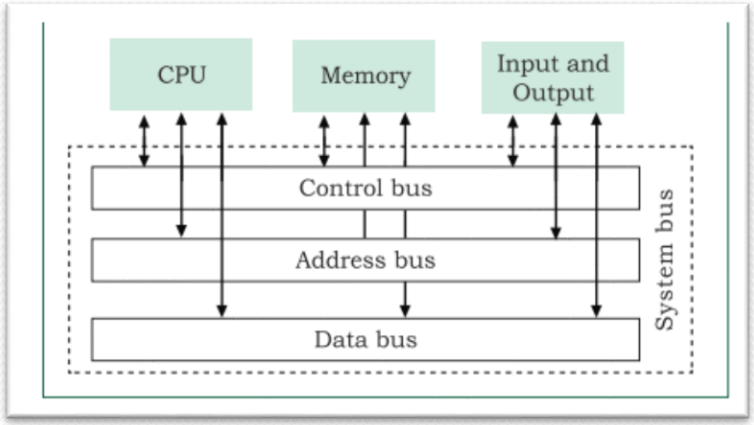
Lecture #2

- Course Number: U 102
- Course Name: Computer Science
- Credit Hours: (2-1-0-2)
- Prerequisites: None
- Course Contents: Computer Architecture, Computer Assembly and parts Characteristics, History of Computer, Generations of computer, Types of computer, Personal computer, major parts of the Computer (Hard Ware); Input Devices, Processor, Output Devices, Storage Devices, Internal Components, Software; Types of software, System software, Application software, Computer Languages and Scripting, Booting, Computer maintenance and troubleshooting, BIOS Setting, Open Source Software and Linux OS, Navigating Linux GUI, The Internet.

4. Data Transfer Between Memory And CPU

- Data need to be transferred between the CPU and primary memory as well as between the primary and secondary memory. Data are transferred between different components of a computer system using physical wires called bus. For example, bus is used for data transfer between a USB port and hard disk or between a hard disk and main memory. Bus is of three types:

I. Data bus to transfer data between different components.
II. Address bus to transfer addresses between CPU and main memory. The address of the memory location that the CPU wants to read or write from is specified in the address bus.
III. Control bus to communicate control signals between different components of a computer. All these three buses collectively make the system bus, as shown in Figure.



- As the CPU interacts directly with main memory, any data entered from input device or the data to be accessed from hard disk needs to be placed in the main memory for further processing. The data is then transferred between CPU and main memory using bus. The CPU places on the address bus, the address of the main memory location from which it wants to read data or to write data. While executing the instructions, the CPU specifies the read or write control signal through the control bus. As the CPU may require to read data from main memory or write data to main memory, a data bus is bidirectional. But the control bus and address bus are unidirectional. To write data into memory, the CPU places the data on the data bus, which is then written to the specific address provided through the address bus. In case of read operation, the CPU specifies the address, and the data is placed on the data bus by a dedicated hardware, called memory controller. The memory controller manages the flow of data into and out of the computer's main memory.

5. Microprocessors

- In earlier days, a computer's CPU used to occupy a large room or multiple cabinets. However, with advancement in technology, the physical size of CPU has reduced and it is now possible to place a CPU on a single microchip only. A processor (CPU) which is implemented on a single microchip is called microprocessor. Nowadays, almost all the CPUs are microprocessors. Hence, the terms are used synonymously for practical purpose.
- Microprocessor is a small-sized electronic component inside a computer that carries out various tasks involved in data processing as well as arithmetic and logical operations. These days, a microprocessor is built over an integrated circuit comprising millions of small components like resistors, transistors and diodes. Microprocessors have evolved over time in terms of their increased processing capability, decreasing physical size and reduced cost. Currently available microprocessors are capable of processing millions of instructions per millisecond.

Table lists different types of microprocessors along with their generation, time period, and underlying technology since their inception in early 1970s.

Generation	Era	Chip type	Word size	Maximum memory size	Clock speed	Cores	Example*
First	1971-73	LSI	4 / 8 bit	1 KB	108 KHz-200 KHz	Single	Intel 8080
Second	1974-78	LSI	8 bit	1 MB	Upto 2 MHz	Single	Motorola 6800 Intel 8085
Third	1979-80	VLSI	16 bit	16 MB	4 MHz - 6 MHz	Single	Intel 8086
Fourth	1981-95	VLSI	32 bit	4 GB	Upto 133 MHz	Single	Intel 80386 Motorola 68030
Fifth	1995 till date	SLSI	64 bit	64 GB	533 MHz - 34 GHz	Multicore	Pentium, Celeron, Xeon

*few prominent examples are included.

5.1 Microprocessor Specifications

Microprocessors are classified on the basis of different features which include chip type, word size, memory size, clock speed, etc. These features are briefly explained below:

A. Word Size Word size is the maximum number of bits that a microprocessor can process at a time. Earlier, a word was of 8 bits, as it was the maximum limit at that time. At present, the minimum word size is 16 bits and maximum word size is 64 bits.

B. Memory Size Depending upon the word size, the size of RAM varies. Initially, RAM was very small (4MB) due to 4/8 bits word size. As word size increased to 64 bits, it has become feasible to use RAM of size up to 16 Exabytes (EB).

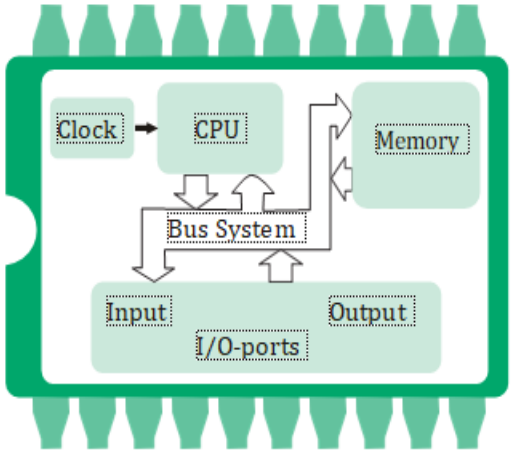
C. Clock Speed Computers have an internal clock that generates pulses (signals) at regular intervals of time. Clock speed simply means the number of pulses generated per second by the clock inside a computer. The clock speed indicates the speed at which the computer can execute instructions. Earlier, it was measured in Hertz (Hz) and Kilohertz (kHz). But with advancement in technology and chip density, it is now measured in Gigahertz (GHz), i.e., billions of pulses per second.

D. Cores Core is a basic computation unit of the CPU. Earlier processors had only one computation unit, thereby capable of performing only one task at a time. With the advent of multicore processor, it has become possible for the computer to execute multiple tasks, thereby increasing the system's performance. CPU with two, four, and eight cores is called dual-core, quad-core and octa-core processor, respectively.

5.2 Microcontrollers

- The microcontroller is a small computing device which has a CPU, a fixed amount of RAM, ROM and other peripherals all embedded on a single chip as compared to microprocessor that has only a CPU on the chip. The structure of a microcontroller is shown in Figure .

Keyboard, mouse, washing machine, digital camera, pendrive, remote controller, microwave are few examples of microcontrollers. As these are designed for specific tasks only, hence their size as well as cost is reduced. Because of the very small size of the microcontroller, it is embedded in another device or system to perform a specific functionality. For example, the microcontroller in a fully automatic washing machine is used to control the washing cycle without any human intervention. The cycle starts with the filling of water, after which the clothes are soaked and washed; thereafter the water is drained and the clothes are spin dry. The simple use of microcontroller has permitted repetitive execution of tedious tasks automatically without any human intervention, thereby saving precious time.



6. Data And Information

- A computer is primarily for processing data. A computer system considers everything as data, be it instructions, pictures, songs, videos, doc raw and unorganized facts that are processed to get meaningful information. So understanding the concept of data along with its different types is crucial to understand the overall functioning of a computer. Sometimes people use the terms data, information and knowledge interchangeably, which is incorrect.

6.1 Data and Its Types

- A computer system has many input devices, which provide it with raw data in the form of facts, concepts, instructions, etc., Internally everything is stored in:
  - Binary form (0 and 1).
  - Data can be input to a computer in the text form consisting of English alphabets A–Z, a–z.
  - Numerals 0 – 9.
  - Special symbols like @, #, etc.
- Data can be input in other languages too or it can be read from the files. The input data may be from different sources, hence it may be in different formats. For example, an image is a collection of Red, Green, Blue (RGB) pixels, a video is made up of frames, and a fee receipt is made of numeric and non-numeric characters. Primarily, there are three types of data.

A. **Structured Data.** Data which follows a strict record structure and is easy to comprehend is called structured data. Such data with pre-specified tabular format may be stored in a data file to access in the future. Table shows structured data related to monthly attendance of students maintained by the school. It is clear that such data is organised in row/column format and is easily understandable. Structured data may be sorted in ascending or descending order. In the example, attendance data is sorted in increasing order on the column 'month'. Other examples of structured data include sales transactions, online railway ticket bookings, ATM transactions, etc.

Structured data: Monthly attendance records of students

Roll No	Name	Month	Attendance (in %)
R1	Mohan	May	95
R2	Sohan	May	75
R3	Sheen	May	92
R4	Geet	May	82
R5	Anita	May	97
R1	Mohan	July	98
R2	Sohan	July	65
R3	Sheen	July	85
R4	Geet	July	94
R5	Anita	July	85

B. Unstructured Data. Data which are not organised in a pre-defined record format is called unstructured data. Examples include audio and video files, graphics, text documents, social media posts, satellite images, etc. Figure 1.10 shows a report card with monthly attendance record details sent to parents. Such data are unstructured as they consist of textual contents as well as graphics, which do not follow a specific format.

Unstructured data: Monthly attendance record

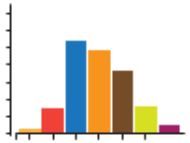
School Logo

ABC SCHOOL

Attendance record for the month of July

Name: John S. **Roll No.:** R1 **Class:** XI A

Total classes held: 150 **Attended:** 100 **Absent:** 50



Guardian's Signature **Principal's Signature**

C. Semi-structured Data. Data which have no well-defined structure but maintains internal tags or markings to separate data elements are called semi-structured data. Examples include email document, HTML page, comma separated values (CSV file), etc. Figure shows an example of semi-structured data containing student's month-wise attendance details. In this example, there is no specific format for each attendance record. Here, each data value is preceded by a tag (Name, Month, Class, Attendance) for the interpretation of the data value while processing.

Name: *Mohan*	Month: *July*	Class: *XI*	Attendance: *98*
Name: *Sohan*	Month: *July*	Class: *XI*	Attendance: *65*
Name: *Sheen*	Month: *July*	Class: *XI*	Attendance: *85*
Name: *Geet*	Month: *May*	Class: *XI*	Attendance: *82*
Name: *Geet*	Month: *July*	Class: *XI*	Attendance: *94*

Semi-structured data: Month-wise totalattendance record maintained by the school

6.2 Data Capturing, Storage and Retrieval

To process data, we need to first input or capture the data. This is followed by its storage in a file or a database so that it can be used in the future. Whenever data is to be processed, it is first retrieved from the file or database so that we can perform further actions on it.

A. Data Capturing It involves the process of gathering data from different sources in the digital form. This capturing may vary from simple instruments like keyboard, barcode readers used at shopping outlets (Figure 1.12), comments or posts over social media, remote sensors on an earth orbiting satellite, etc. Sometimes, heterogeneity among data sources makes data capturing a complex task.

B. Data Storage It is the process of storing the captured data for processing later. Now-a-days data is being produced at a very high rate, and therefore data storage has become a challenging task. However, the decrease in the cost of digital storage devices has helped in simplifying this task. There are numerous digital storage devices available in the market like as shown in Figure 1.7. Data keeps on increasing with time. Hence, the storage devices also require to be upgraded periodically. In large organisations, computers with larger and faster storage called data servers are deployed to store vast amount of data. Such dedicated computers help in processing data efficiently. However, the cost (both hardware and software) of setting up a data server as well as its maintenance is high, especially for small organisations and startups.

C. Data Retrieval It involves fetching data from the storage devices, for its processing as per the user requirement. As databases grow, the challenges involved in search and retrieval of the data in acceptable time, also increase. Minimising data access time is crucial for faster data processing.

6.3 Data Deletion and Recovery

- One of the biggest threats associated with digital data is its deletion. The storage devices can malfunction or crash down resulting in the deletion of data stored. Users can accidentally erase data from storage devices, or a hacker or malware can delete the digital data intentionally. Deleting digitally stored data means changing the details of data at bit level, which can be very time-consuming. Therefore, when any data is simply deleted, its address entry is marked as free, and that much space is shown as empty to the user, without actually deleting the data. In case data gets deleted accidentally or corrupted, there arises a need to recover the data. Recovery of the data is possible only if the contents or memory space marked as deleted have not been overwritten by some other data.
- Data recovery is a process of retrieving deleted, corrupted and lost data from secondary storage devices. There are usually two security concerns associated with data. One is its deletion by some unauthorised person or software. These concerns can be avoided by limiting access to the computer system and using passwords for user accounts and files, wherever possible. There is also an option of encrypting files to protect them from unwanted modification. The other concern is related to unwanted recovery of data by unauthorised user or software. Many a times, we discard our old, broken or malfunctioning storage devices without taking care to delete data. We assume that the contents of deleted files are permanently removed. However, if these storage devices fall into the hands of mischief-mongers, they can easily recover data from such devices; this poses a threat to data confidentiality. This concern can be mitigated by using proper tools to delete or shred data before disposing off any old or faulty storage device.