Chapter 2

The System Unit Processing and Memory

Introduction

The system unit of the computer is sometimes thought of as the black box of the computers with respect to the users. **This chapter introduces the following topics:**

- How computers represent data and programs.
- How the CPU, memory, and other components are arranged inside the system unit.
- How the CPU works.
- Strategies to speed up a computer today and create faster computers in the future.

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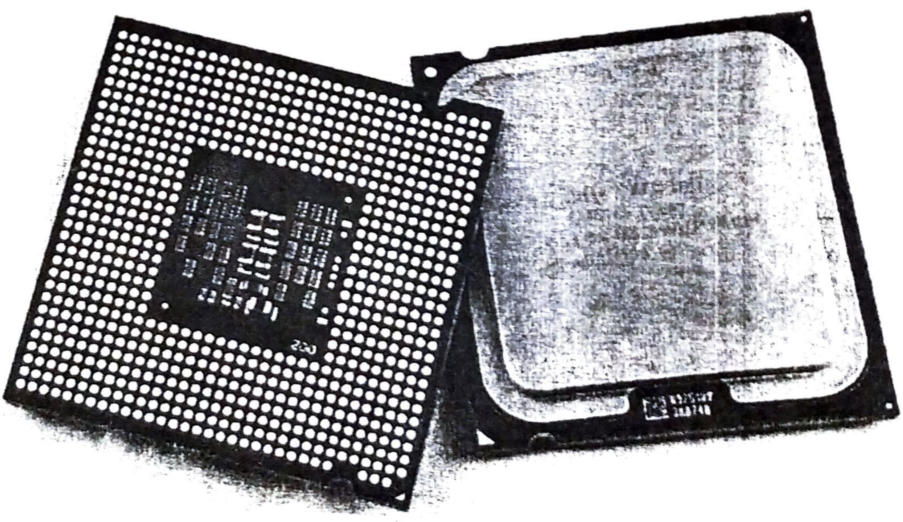

CPU

Note:

The general objectives of this chapter are:

After completing this chapter, you will be able to do the following:

1. Understand how data and programs are represented to a computer and be able to identify a few of the coding systems used to accomplish this.
2. Explain the functions of the hardware components commonly found inside the system unit, such as the CPU, memory, buses, and expansion cards.
3. Describe how peripheral devices or other hardware can be added to a computer.
4. Understand how a computer's CPU and memory components process program instructions and data.
5. Name and evaluate several strategies that can be used today for speeding up the operations of a computer.
6. List some processing technologies that may be used in future computers.

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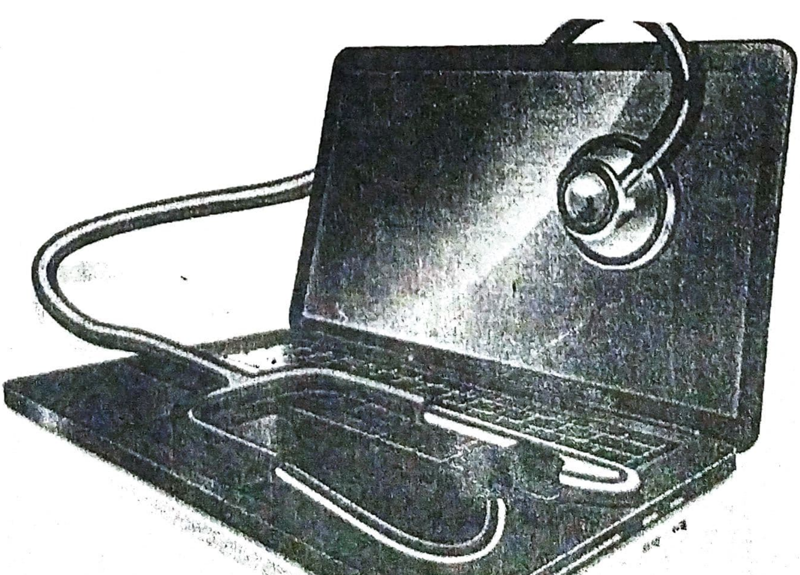
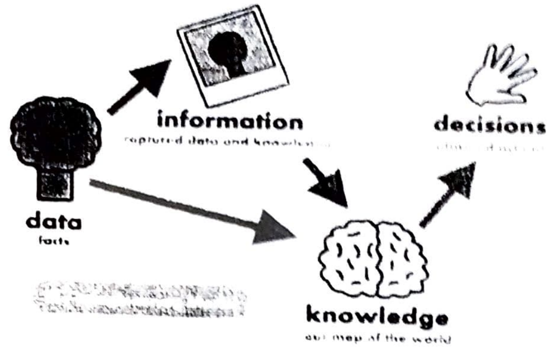


Data and Program Representation

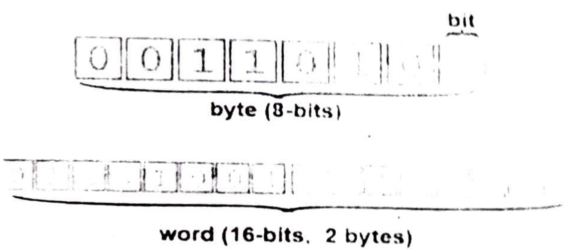
- In order to be understood by a computer, data and programs **need to be represented appropriately.**
- **Coding systems** (or coding schemes):
  Used to represent numeric, text-based, and multimedia data, as well as to represent programs.



Data information knowledge

Digital Data Representation

- **Digital computers:** devices that can only understand two states, off and on, represented by the digits **0 and 1** (bits, from binary digits)
- **Digital data representation:** process of representing data in digital form so it can be used by a computer
  Computers represent programs and data through a variety of binary-based coding schemes
  Bit = a single 1 or 0
  Byte = 8 bits



Byte terminology used to express the size of documents and other files, programs, etc.
Prefixes are often used to express larger quantities of bytes: kilobyte (KB), megabyte (MB), gigabyte (GB), etc.

Medida	Simbologia	Equivalencia	Equivalente en Bytes
byte	b	8 bits	1 byte
kilobyte	Kb	1024 bytes	1 024 bytes
megabyte	MB	1024 KB	1 048 576 bytes
gigabyte	GB	1024 MB	1 073 741 824 bytes
terabyte	TB	1024 GB	1 099 511 627 776 bytes
Petabyte	PB	1024 TB	1 125 899 906 842 624 bytes
Exabyte	EB	1024 PB	1 152 921 504 606 846 976 bytes
Zetabyte	ZB	1024 EB	1 180 591 620 717 411 303 424 bytes
Yottabyte	YB	1024 ZB	1 208 925 819 614 629 174 706 176 bytes
Brontobyte	BB	1024 YB	1 237 940 039 285 380 274 899 124 224 bytes
Geopbyte	GB	1024 BB	1 267 650 600 228 229 401 496 703 205 376 bytes

The Binary Numbering System

- Computers use the **binary numbering system,** which represents all numbers using just two symbols (0 and 1).
- *Decimal numbering system: uses 10 symbols (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9).*

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Decimal	Binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

100111

$2^0 \times 1 = 1$
$2^1 \times 1 = 2$
$2^2 \times 1 = 4$
$2^3 \times 0 = 0$
$2^4 \times 0 = 0$
$2^5 \times 1 = 32$
+
Decimal ← 39

Note:

MSB	Binary Digit							LSB
2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
256	128	64	32	16	8	4	2	1

Numbering Systems

Introduction

The numbering system is a way to represent numbers. People generally use the decimal number system but computers process data using the binary numbering system. Another numbering system related to computer use the hexadecimal numbering system, which can be used to represent long strings of binary numbers in a manner more understandable to people than the binary numbering system.

In this chapter, binary, decimal, octal and hexadecimal numbering systems will be discussed. The conversion between these numbering systems will be also explained. Some mathematical operations of these numbering systems will be covered.

General objectives of this chapter:

On completing this chapter, you will be able to:

- Explain the different numbering systems.
- Convert from one numbering system to another.
- Perform mathematical operations on the different numbering systems.

Number of Binary Digits (bits)	Common Name
1	Bit
4	Nibble
8	Byte
16	Word
32	Double Word
64	Quad Word

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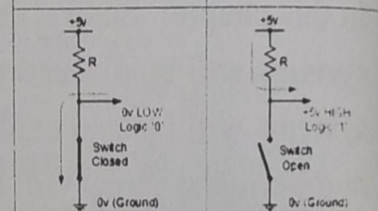
Note:

Why Binary ?

- Early computer design was decimal.
  - Mark I and ENIAC.
- John von Neumann proposed binary data processing (1945).
  - Simplified computer design.
  - Used for both instructions and data.
- Natural relationship between on/off switches and . calculation using Boolean logic.

First State	Second State
Logic "0"	Logic "1"
LOW	HIGH
FALSE	TRUE
Low Level Voltage Output	High Level Voltage Output
0V or Ground	+5 Volts



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Counting and Arithmetic

- Decimal or base 10 number system.
  - **Origin**: counting on the fingers.
  - **"Digit"** from the Latin word digitus meaning "finger".
- Base: the number of different digits including zero in the number system.
  Example: Base 10 has 10 digits, 0 through 9.
- Binary or base 2 .
- Bit (binary digit): 2 digits, 0 and 1 .
- Octal or base 8: 8 digits, 0 through 7.
- Hexadecimal or base 16:
  16 digits, 0 through F.
  Examples: 1010 = A16; 1110 = B16.

Note:

Numbering Systems		
System	**Base**	**Digits**
Binary	2	0 1
Octal	8	0 1 2 3 4 5 6 7
Decimal	10	0 1 2 3 4 5 6 7 8 9
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F

Why Octal Number System ?

The Octal Number System is another type of computer and digital base number system. The Octal Numbering System is very similar in principle to the previous hexadecimal numbering system except that in Octal, a binary number is divided up into groups of only 3 bits, with each group or set of bits having a distinct value of between 000 (0) and 111 (4+2+1 = 7).

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Octal numbers therefore have a range of just "8" digits, (0, 1, 2, 3, 4, 5, 6, 7) making them a Base-8 numbering system and therefore, q is equal to "8".

Decimal Number	3-bit Binary Number	Octal Number
0	000	0
1	001	1
2	010	2
3	011	3
4	100	4
5	101	5
6	110	6
7	111	7
8	001 000	10 (1+0)
9	001 001	11 (1+1)
Continuing upwards in groups of three		

Note:

MSB	Octal Number							LSB
8^8	8^7	8^6	8^5	8^4	8^3	8^2	8^1	8^0
16M	2M	262k	32k	4k	512	64	8	1

Why hexadecimal ?

Hexadecimal numbering system helps to represent long binary numbers in a way more understandable to people. Also, modern computer operating systems and networks present variety of troubleshooting data in hex format.

Decimal Number	4-bit Binary Number	Hexadecimal Number
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F
16	0001 0000	10 (1+0)
17	0001 0001	11 (1+1)
Continuing upwards in groups of four		

MSB	**Hexadecimal Number**							LSB
16^8	16^7	16^6	16^5	16^4	16^3	16^2	16^1	16^0
4.3G	2.6G	16M	1M	65k	4k	256	16	1

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Note: ....

Using Positional Notation

1- Binary:

$1101\ 0110_2 = 214_{10}$

Place	1	1	0	1	0	1	1	0
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Evaluate	1 * 128	1 * 64	0 * 32	1 *16	0 * 8	1 * 4	1 * 2	0 * 1
Sum for Base 10	128	64	0	16	0	4	2	0
	128+64+16+4+2=214							

2- Decimal "Base 10":

$527 = 5 \times 10^2 + 2 \times 10^1 + 7 \times 10^0$

Place	5	2	7
	10^2	10^1	10^0
Value	100	10	1
Evaluate	5 * 100	2 * 10	7 *1
Sum	500	20	7

3- Octal:

$624_8 = 404_{10}$

Place	6	2	4
	8^2	8^1	8^0
Value	64	8	1
Evaluate	6 * 64	2 * 8	4 *1
Sum	384	16	4
	384+16+4 = 404		

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Note:

4- Hexadecimal:

$6{,}704_{16} = 26{,}372_{10}$

Place	6	7	0	4
	16^3	16^2	16^1	16^0
Value	4,096	256	16	1
Evaluate	6 * 4,096	7 * 256	0 * 16	4 * 1
Sum for Base 10	24,576	1,792	0	4
	24,576 + 1,792 + 4 = 26,372			

Base or Radix

- Base:
  The number of different symbols required to represent any given number.
- The larger the base, the more numerals are required:

Base 10: 0,1, 2,3,4,5,6,7,8,9
Base 2: 0,1
Base 8: 0,1,2, 3,4,5,6,7
Base 16: 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

Conversion

1- from Base 10 "decimal" to Base 2 "binary":

$156_{10} = 10011100_2$

	Remainder
2)156	
2)78	0
2)39	0
2)19	1
2)9	1
2)4	1
2)2	0
2)1	0
	1

$\boxed{156_{10} = 10011100_2}$

Divide. Write the integer answer (quotient) under the long division symbol, and write the remainder (0 or 1) to the right of the dividend.
Since we are dividing by 2, when the dividend is even the binary remainder will be 0, and when the dividend is odd the binary remainder will be 1

Continue to divide until you reach 0. Continue downwards, dividing each new quotient by two and writing the remainders to the right of each dividend. Stop when the quotient is 0.

2- from Base 10 "decimal" to Base 16 "Hexadecimal":

$39_{10} = 27_{16}$

Input	Result	Remainder
39 / 16	2	7
2 / 16	0	2
base	result is zero, so stop	Remainders contain the result in desired system (backwards).

$43868_{10} = 0AB5C_{16}$

Input	Result	Remainder
43868 / 16	2741	12
2741 / 16	171	5
171 / 16	10	11
10 / 16	0	10
base	result is zero, so stop	Remainders contain the result in desired system (backwards).

convert to real hex numbers according to table:

10	11	5	12
↓	↓	↓	↓
A	B	5	C

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Note: ....

Fractions

1- Consider the decimal fraction $(0.2589)_{10}$:

Place	2	5	8	9
	10-1	10^{-2}	10-3	10-4
Value	1/10	1/100	1/1000	1/10000
Evaluate	2*1/10	2*1/100	2*1/1000	2*1/10000
Sum for Base 10	.2	.05	.008	.0009
	.2+.05+.008+.0009 = 0.2589			

2- Convert the binary fraction 0.101011_2 to decimal 0.671875_{10}:

Place	1	0	1	0	1	1
	2-1	2-2	2-3	2-4	2-5	2-6
Value	1/2	1/4	1/8	1/16	1/32	1/64
Evaluate	1*1/2	0*1/4	1*1/8	0*1/16	1*1/32	1*1/64
Sum for Base 10	.5		.125		0.03125	0.015625
	.5+.125+0.03125+0.015625 = 0.671875					

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Note:

Binary Arithmetic

1- Addition:

Carries	101100
Augends	10110
+	10111
101101	

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2- Subtraction:

Borrows	001010
Minuend	1110101
-	1001010
101011	

3- Multiplication:

*	10110
	1101
+	10110 00000 10110 10110
100011110	

Note: ....

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Octal Arithmetic

1- Addition:

Carries	111
Augends	5471
+	3754
11445	

2- Subtraction:

Borrows	6 10 4 10
Minuend	7 4 5 1
-	5 6 4 3
1606	

Note

Hexadecimal Arithmetic

1- Addition:

Carries	1011
Augends	5BA9
+	D058
12C58	

2- Subtraction:

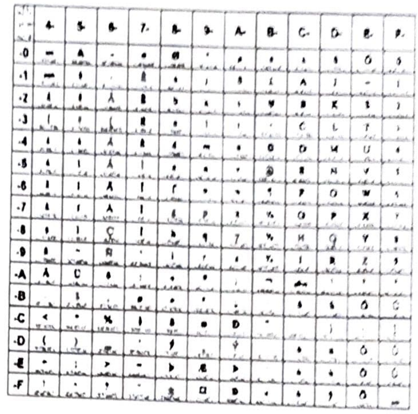
Borrows	9 10 A 10
Minuend	A 5 B 9
-	5 8 0 D
4 D A C	

Coding Systems for Text-Based Data

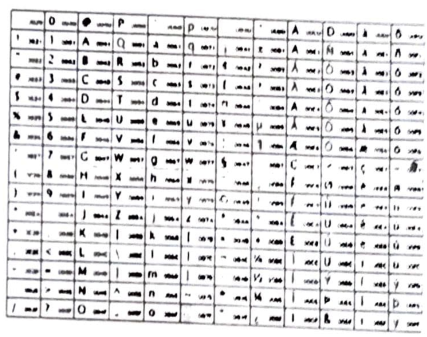
- **ASCII and EBCDIC**

  ASCII (American Standard Code for Information Interchange): coding system traditionally used with PCs

  EBCDIC (Extended Binary-Coded Decimal Interchange Code): developed by IBM, primarily for mainframe use.



- **Unicode:** newer code (32 bits per character is common); universal coding standard designed to represent text-based data written in any language.

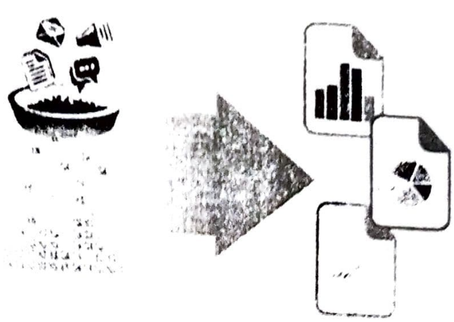


Coding Systems for Other Types of Data

- **Graphics data:** still images often stored as bitmap, a grid of hundreds of thousands of dots, called pixels.

- **Audio data:** to convert analog sound to digital sound, several thousand samples are taken every second; MP3 compression makes audio files much smaller.

- **Video data:** displayed using a collection of frames; amount of data can be substantial, but can be compressed.



Data analysis

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Note:

Machine Language

Machine language: binary-based language for representing computer programs the computer can execute directly.

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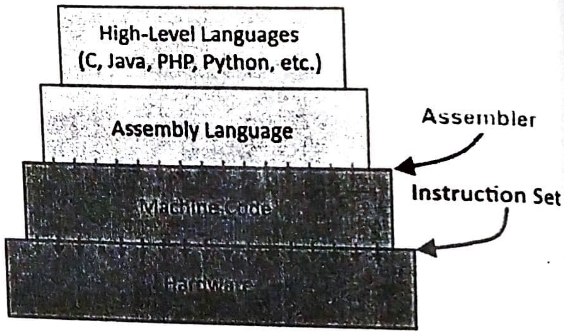
Early computers required programs to be written in machine language. Today's programs are translated into machine language in order to be understood by the computer.

Most programmers rely on language translators to translate their programs into machine language for them.

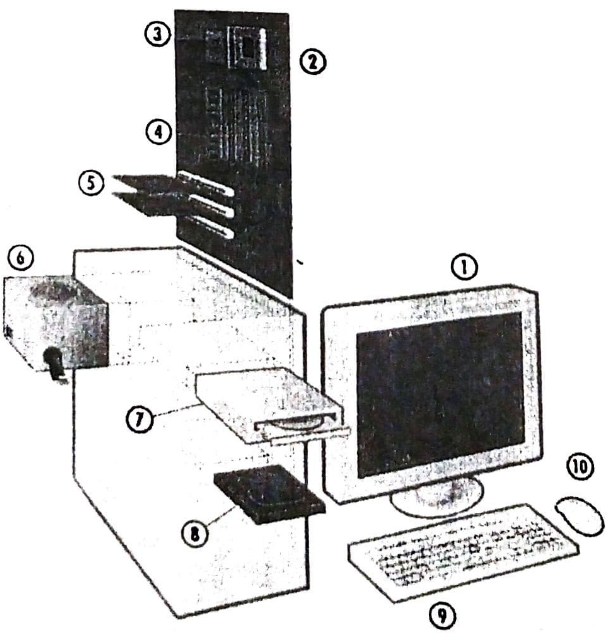


Machine code vs assembly

Inside the System Unit

Note:

the main case of a computer
The system unit houses the processing hardware for that computer, as well as disk drives, memory, the power supply, cooling fans, etc.
The system unit for a desktop PC often looks like a rectangular box



1. Monitor
2. Motherboard
3. CPU
4. RAM
5. Expansion cards
6. Power supply
7. Optical disc drive
8. Hard disk drive
9. Keyboard
10. Mouse

The Motherboard

- **Circuit board:** thin board containing chips—very small pieces of silicon or other semi-conducting material onto which integrated circuits are embedded—and other electronic components.

- **Motherboard** or **system board:** the main circuit board inside the system unit.

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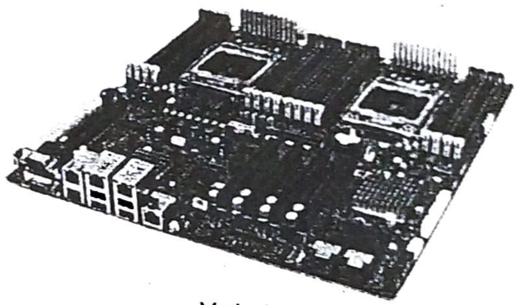
- **External devices** (monitors, keyboards, mice, printers) connect to the motherboard by plugging into a *port* exposed through the exterior of the system unit.

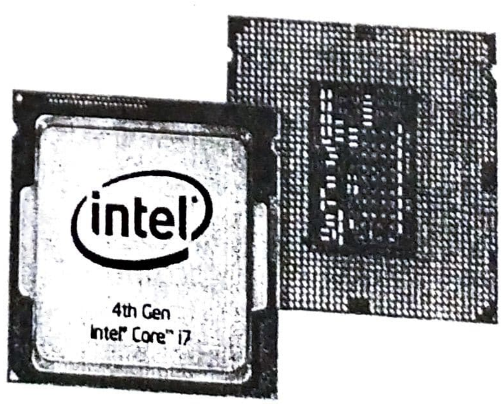


Motherboard

The CPU

Central processing unit (CPU):

- circuitry and components packaged together on a chip which is plugged directly into the motherboard.
- CPU does the vast majority of processing for a computer. الغالبية العظمى
- Also called the **microprocessor** or just the **processor.**
- Can have multiple cores (dual-core).
- Most CPUs are made by Intel (Pentium 4, Pentium D, Pentium M, Celeron, etc.) or AMD (Athlon 64, Sempron, Turion 64, etc.
- Servers typically use different CPUs than desktop PCs.



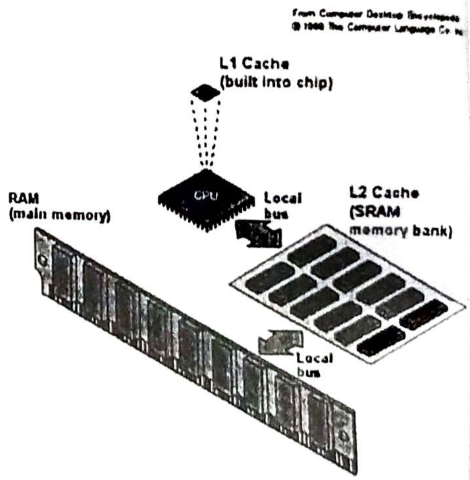
CPU

Note:

Processing speed

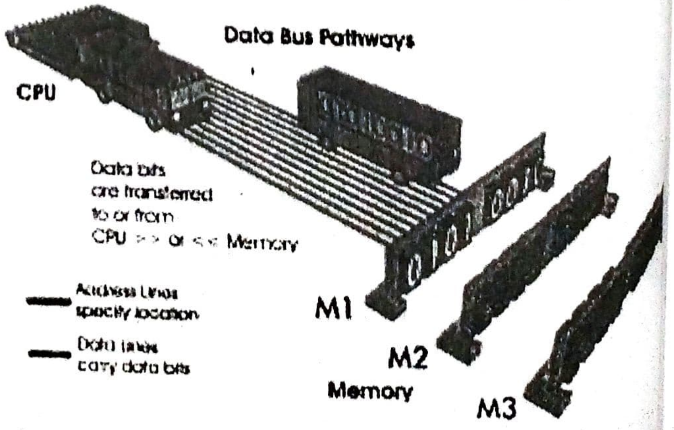
The processing speed of the computer depends on the following factors:

- **CPU clock speed:** which is measured in megahertz (MHz) or gigahertz (GHz); higher CPU clock speed = more instructions processed per second.
- **CPU architecture.**
- **Memory.**
- **Word size:** the amount of data that a CPU can manipulate at one time; typically 32 or 64 bits.
- **Cache memory:** special group of very fast memory chips located on or close to the CPU.
  - Level 1 is fastest, followed by Level 2.
  - More cache memory typically = faster processing.



Cache memory

- **Bus width and bus speed:**
  - Bus = an electronic path over which data can travel.
  - Bus width = the number of wires in the bus over which data can travel; bus width and speed determine the throughput of the bus.



Data Bus

Memory

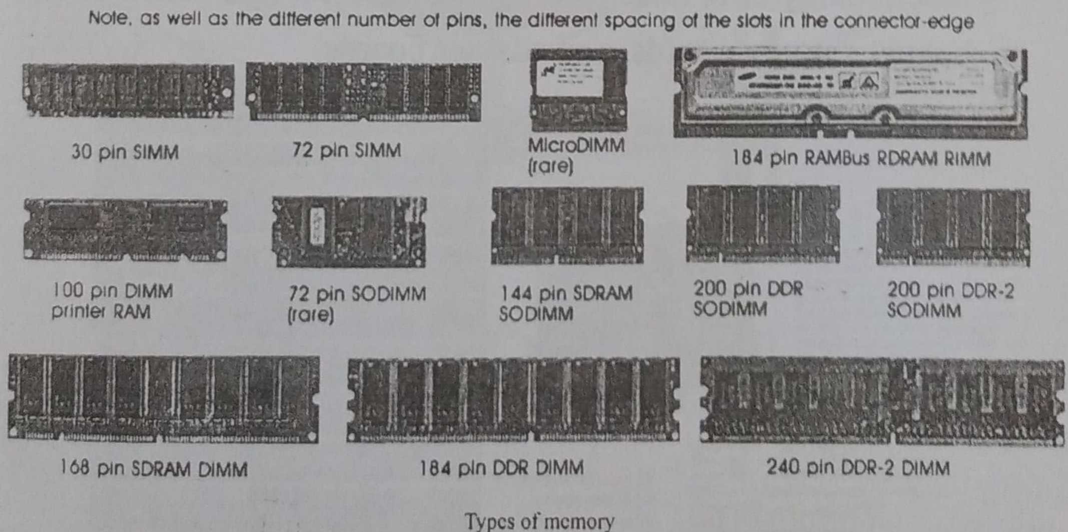
RAM (random access memory): temporary memory that the computer uses.

- Consists of chips connected to a memory module which is connected to the motherboard as shown in the following Figure.
- Hold data and program instructions while they are needed.
- RAM is volatile, its content is lost when the computer is shut off.

Registers: high speed memory built into the CPU; used by the CPU.

ROM (read-only memory): non erasable chips located on the motherboard into which data or programs have been permanently stored; retrieved by the computer when needed.

Flash memory: type of nonvolatile memory that can be erased and reprogrammed; some is built into a PC, also used in sticks, cards, and drive for storage



Types of memory

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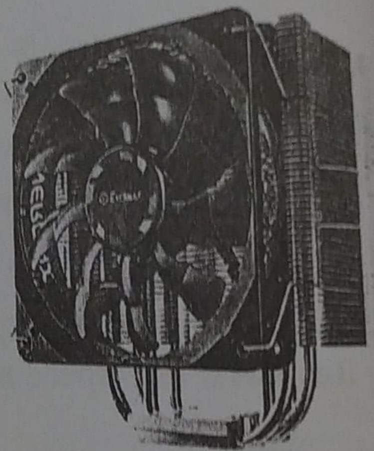
Note:

Fans, Heat Sinks, and Other Cooling Components

- One byproduct of packing an increasing amount of technology in a smaller system unit is heat, a continuing problem for CPU.
- Virtually all computers today employ fans, heat sinks (small components typically made out of aluminum with fins that help to dissipate heat), or other methods to cool the CPU and system unit.
- Water cooling systems are also available.



Fan

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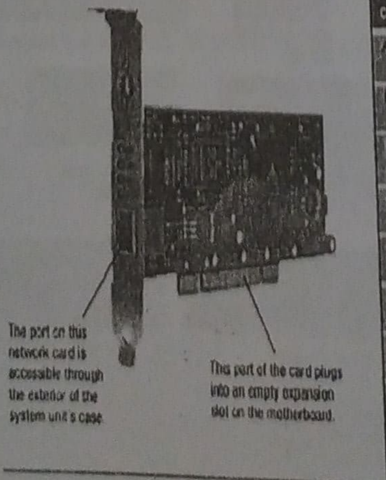
Expansion Slots and Cards

- **Expansion slot:** a location on the motherboard into which expansion cards are inserted.

- **Expansion card:** a circuit board that can be inserted into an expansion slot on a PC's motherboard to add additional functionality or to attach a peripheral device; also called add-in boards, interface cards, and adapter boards.

Note: ....



COMMON EXPANSION CARDS

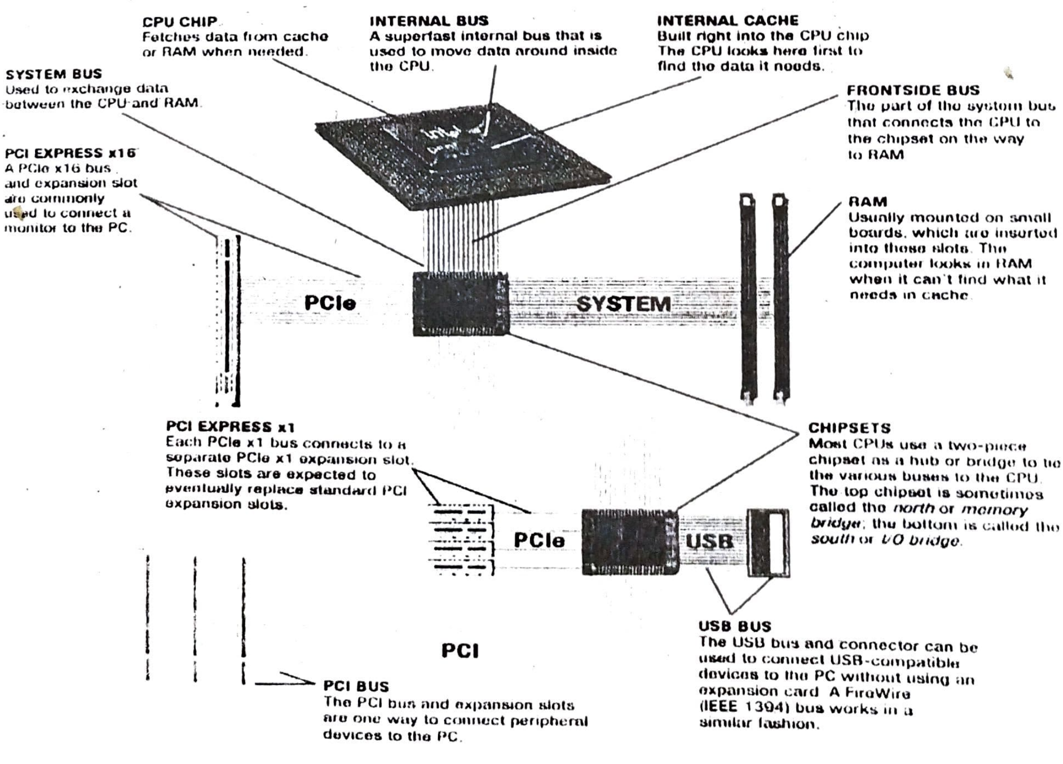
Card Type	Purpose
Accelerator board	Uses specialized processor chips that speed up overall processing.
Disk controller card	Enables a particular type of disk drive to interface with the PC.
Modem card	Provides communications capabilities to connect to a network or the Internet
Network interface card	Enables a PC to connect to a network
Sound card	Enables users to attach speakers to a PC and provides sound capabilities
TV tuner card	Allows a PC to pick up television signals
USB or FireWire card	Adds one or both of these ports to the PC
Video capture board	Allows video images to be input into the computer from a video camera.
Video graphics board	Enables the connection of a monitor; may provide additional graphics capabilities

Expansion card for PCs

Buses

The bus is an electronic path within a computer over which data travels. It is classified into two types; the system bus and the expansion bus.

- **System bus:** the bus that moves data back and forth between the CPU and memory.
- **Expansion buses:** the buses that connect the CPU to peripheral (typically input and output) devices.
- **Common expansion buses:**
  - PCI and PCI Express (PCIe) Bus: very common.
  - AGP Bus.
  - Hyper Transport Bus.
  - Universal Serial Bus (USB): very common.
  - FireWire/IEEE 1394 Bus: commonly used with video cameras.
  - Card Bus: used with portable PCs; expected to be replaced by cards that connect via USB or PCIe.



Buses and expansion slots

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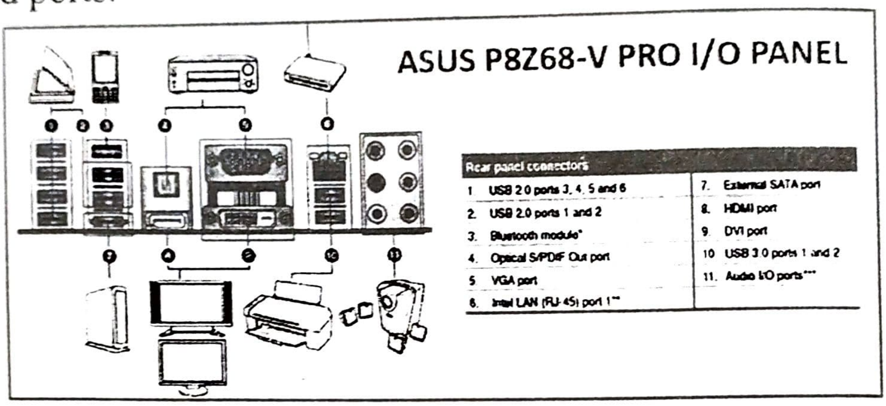
Note:

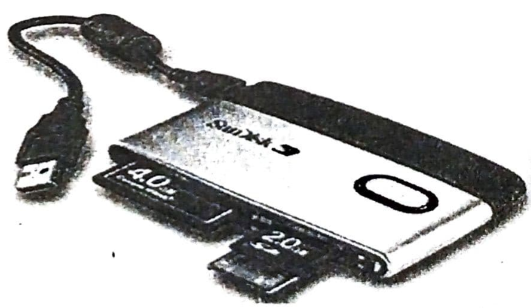
Ports

- Connector on the exterior of a PC's system unit to which a device may be attached.
- Common ports: the following table shows some of the commonly used ports.

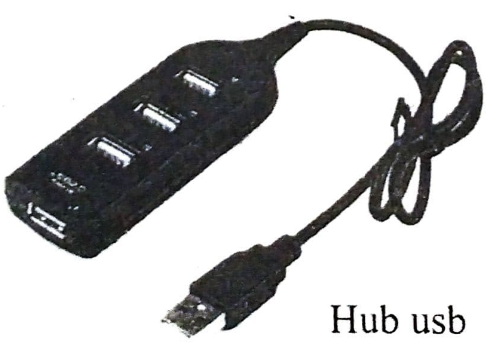


Typical ports and connectors for a desktop PC

- Many desktop PCs come with a variety of ports on the front of the system unit for easy access (USB, FireWire, audio, slots for flash memory cards, etc.).
- A hub can connect many devices to a single USB or FireWire port.



Memory cards

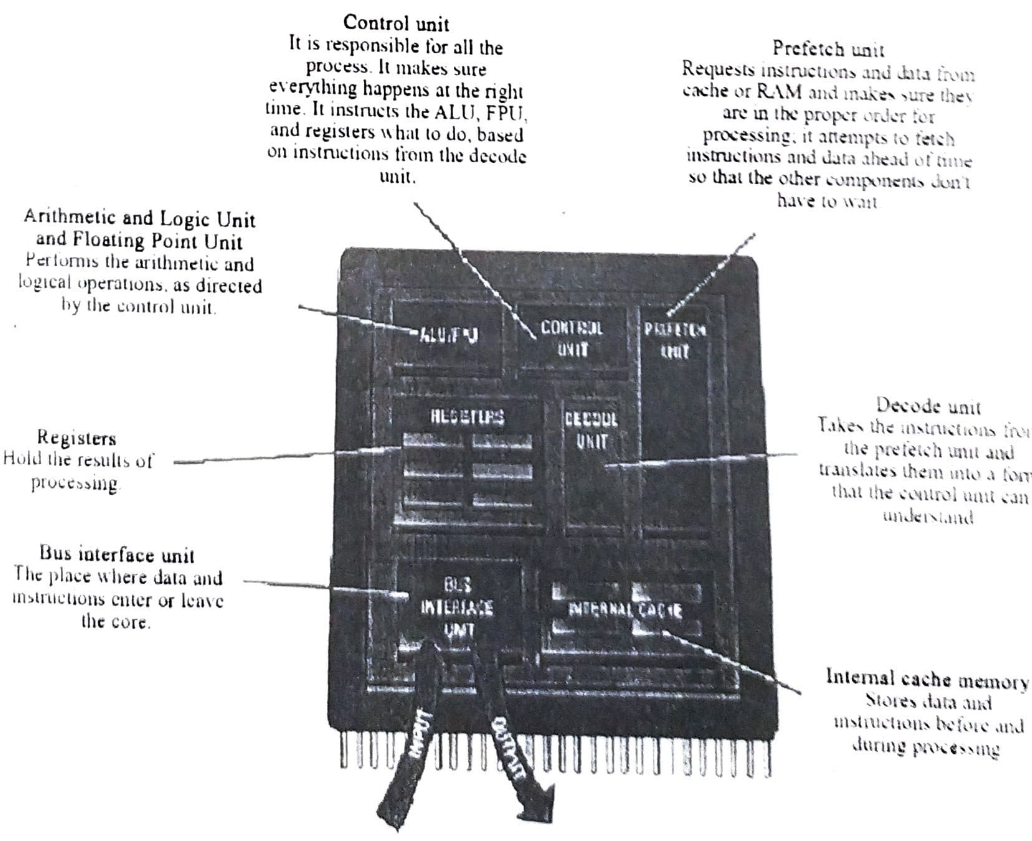


Hub usb

How the CPU Works ?

To understand how the CPU works, we should know the components of the CPU which is referred to as the micro architecture. The micro architecture varies from processor to processor. The following Figure illustrates a simplified example of the principal components that might be included in a single core of a typical CPU. It should be noted that there are some components which are not shown here because they are not in all the processors. From these components, the buses to connect the CPU cores to each other (quick path interconnect, QPI), buses to connect each core to the CPU's memory controller and the buses to connect each core to any cache memory that is shared between the cores.

In the following Figure, the function of the principal components is briefly given.



Inside a CPU core (simplified micro architecture)

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Note:

The System Clock and the Machine Cycle

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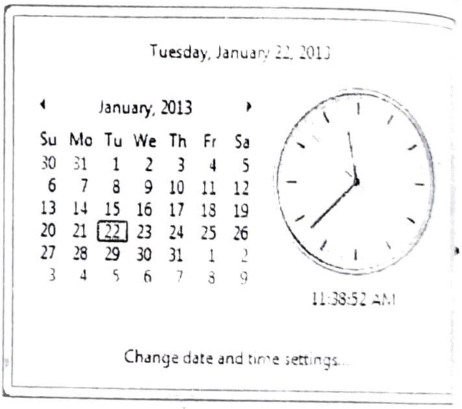
System clock:

Timing mechanism within the computer system that synchronizes the computer's operations

- Each signal is a cycle.
- Number of cycles per second = hertz (Hz).
- Many PC system clocks run at 200 MHz.
- All devices run at a multiple or fraction of the system clock; for instance, a CPU clock speed of 2 GHz means the CPU clock "ticks" 10 times during each system clock tick.
- During each CPU clock tick, one or more pieces of microcode are processed.



Time and date

Note:

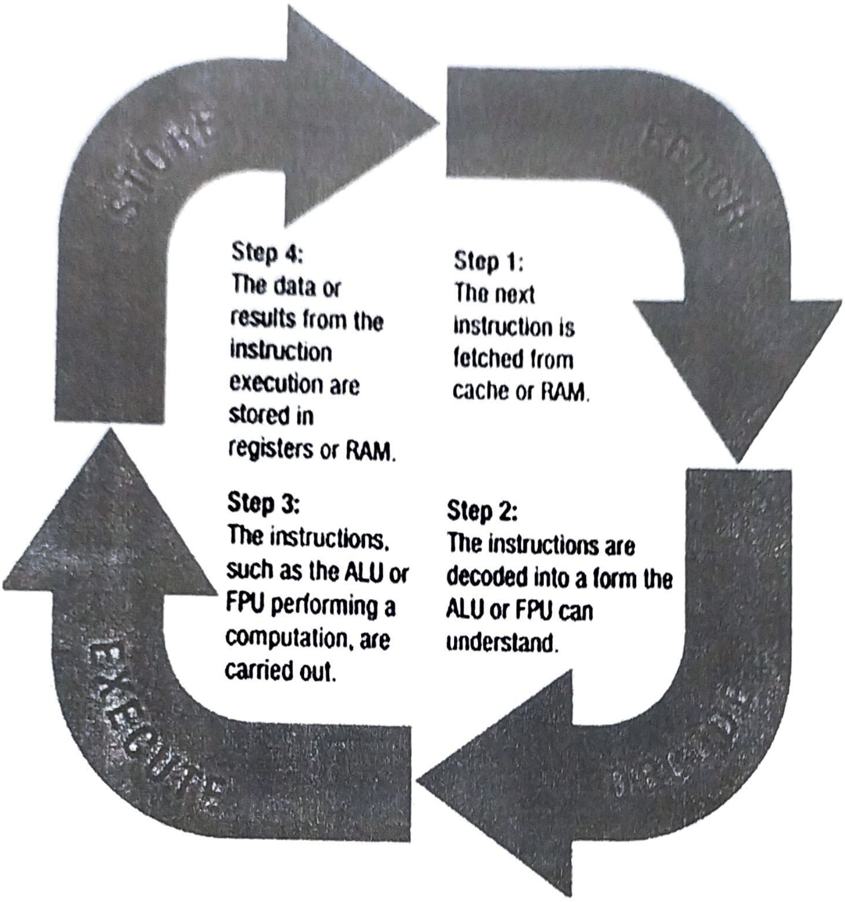
Machine cycle:

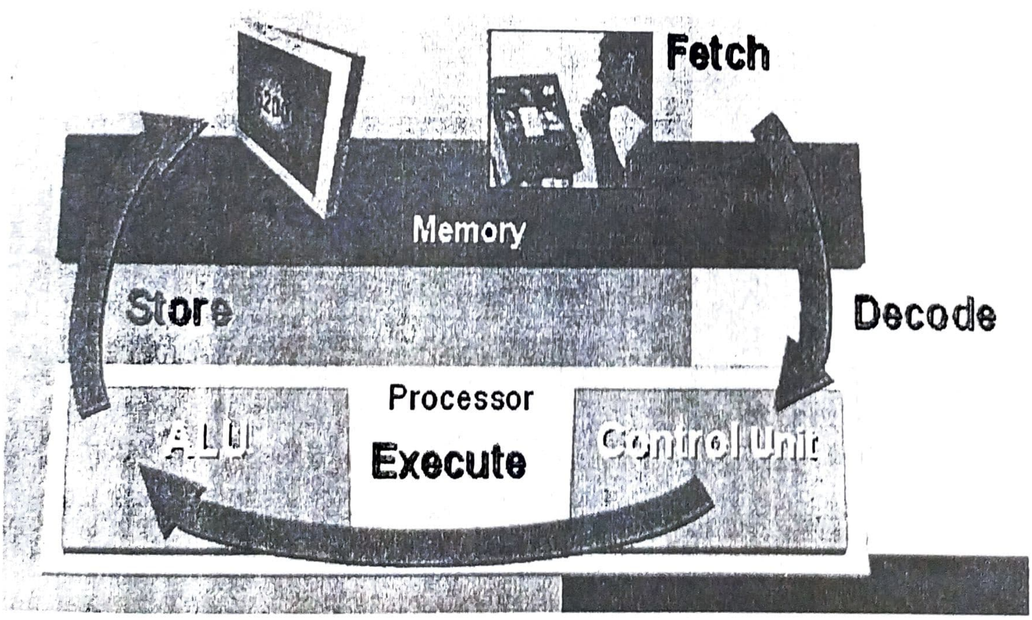
Machine cycle is the series of operations involved in the execution of a single machine level instruction.

The machine cycle consists of four steps as follows:

- **Fetch:** the program instruction is fetched.
- **Decode:** the instructions are decoded so the control unit, ALU and FPU can understand them.
- **Execute:** the instructions are carried out.
- **Store:** the original data or the result from the ALU or FPU execution is stored either in the CPU's registers or in memory depending on the instruction.

The following Figures illustrate the four steps of machine cycle showing the action of each step.





Machine cycle

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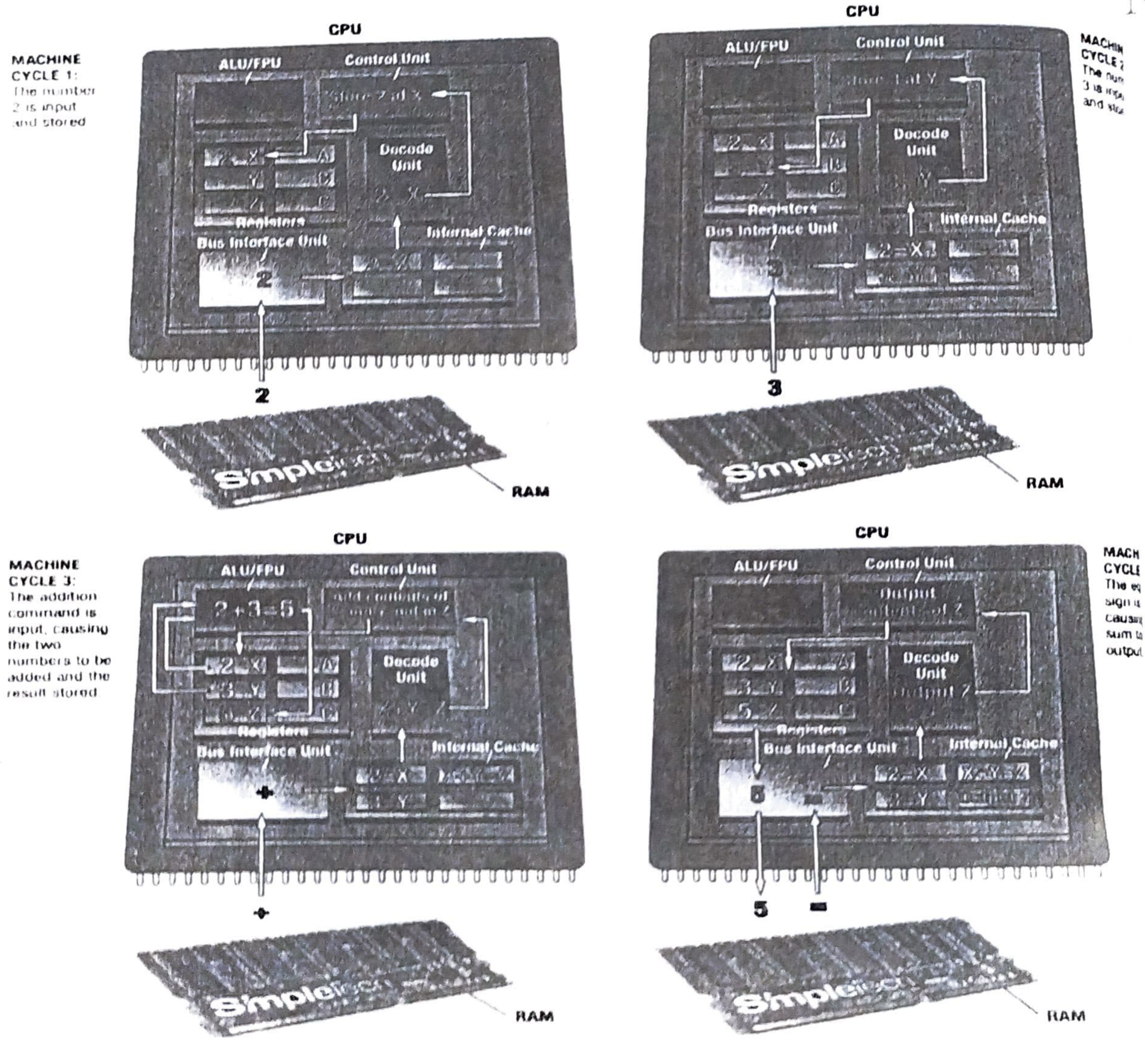
The following Figure shows the application of the machine cycle to execute the instruction: 2 + 3 = 5



Note

As an example for the machine cycle

To compute 2 + 3 = 5

Making Computers Faster and Better Now and in the Future

- Over the years, computer designers have developed a number of strategies to achieve faster, more powerful, and more reliable computing performance.
- Researchers are constantly working on ways to improve the performance of computers of the future.
- There are several ways computer users can speed up their computers today, and a number of technologies being developed by manufacturers to improve computers both today and in the future.

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Improving the Performance of Your System Today

- Add more memory.
- Perform system maintenance (uninstall programs properly, delete temporary files, scan for viruses and spyware, etc.).
- Buy a larger or second hard drive.
- Upgrade your Internet connection.
- Upgrade your video card.

Strategies for Making Faster and Better Computers

- Improved architecture (smaller components, faster bus speeds, multiple CPU cores, etc.).
- Improved materials (new backing materials, flexible circuits, etc.).
- Pipelining: allows multiple instructions to be processed at one time.
- Multiprocessing and parallel processing: use multiple processors to speed up processing.

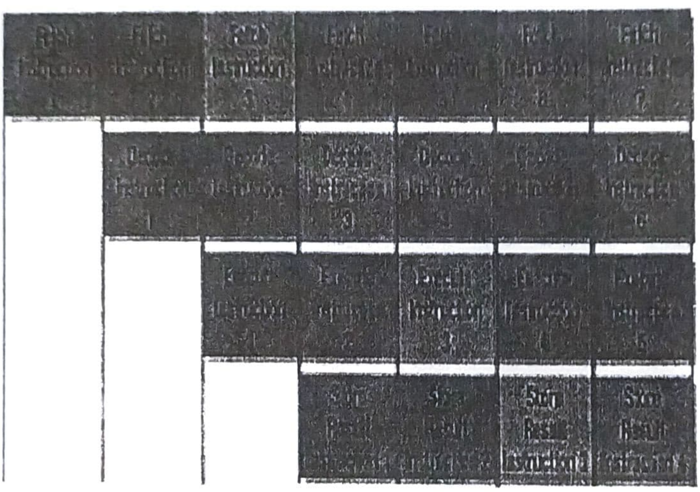
Note:

Pipelining

Stages

Without pipelining
An instruction finishes an entire machine cycle before another instruction is started.

Stages



With pipelining
A new instruction is started when the preceding instruction moves to the next stage of the pipeline.

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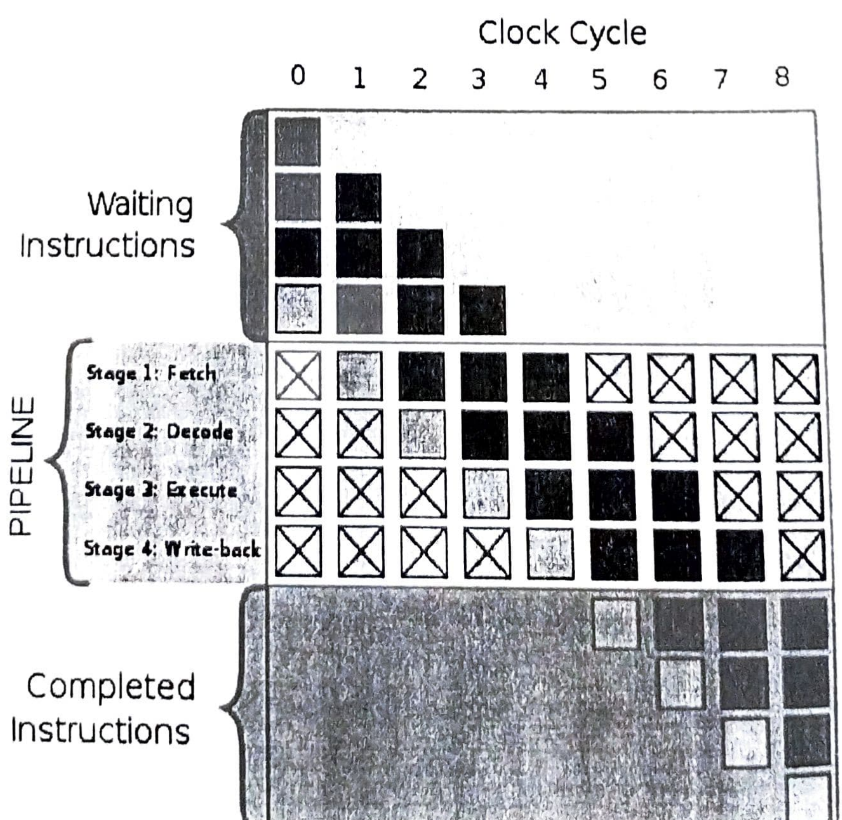
Note: ....

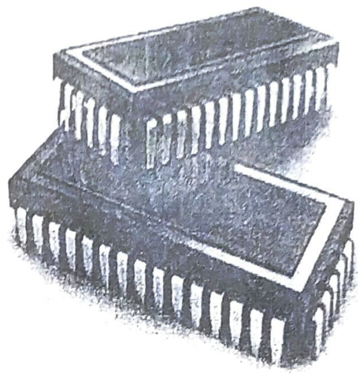


Future Trends

Nanotechnology:

The science of creating tiny computers and components (less than 100 nanometers in size).

- Some components today fit this definition.
- In the future, components may be built by working at the individual atomic and molecular levels.
- Nanotechnology opens up the door to many new applications.



Nanotechnology

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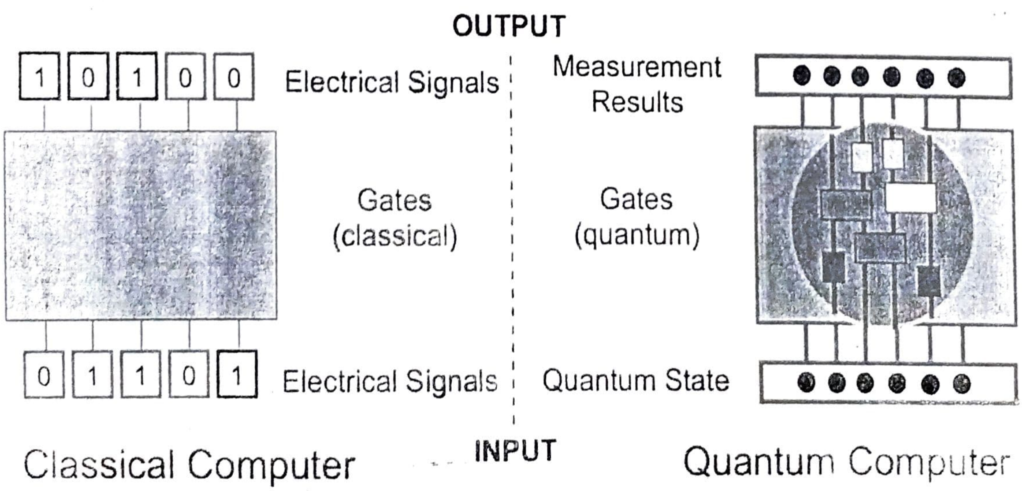
Quantum computing:

A technology that applies the principles of quantum physics and quantum mechanics to computers.

- Utilizes atoms or nuclei working together as quantum bits (qubits).
- Qubits function simultaneously as the computer's processor and memory and can represent more than two states.
- Expected to be used for specialized applications, such as encryption and code breaking.



Quantum computing

Note:

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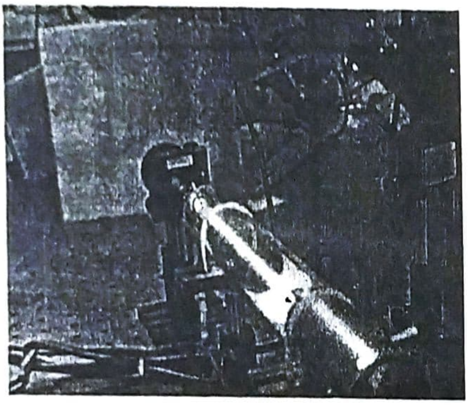
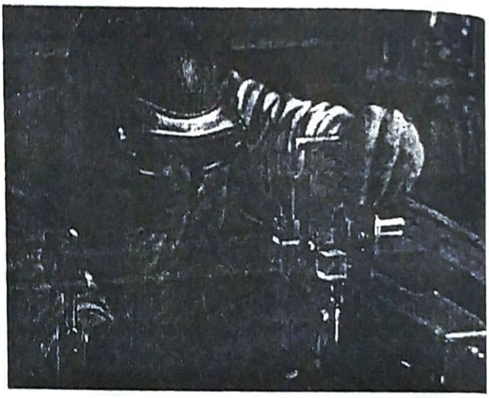
Optical computer:

A computer that uses light, such as from laser beams or infrared beams, to perform digital computations.

- **Opto-electronic computers** use both optical and electronic components.



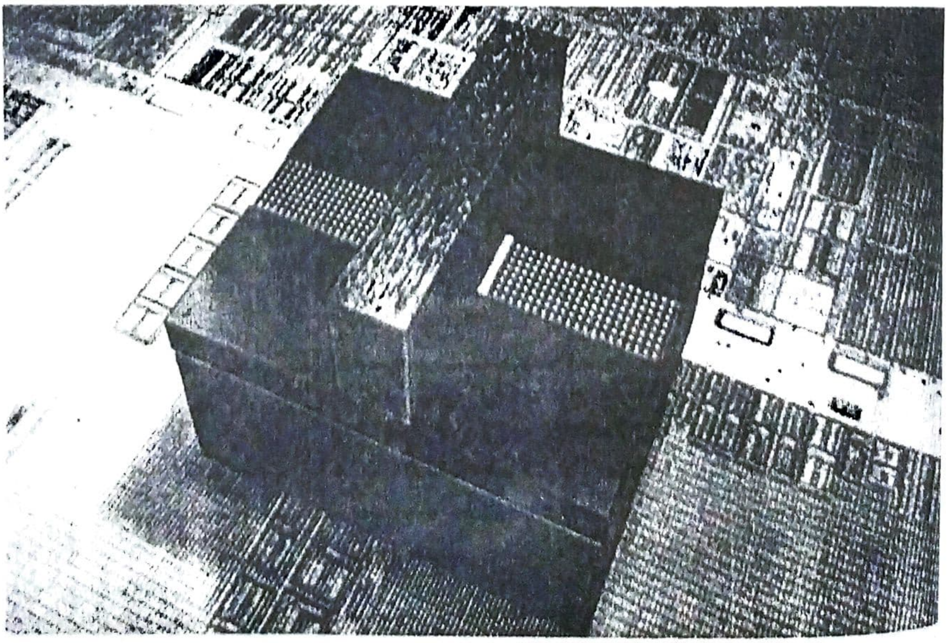


Opto-electronic computers

3D chips:

Layer transistors to cut down on the surface area required.

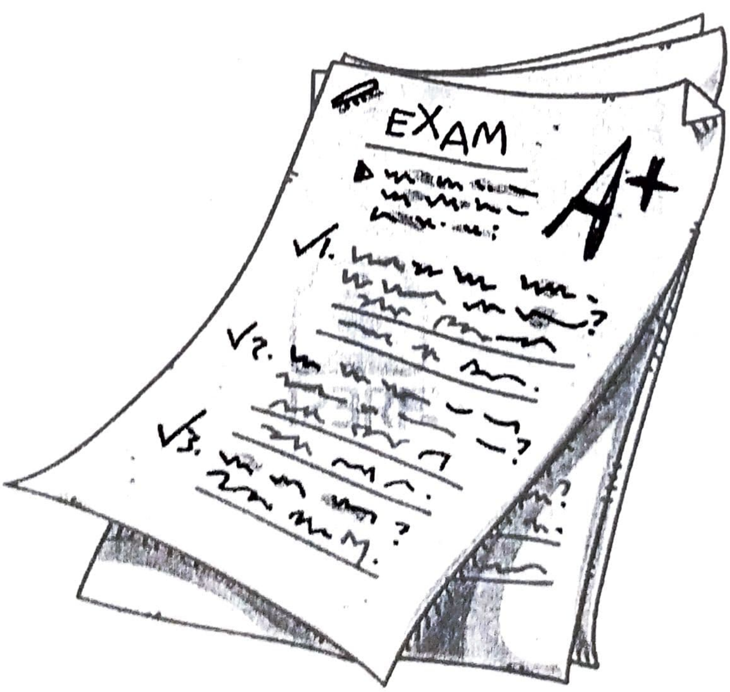
Note: ....



3D chips

Date / / 20

Exercises



1- Match each key term on the left with the definition on the right that best describes it.

Key term matching	Description
a. ASCII	1. A processing technique that uses multiple processors or processing cores simultaneously, usually to process a single job as fast as possible.
b. binary numbering system	2. A fixed-length, binary coding system used to represent text-based data for computer processing on many types of computers.
c. byte	3. A group of 8 bits.
d. central processing unit (CPU)	4. A universal bus used to connect up to 127 peripheral devices to a computer without requiring th use of additional expansion cards.
e. control unit	5. Chips connected to the motherboard to provide a temporary location for the computer to hold data and program instructions while they are needed.
f. motherboard	6. The chip located on the motherboard of a computer that performs the processing for a computer.
g. nanotechnology	7. The main circuit board of a computer, located inside the system unit, to which all computer system components connect.
h. parallel processing	8. The numbering system that represents all numbers using just two symbols (0 and 1).
i. RAM (random access memory)	9. The part of the CPU that coordinates its operations
j. Universal Serial Bus (USB)	10. The science of creating tiny computers and components by working at the individual atomic and molecular levels.

2- Circle T if the statement is true, F if the statement is false, or write the best answer in the space provided.

1. T F A storage medium that can hold 256 GB can hold about 256 billion characters.
2. T F The amount of data that can be transferred over a bus in a given time period determines the bus's volatility.
3. T F Cache memory is typically built into a CPU.
4. T F A bus is a pathway, such as on the motherboard or inside the CPU, along which bits can be transferred.
5. T F Computers that process data with light are referred to as quantum computers.

3- Number the following terms from 1 to 9 to indicate their size from smallest to largest.

a.	Petabyte	d.	Yottabyte	g.	Zettabyte
b.	Kilobyte	e.	Exabyte	h.	Terabyte
c.	Gigabyte	f.	Byte	i.	Megabyte

4- What do each of the following acronyms stand for ?

a. KB	c. ROM	e. PCIe
b. RAM	d. USB	f. CPU

5- Supply the missing words to complete the following statements.

1. The smallest piece of data that can be represented by a computer (a 0 or 1) i called a(n) ....
2. .... is an international coding system for text-based data using any written language.
3. The part of the CPU that performs logical operations and integer arithmetic the ....
4. The binary number 1101 is equivalent to the decimal number ....
5. A CPU with four separate processing cores is referred to as a(n) .... CPU.
6. A(n) .... is a connector on the exterior of a computer into which a peripheral device may be plugged.
7. Multi-core CPUs allow .... , in which the CPU is able to work on multiple jobs at one time.

6- Assume you have a USB mouse, USB keyboard, and USB print to connect to a computer, but you have only two USB ports. Expla one solution to this problem that does not involve buying a new mouse, keyboard, or printer.

7- If your computer seems sluggish, list two things you could do t try to speed it up without resorting to purchasing an entirely new system.

8- Conversions of Numbering System.

1) Convert from decimal to binary

a. $(635)_{10}$

b. $(1750)_{10}$

c. $(419)_{10}$

d. $(765)_{10}$

e. $(2309)_{10}$

f. $(45)_{10}$

g. $(285)_{10}$

h. $(217.625)_{10}$

i. $(125.5)_{10}$

j. $(257.875)_{10}$

2) Convert from decimal numbers to corresponding octal numbers

a. $(110)_{10}$

b. $(665)_{10}$

c. $(366)_{10}$

d. $(5975)_{10}$

e. $(4036)_{10}$

f. $(6507)_{10}$

g. $(3915)_{10}$

h. $(385)_{10}$

i. $(797)_{10}$

j. $(325)_{10}$

k. $(1005)_{10}$

l. $(125.125)_{10}$

m. $(225.625)_{10}$

n. $(86.875)_{10}$

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3) **Convert from decimal to hexadecimal**

a. $(275)_{10}$

b. $(996)_{10}$

c. $(1565)_{10}$

d. $(988)_{10}$

e. $(2925)_{10}$

f. $(1288)_{10}$

g. $(8275)_{10}$

h. $(387)_{10}$

i. $(719)_{10}$

j. $(1050)_{10}$

4) **Convert from decimal to Binary, Octal and Hexadecimal**

a. $(2555)_{10}$

b. $(45)_{10}$

c. $(285)_{10}$

5) **Convert binary numbers to decimal numbers**

a. $(10110101)_2$

b. $(1101)_2$

c. $(1001110)_2$

d. $(1110011)_2$

e. $(100010)_2$

f. $(1111001)_2$

g. $(1000011)_2$

h. $(110011.11)_2$

i. $(100001.101)_2$

6) **Convert from binary to corresponding octal**

a. $(111001110)_2$
b. $(100110101)_2$
c. $(10001011110)_2$
d. $(10101010)_2$
e. $(111000101.101)_2$
f. $(100000100.010)_2$

7) **Convert from binary to hexadecimal**

a. $(10101110)_2$
b. $(11001)_2$
c. $(1011000110101111110010)_2$
d. $(110111001)_2$
e. $(11101010)_2$
f. $(100011000010)_2$
g. $(111000111101)_2$
h. $(11110000101)_2$
i. $(10001.0011)_2$
j. $(1000100010.1010)_2$
k. $(1000000101.111)_2$

8) **Convert octal numbers to corresponding binary numbers**

a. $(567)_8$
b. $(2035)_8$
c. $(12467)_8$
d. $(2536.4)_8$
e. $(727.5)_8$

9) **Convert octal to corresponding decimal**

a. $(364)_8$

b. $(1035)_8$

c. $(2167)_8$

d. $(7051)_8$

e. $(50007)_8$

f. $(4056)_8$

g. $(727)_8$

10) **Convert octal to hexadecimal**

a. $(565)_8$

b. $(3003)_8$

c. $(20503)_8$

d. $(3045)_8$

e. $(757)_8$

11) **Convert hexadecimal to binary**

a. $(6AB5)_{16}$

b. $(4F5D)_{16}$

c. $(69ABC)_{16}$

d. $(4053)_{16}$

12) **Convert hexadecimal to decimal**

a. $(1A2)_{16}$
b. $(A3B1)_{16}$
c. $(ABCD)_{16}$
d. $(567A)_{16}$
e. $(3459B)_{16}$
f. $(30C7)_{16}$
g. $(C00AB)_{16}$
h. $(3459B)_{16}$
i. $(AACC5)_{16}$
j. $(FFFFF)_{16}$

13) **Convert hexadecimal to octal**

a. $(FED)_{16}$
b. $(98CA)_{16}$
c. $(ABCD25)_{16}$
d. $(FAB02)_{16}$