# Microcomputer Systems

Course Code: CSC 2106

Course Title: Computer Organization and Architecture

**Dept. of Computer Science**
**Faculty of Science and Technology**

| | | | | | |
|---|---|---|---|---|---|
| **Lecturer No:** | 1 | **Week No:** | 1 | **Semester:** | |
| **Lecturer:** | | | | | |

## Lecture Outline

1. Introduction to the architecture of microcomputers
   and IBM PC

2. Peripherals and their relations to the software or Programs

3. What computer does while executing instructions

4. Advantages and disadvantages of assembly language programming

**As a microcomputer user, you already know most of these terms

## Components of Microcomputer System

- **SYSTEM UNIT**
- **I/O DEVICES OR PERIPHERALS**
  - ➢ Keyboard
  - ➢ Display Unit
  - ➢ Disk drives
- **INTEGRATED-CIRCUIT (IC)**
  - ➢ Contains transistors. Digital circuits [0’s& 1’s]
  - ➢ Binary Digits/ Bits: 0 or 1

## Components (cont'd...)

**CPU:**

- Brain of the computers
- Controls all the operations
- A single chip processor (microprocessor)

**MEMORY CIRCUITS :** Stores information

**I/O CIRCUITS :** Communicate with I/O devices

## The System Board

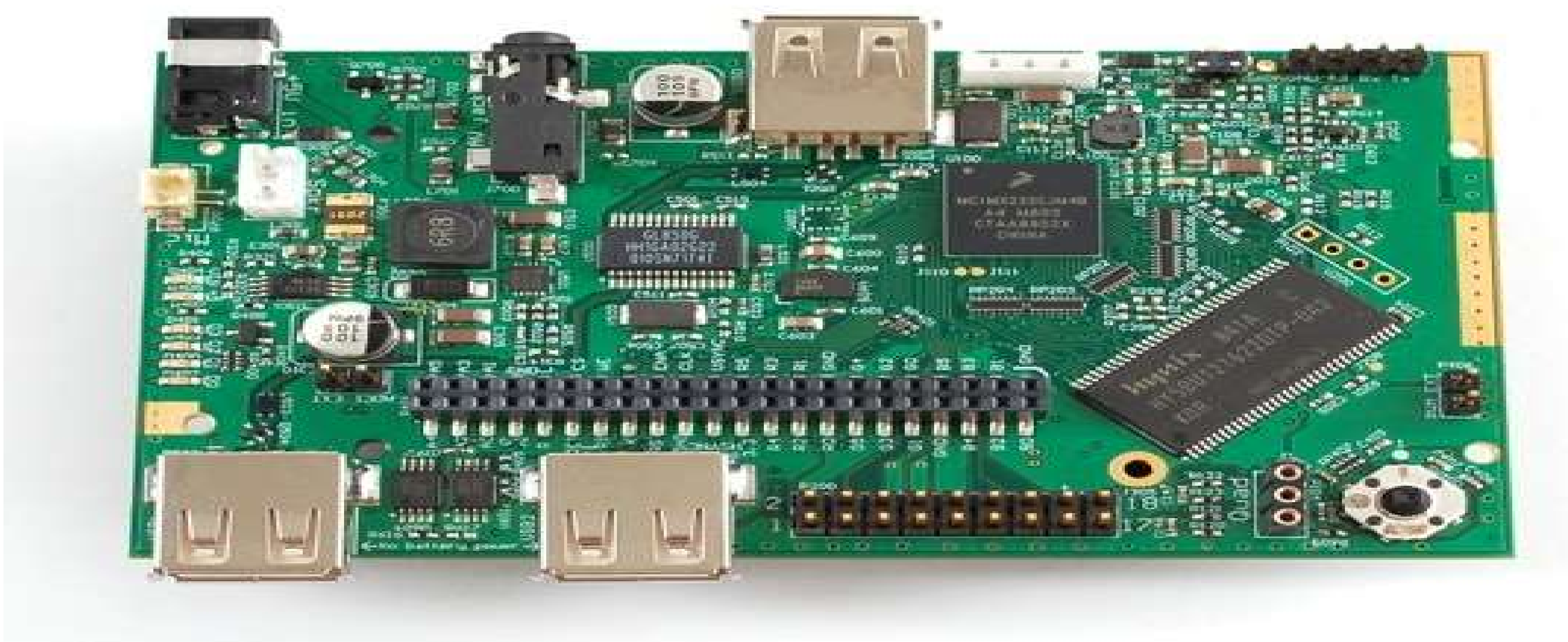
**System Board/motherboard** resides in the system unit

It **contains** microprocessors and memory circuits

- It has **expansion slots** to connect additional circuit boards called **add-in cards/add-in boards**

I/O circuits are located in add-in cards

# A Glimpse of Motherboard



The Components of a Microcomputer System,
MSU, CS, AIUB

# Memory

**Bytes and Words:**

- Information processed is stored in memory
- A memory circuit element can store one bit of data [i.e. 0 or 1]
- Memory circuits are organized as a group of **8 bits** of data
- 8 bits of string = 1 Byte
- Memory bytes are known as **address**( i.e. street address of a house).

## Address Vs Contents

The stored data in a memory byte are called **contents/value.**

| Address | Contents |
|---|---|
| The address of a memory byte is **FIXED** and different from other addresses( **unique**). | Contents are **NOT** unique as they deal with current data. |
| The number of bits in an address depend on the processor [ i.e. Intel 8086 = 20-bit & Intel 80286=24-bit ] | Contents of memory byte are always 8 bits |

## Memory byte addressing

Suppose a processor uses 20 bits for an address. How many memory bytes can be addressed using this processor?

- A bit can have two possible values (i.e. 0 or 1)
- So, in a 20-bit address, we can have **$2^{20}$** or **10,48,576**

In computer terminology $2^{20}$ = 1 Mega

Therefore, 20-bit address can be used to address **1 MB**.

## Memory Word

In a Microcomputer, **Two bytes = a word**

So to store a word data, IBM PC needs :

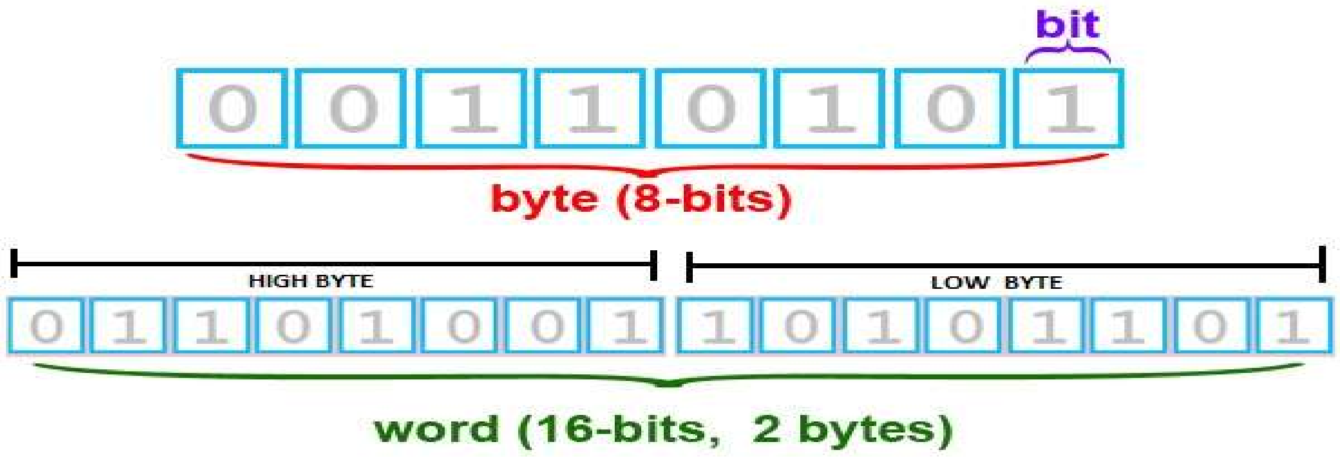
- A pair of successive memory bytes
- **A pair of memory bytes = Memory word**

The **lower** address of the two memory bytes is the memory address.

- i.e. a memory word with address 2 is made up of address 2 and 3

A microprocessor can detect memory byte or memory word from memory **location/address.**

## Bit Positions in byte and Word



- Bit positions are numbered from **Right to left**
- **Bit 0-7 = low byte** [ Lower address of word]
- **Bit 8-15 = high byte** [ Higher address of word]

## Memory Operations

The processor can perform **two** operations on memory

- **Read** or fetch the contents from a location
  - Processor only gets a copy of the data
  - **Original contents** of the location are **unchanged**

- **Write** or Store data at a location
  - The data written become the new contents
  - The Original/previous **contents are lost**

## RAM and ROM

**RAM: Random Access Memory**

- RAM locations can be **read** and **written**
- Program instructions and data are stored
- RAM memory are lost when the machine is turned off

**ROM: Read Only Memory**

- Once initialized can’t be changed (**Read Only**)
- Retain values unlike RAM [example]
- ROM based programs are known as **firmware**
- Responsible for loading start-up programs

## BUSES

A processor communicates with memory and I/O devices by using signals.
Signals are travelled along set of wires or connections called buses.
There are three kinds of signals and buses

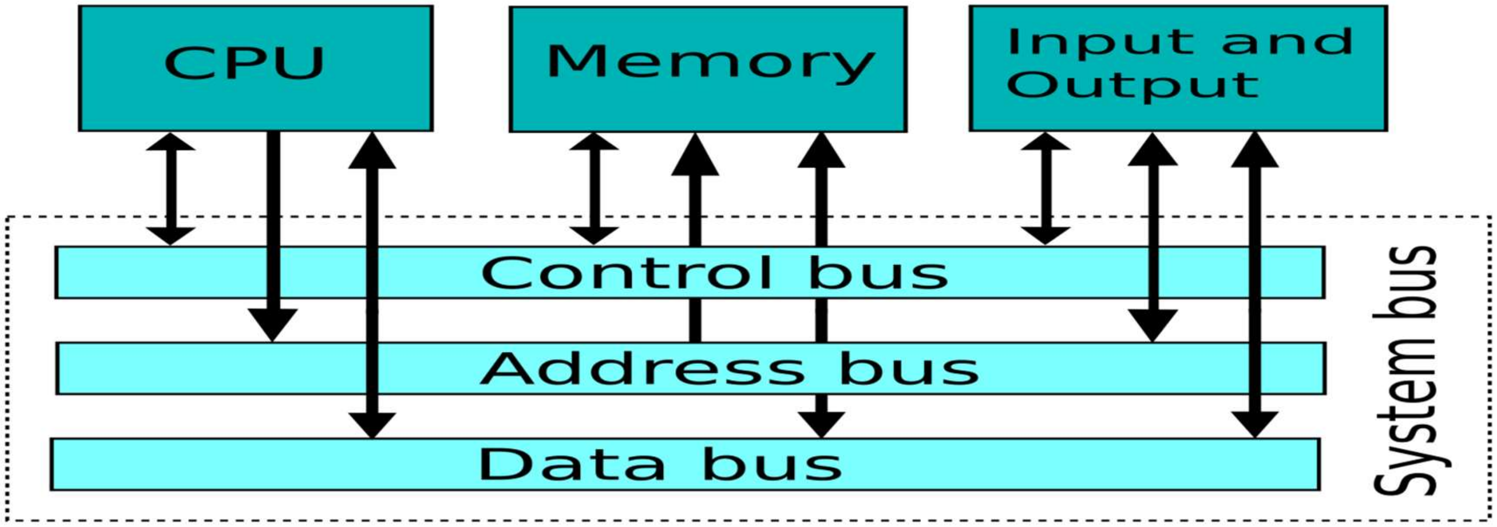
- Address & Address Buses
- Data & Data Buses
- Control & Control Buses

# BUSES(cont'd...)

**Address Bus:** The CPU places the **address** of memory location on address bus to **read** the contents.

**Data Bus:** CPU receives the data, sent by memory circuits on the data bus.

**Control Bus:** CPU sends control signals on control bus perform read operation in memory.



## CPU

CPU is the brain of computer.

CPU controls computer by executing programs (i.e. system or application).

Each instruction CPU executes, is a **bit** string.

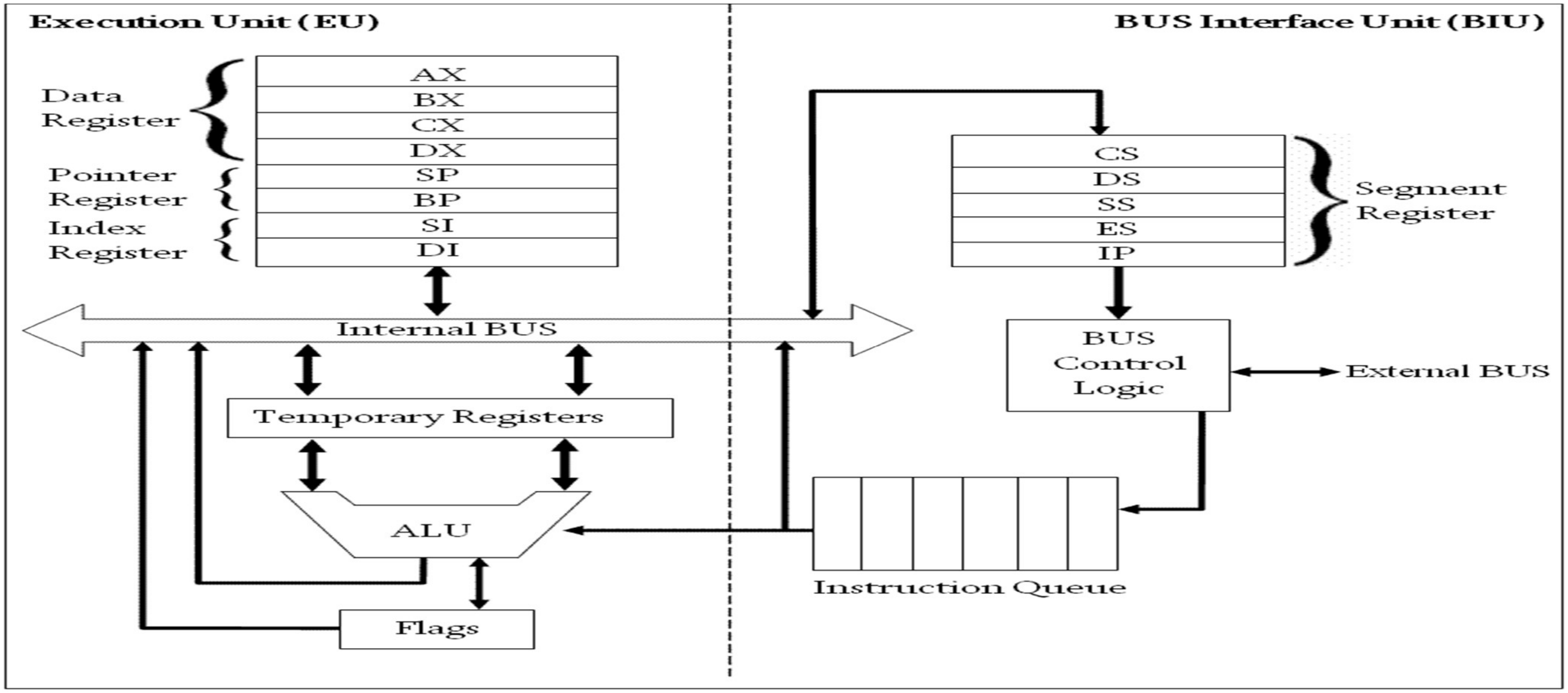
**Machine language:** The language of 0's and 1's

- Instructions are designed to be simple
- Sequence of very basic operations

**Instruction Set:** The instructions performed by CPU.

- The instructions set for each CPU is unique

# Intel 8086 Microprocessor Organization



## Execution Unit (EU)

- EU contains ALU circuits.
- ALU performs **arithmetic** and **logical** operations.
- **Data operations** are stored in **registers**.
- A **register** is like **memory location**, however, we refer to it by name not number.
  - **i.e. AX, BX, CX, DX, SI, DI, SP, BP**
- Also, EU Contains **temporary registers** for **holding operands** for the ALU and FLAGS registers.
- FLAG register's **individual bits** reflect the **result of computation**

## Bus Interface Unit (BIU)

- BIU **enables communication** between the EU and memory or I/O circuits.

- Primarily responsible for transmitting address, data and control signals on the buses.

- BIU registers are: **CS,DS, ES and IP**
    - BIU registers hold the addresses of the memory locations

## EU and BIU

- EU and BIU are connected by **internal bus** and they work together.

- While EU executes an Instruction, BIU fetches up to six bytes of the next instruction and places instructions in instruction queue (IQ).

- The overall process is called ***instruction prefetch*** and it's purpose is to speed up the processor.

- However, if EU needs to communicate with memory, BIU suspends instruction prefetch and performs required operations.

# I/O Ports

I/O ports functions as **transfer points** between the CPU and I/O devices.

I/O devices are connected through I/O ports

| Serial | Parallel |
|---|---|
| Transfers 1 bit at a time | Transfers 8 or 16 bits at a time |
| Serial ports tend to be slower | Requires more wiring connection |
| Slow devices are connected to serial port. (**i.e. Keyboard**) | Fast devices are connected to parallel port. (**i.e. disk drive**) |

## Instruction Execution

How the CPU is operated?

Machine language has two parts

- **Opcode:** Type of operation
- **Operands:** Data to be operated on (Memory addresses are used)

**The fetch- execute cycle**

**Fetch**

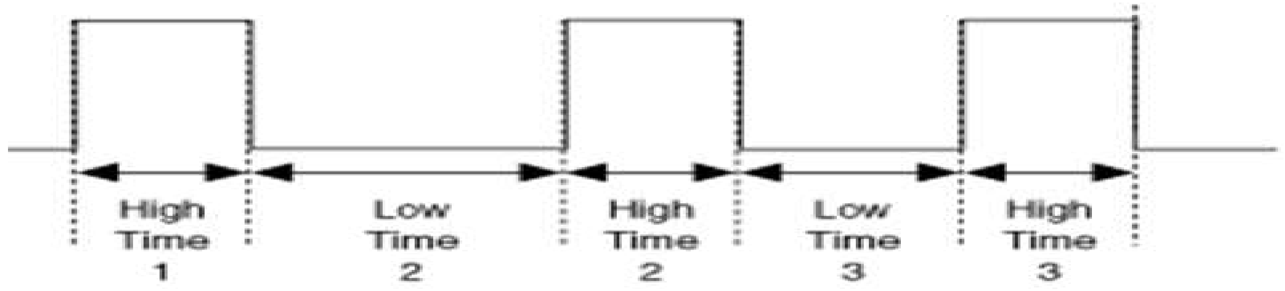
- Fetch an instruction from memory
- Decode the instruction to determine the operation
- Fetch data from memory if necessary

**Execute cycle**

- Perform operation on the data
- Store the result if needed

# Timing

To ensure execution steps are carried out in an **orderly fashion**, a clock circuit controls the processor by generating a **train of clock pulses**



**Clock Period:** The time interval between two pulses.

**Clock rate/speed:** Number of Pulses per second.

- Measured in Megahertz (MHz)
- 1 MHz = **1000000** (1 million) pulses per second

## Timing Task

If you have computer with processor 2.3 GHz, How many pulses are generated per seconds from your computer?

- 2.3 X 1000X 1000000 = 2,30,00,00,000 pulses

## Programming Languages

- **Machine Language:** Bit strings (i.e. 0 & 1)
- **Assembly language:**
  - Symbolic names are used to represent operations, registers and memory locations(i.e. MOV AX, A)
  - Assembly program must be converted into machine language using assembler.
- **High-Level language:**
  - Allows programmer to write program in more natural language text.
  - A Compiler is needed to translate high-level programs into machine language

## Advantages

### High-level

- Closer to natural language. So, algorithm conversion in easier.
- Less instruction and time required than assembly language.
- Programs can be executed in any machine

### Assembly

- So close to the machine language. So programs are faster and shorter.
- Reading or writing to specific memory location, I/O ports is easy.
- It can be a sub program of a high-level language.
- Going into more details like how computer thinks.

## References

- Assembly Language Programming and Organization of the IBM PC, Ytha Yu and Charles Marut, McGraw Hill, 1992. (ISBN: 0-07-072692-2).

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