CSC405 Microprocessor

Microprocessor Introduction

Syllabus

Course Code	Course Name	Credits
CSC405	Microprocessor	3

Prerequisites: Digital Logic and Computer Architecture	
Course objectives:	
1	To equip students with the fundamental knowledge and basic technical competence in thefield of Microprocessors.
2	To emphasize on instruction set and logic to build assembly language programs.
3	To prepare students for higher processor architectures and embedded systems
Course outcomes: On successful completion of course, learner will be able to:	
1	Describe core concepts of 8086 microprocessor.
2	Interpret the instructions of 8086 and write assembly and Mixed language programs.
3	Identify the specifications of peripheral chip.
4	Design 8086 based system using memory and peripheral chips.
5	Appraise the architecture of advanced processors
6	Understand hyperthreading technology

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4 Design 8086 based system using memory and peripheral chips.

5 Appraise the architecture of advanced processors.

6 Understand hyperthreading technology.

Module	Detailed Contents		Hours
1	**The Intel Microprocessors 8086 Architecture**		8
	1.1	8086CPU Architecture,	
	1.2	Programmer's Model	
	1.3	Functional Pin Diagram	
	1.4	Memory Segmentation	
	1.5	Banking in 8086	
	1.6	Demultiplexing of Address/Data bus	
	1.7	Functioning of 8086 in Minimum mode and Maximum mode	
	1.8	Timing diagrams for Read and Write operations in minimum and maximum mode	
	1.9	Interrupt structure and its servicing	
2	**Instruction Set and Programming**		**6**
	2.1	Addressing Modes	
	2.2	Instruction set-Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions	
	2.3	Assembler Directives and Assembly Language Programming, Macros, Procedures	

3	**Memory and Peripherals interfacing**		**8**
	3.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	3.2	8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086.	
	3.3	8257-DMAC-Block diagram, DMA operations and transfer modes.	
	3.4	Programmable Interrupt Controller 8259-Block Diagram, Interfacing the 8259 in single and cascaded mode.	
4	**Intel 80386DX Processor**		**7**
	4.1	Architecture of 80386 microprocessor	
	4.2	80386 registers–General purpose Registers, EFLAGS and Control registers	
	4.3	Real mode, Protected mode, virtual 8086 mode	
	4.4	80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	

5	**Pentium Processor**		**6**
	5.1	Pentium Architecture	
	5.2	Superscalar Operation,	
	5.3	Integer &Floating-Point Pipeline Stages,	
	5.4	Branch Prediction Logic,	
	5.5	Cache Organization and	
	5.6	MESI protocol	
6	**Pentium 4**		**4**
	6.1	Comparative study of 8086, 80386, Pentium I, Pentium II and Pentium III	
	6.2	Pentium 4: Net burst micro architecture.	
	6.3	Instruction translation look aside buffer and branch prediction	
	6.4	Hyper threading technology and its use in Pentium 4	

Syllabus Summary

Module	Contents	Hours
1	The Intel Microprocessors 8086 Architecture	8
2	Instruction Set and Programming	6
3	Memory and Peripherals interfacing	8
4	Intel 80386DX Processor	7
5	Pentium Processor	6
6	Pentium 4	4

Textbooks:	
1	John Uffenbeck, "8086/8088 family: Design Programming and Interfacing", PHI.
2	Yu-Cheng Liu, Glenn A. Gibson, "Microcomputer System: The 8086/8088 Family, Architecture, Programming and Design", Prentice Hall
3	Walter A. Triebel, "The 80386DX Microprocessor: hardware, Software and Interfacing", Prentice Hall
4	Tom Shanley and Don Anderson, "Pentium Processor System Architecture", Addison-Wesley.
5	K. M. Bhurchandani and A. K. Ray, "Advanced Microprocessors and Peripherals", McGraw Hill
References:	
1	Barry B. Brey, "Intel Microprocessors", 8th Edition, Pearson Education India
2	Douglas Hall, "Microprocessor and Interfacing", Tata McGraw Hill.
3	Intel Manual
4	Peter Abel, "IBM PC Assembly language and Programming", 5th Edition, PHI
5	James Antonakons, "The Pentium Microprocessor", Pearson Education

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://swayam.gov.in/nd1_noc20_ee11/preview
2	https://nptel.ac.in/courses/108/105/108105102/
3	https://www.classcentral.com/course/swayam-microprocessors-and-microcontrollers-9894
4	https://www.mooc-list.com/tags/microprocessors

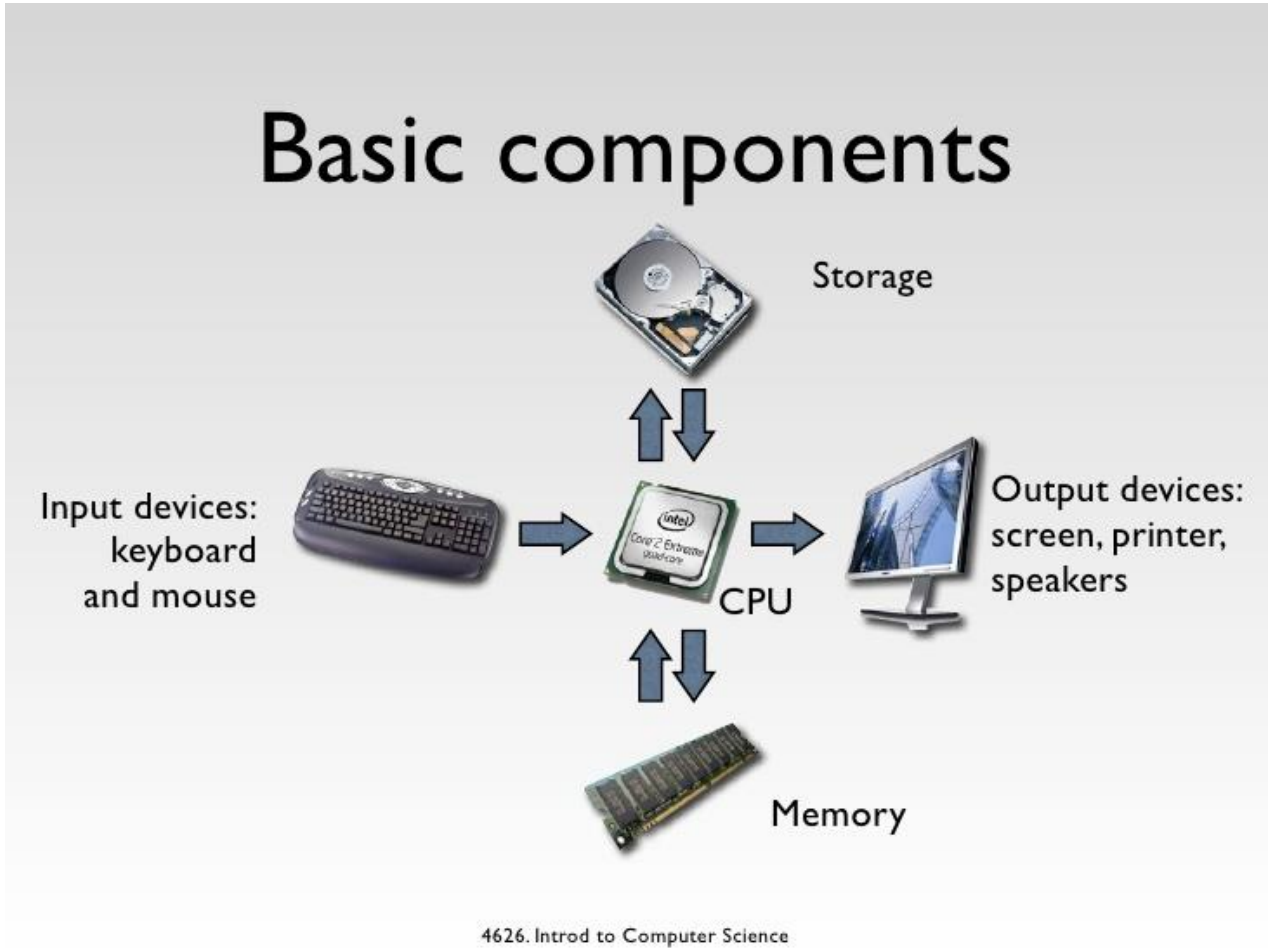
Introduction

Rationale

- What is the reason (logical basis) for learning this course “Microprocessor”?

A General Purpose Computer

A General Purpose Computer



A General Purpose Computer

- All general-purpose computers require the following hardware components:

I. **Central processing unit (CPU)**

II. **Memory (IC or chip)**

III. **Mass storage device**

IV. **Input device**

V. **Output device**

A General Purpose Computer

I. **Central processing unit (CPU)**:

- This component is the **brain** of the computer, that actually executes instructions.
- Instructions are commands to the computer to perform different tasks.
- A set of instructions is called Program & a group of programs is called software

A General Purpose Computer

II. Memory

- Physical device (**IC or chip**) that enables a computer to store data and programs temporarily or permanently.
- It is also known as "primary storage" or "primary memory"
- **Example**: read-write memory (**RAM**) and read-only memory (**ROM**).

A General Purpose Computer

III. Mass storage device (MSD)

- Allows a computer to permanently retain large amounts of data.
- It is also called as "secondary storage"
- **Example**: *disk drives* and *tape drives*, *USB drives*, *CD ROMs,* etc.

A General Purpose Computer

IV. Input device

- Any hardware device through which data and instructions (inputs) enter a computer.
- **Example:** *keyboard, mouse, etc.*

V. Output device:

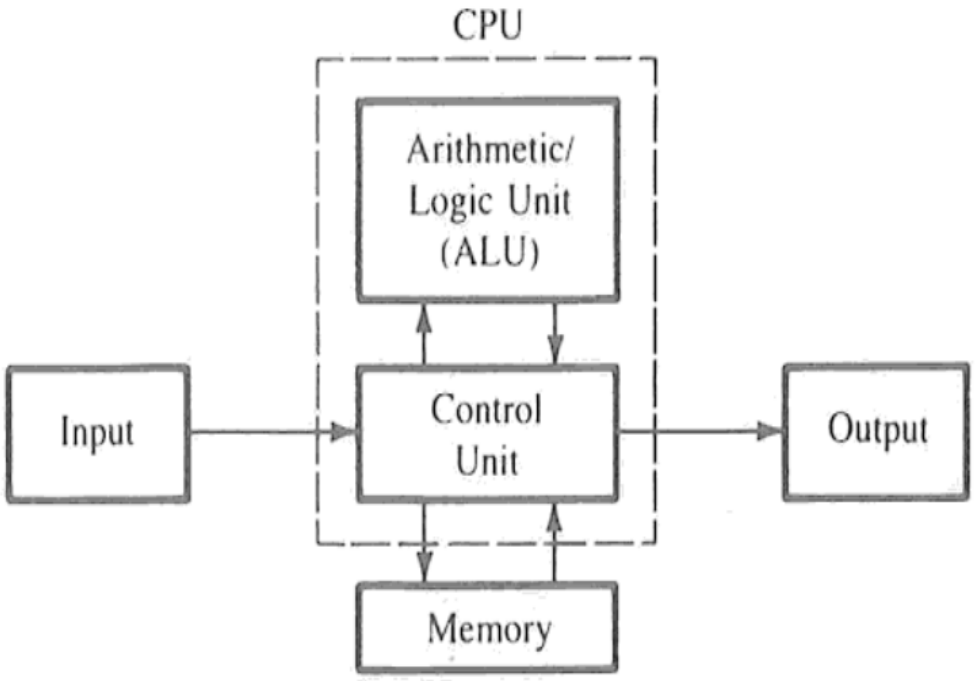
- Any hardware device that lets you see what the computer has accomplished.
- **Example:** *display screen, printer,* etc.

A General Purpose Computer

- In addition to these components, many others make it possible for the basic components to work together efficiently.
- **For example**, every computer requires a ***bus*** that transmits data from one part of the computer to another.

Microprocessor as A CPU (MPU)

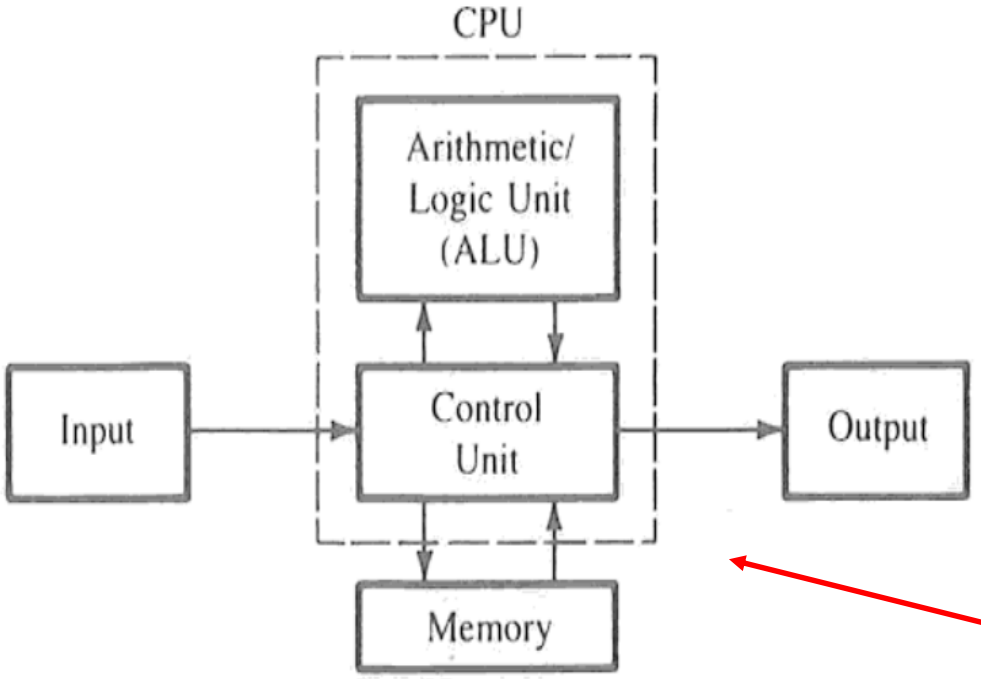
Block Diagram of a Traditional Computer



- A computer has 4 components:
  1. Central processing unit (CPU)
     i. Arithmetic/logic unit (ALU)
     ii. Control unit (CU)
  2. Memory
  3. Input
  4. Output

MICROPROCESSOR AS A CPU (MPU)

Block Diagram of a Traditional Computer

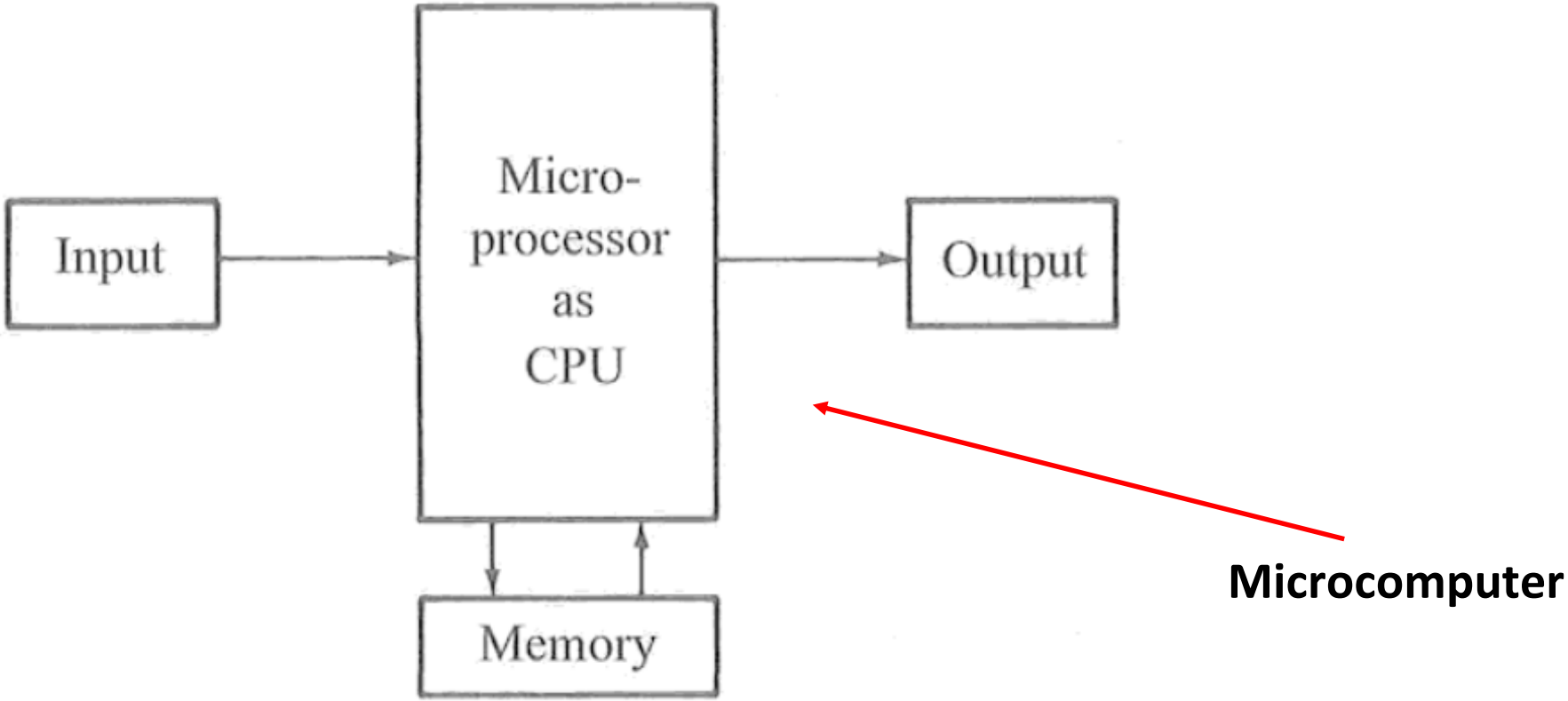


- The CPU contains
  - Various registers
  - ALU
  - Instruction decoder
  - Counters &
  - Control lines

Traditional Computer

Microprocessor as A CPU (MPU)

Computer with Microprocessor as its CPU = Microcomputer



Microprocessor

A microprocessor is a

i. Multipurpose,
ii. Programmable,
iii. Clock Driven,
iv. Register/ Flipflops based &
v. Timing based Electronic/Logic Device

Microprocessor - Functions

- A microprocessor

    1. **Reads binary instructions** from a storage device called **memory**
    2. **Accepts a binary data** as **input** and
    3. **Processes data** according to those instructions and
    4. **Provides results** as output.

Microprocessor

- A microprocessor is a
  - semiconductor device manufactured by using either a large-scale integration (**LSI**) or very-large-scale integration (**VLSI**) technique.
- It is capable of
  - ✓ performing various **computing functions**, and
  - ✓ **making decisions** to change the sequence of program execution.

Advances In Semiconductor technology

Year	Technology	Examples
1949	Transistor invented	
1958	Integrated Circuit (IC) invented	
1960-64	Small-scale integration (**SSI**): 1 to 20 gates on a single chip	7400 quad NAND **gate**, D flip-flops
1965-70	Medium-scale integration (**MSI**): 20-200 gates on a single chip	7490 decade counter, **ALU**, Shift registers
1970-76	Large-scale integration (**LSI**): 200-2000 gates on a single chip	**Small memories**, **low end processors**, programmable logic devices (PLDs)
1976	Very large scale integration (**VLSI**)-More than 1,000,000 transistors on a single chip	**Most microprocessors** & **memories** of today
	Ultra large scale integration (**ULSI**)- billions of transistors on a chip	**Superscalar** processors & **multicore** processors

Microprocessor Evolution

Microprocessor	Introduction Date	Introduction Speed	Process Technology	Transistor Count	Addressable Memory	Bits
4004	Nov, 1971	108 kHz	10,000nm	2,300	640 bytes	4
8008	Apr, 1972	200 kHz	10,000nm	3,500	16 KB	8
8080	Apr, 1974	2 MHz	6,000nm	4,500	64 KB	8
8085	Mar, 1976	4.77 MHz	3,000nm	6,500	64 KB	8
8086	Jun, 1978	4.77 MHz	3,000nm	29,000	1 MB	16
80286	Feb, 1982	6 MHz	1,500nm	134,000	16 MB	16
80386	Oct, 1985	16 MHz	1,500nm	275,000	4 GB	32
80486	Apr, 1989	25 MHz	1,000nm	1.2 Million	4 GB	32
Pentium	Mar, 1993	60 MHz	800nm	3.1 Million	4 GB	32
Pentium Pro	Nov, 1995	150 MHz	600nm	5.5 Million*	64 GB~	32
Pentium II	May, 1997	233 MHz	350nm	7.5 Million*	64 GB~	32
Pentium III	Feb, 1999	450 MHz	250nm	9.5 Million*	64 GB~	32
Pentium 4	Nov, 2000	1.4 GHz	180nm	42 Million	64 GB~	32
Itanium	May, 2001	800 MHz	180nm	295 Million	18 Terabytes	64

** Transistor count does not include L2 cache*

~ 4GB standard, 64GB with Paging Address Extensions

Core 2 Duo

i3

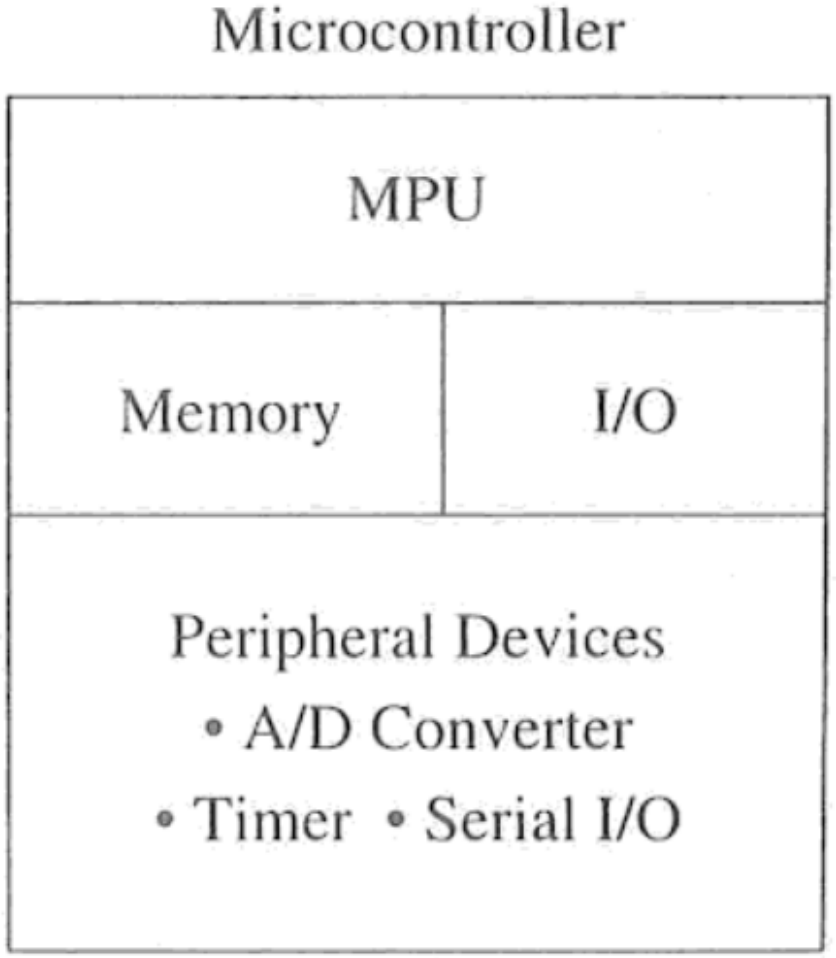
i5

i7

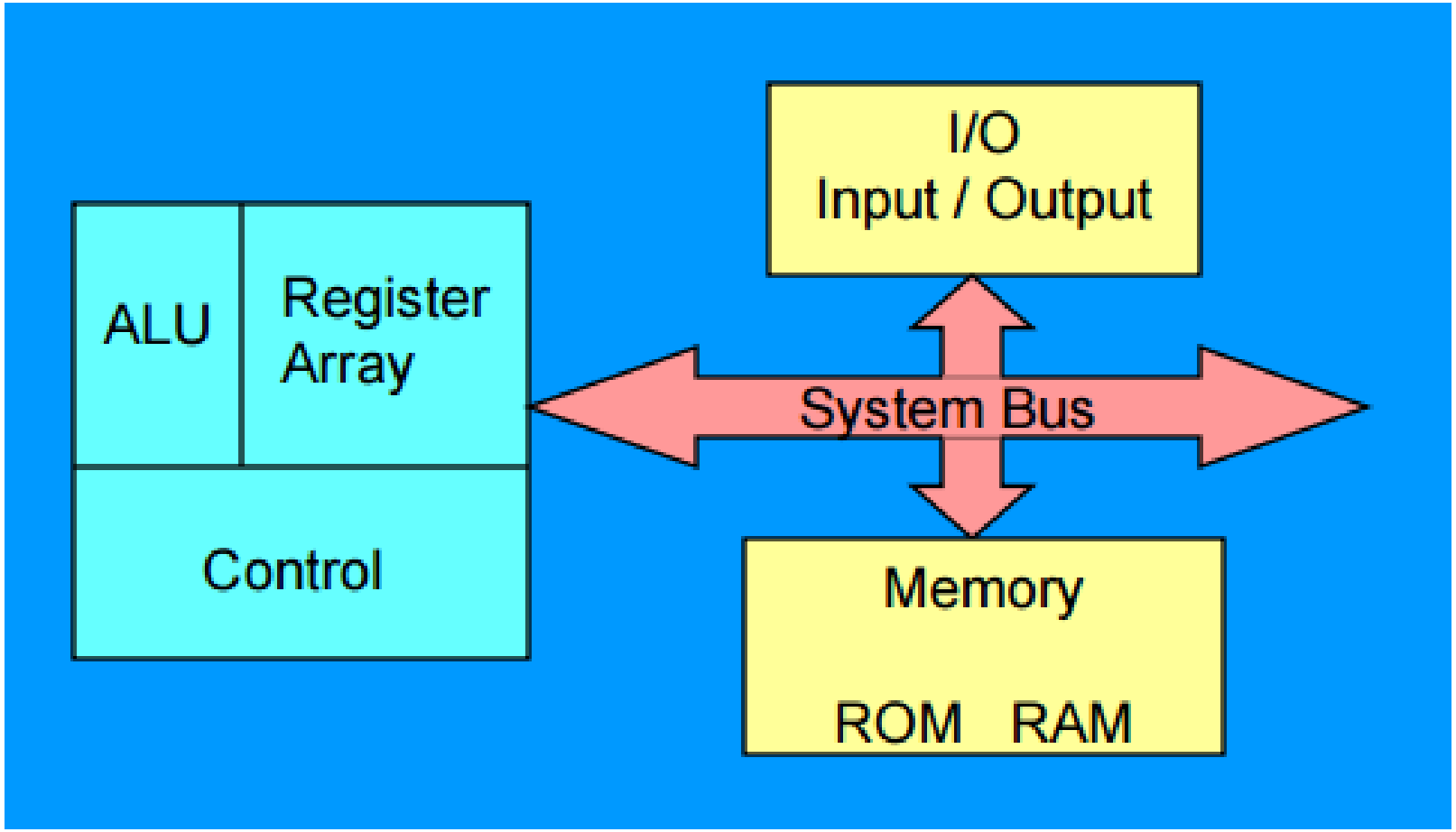
i9

MicroCONTROLLER (Computer on a single chip)

- As the semiconductor fabrication became more advanced, manufacturers were able to place not only MPU but also memory & I/O interfacing circuits on a single chip



Organization of a microprocessor-based system



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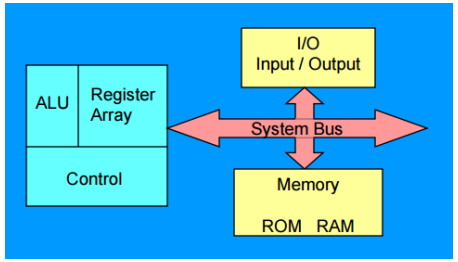
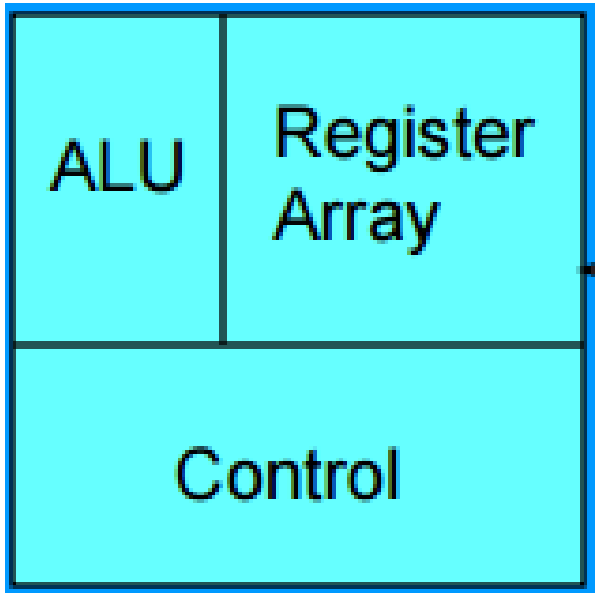


A. Arithmetic/Logic Unit:

- Area of the microprocessor where various computing functions are performed on the data.
- The operations are:
  - ✓ Addition & subtraction and
  - ✓ Logic operations as AND, OR, and EXOR.



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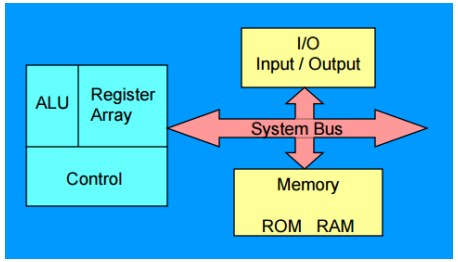
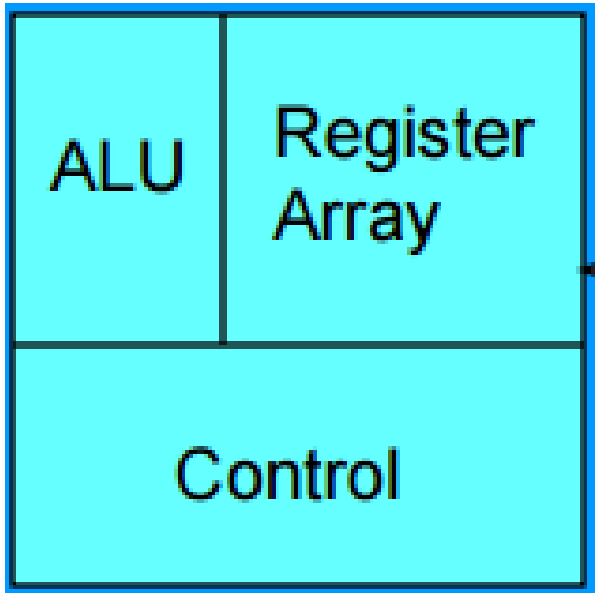


B. Register Array :

- It consists of various registers identified by letters such as ***B, C, D, E, H, and L.***
- These registers are used to store data temporarily during the execution of a program
- They are **accessible to the user** through instructions.



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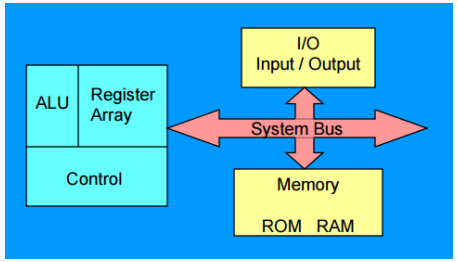
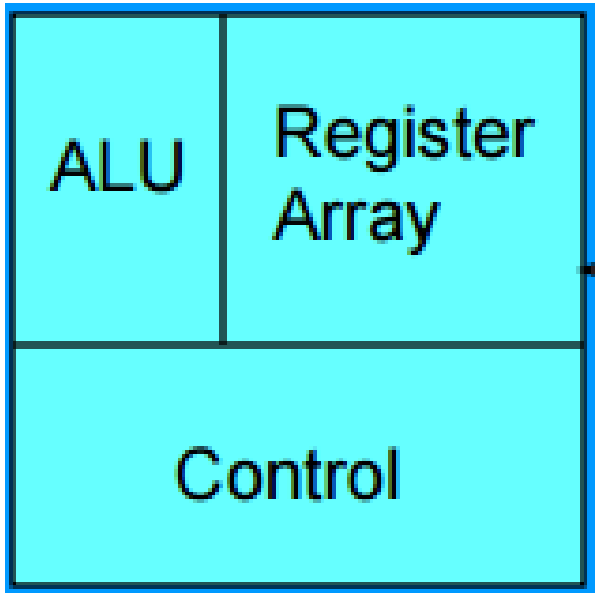


C. Control Unit :

- It provides the necessary ***timing* and *control signals*** to all the operations in the microcomputer.
- It ***controls the flow of data*** between the microprocessor and memory and peripherals.



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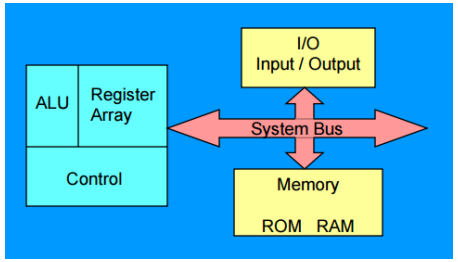
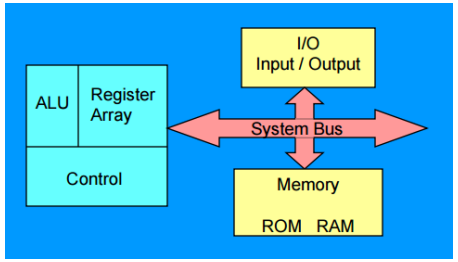


2. Memory :

- Memory **stores** such binary information as **instructions** and **data**
- To execute a program, the microprocessor reads instructions & data from memory & performs the computing operations in the ALU section.
- The results are either transferred to the output section for display or stored in memory for later use.

Organization of a microprocessor-based system



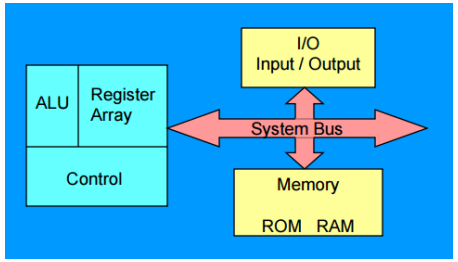
2. Memory :

- **Two types of memory :**

I. Read-Only memory (**ROM**) and

II. Read/Write memory (**R/W M**) or Random- Access memory (**RAM**).

Organization of a microprocessor-based system

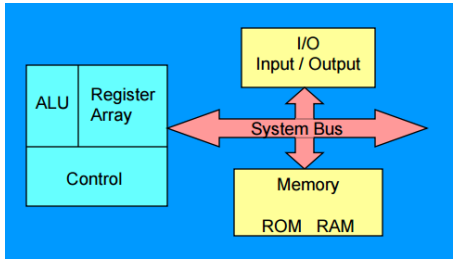


2. **Memory :**

I. Read-Only memory (**ROM**)

- ✓ The ROM is used to store programs that do not need alterations.
- ✓ The ***monitor program*** of a single-board microcomputer is generally stored in the ROM.

Organization of a microprocessor-based system

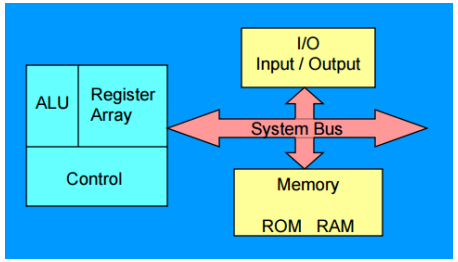


2. **Memory :**

I. Read-Only memory (**ROM**)

- ✓ The monitor program interprets the information entered through a keyboard and provides equivalent binary digits to the microprocessor.
- ✓ Programs stored in the ROM can only be read; they cannot be altered.

Organization of a microprocessor-based system

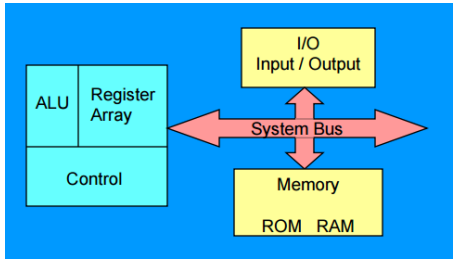


2. Memory :

II. Random- Access memory (**RAM**)

- ✓ The Read/Write memory (R/WM) is also known as **user memory**.
- ✓ It is used to store ***user programs*** and ***data***.
- ✓ The information stored in this memory can be easily ***read and altered***.

Organization of a microprocessor-based system



III. I/O (Input/Output):

It communicates with the outside world.

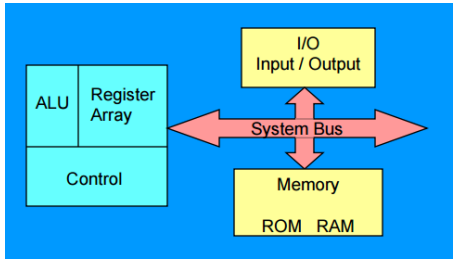
I/O includes two types of devices:

I. **Input devices –** Keyboard (hexadecimal, ASCII, or decimal), switches, mouse, ADC, etc

II. **Output devices –** LED, monitor, printer, DAC, etc.

- These I/O devices are also known as ***peripherals***.

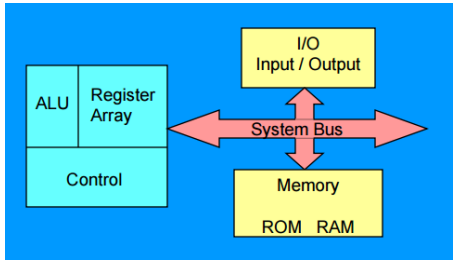
Organization of a microprocessor-based system

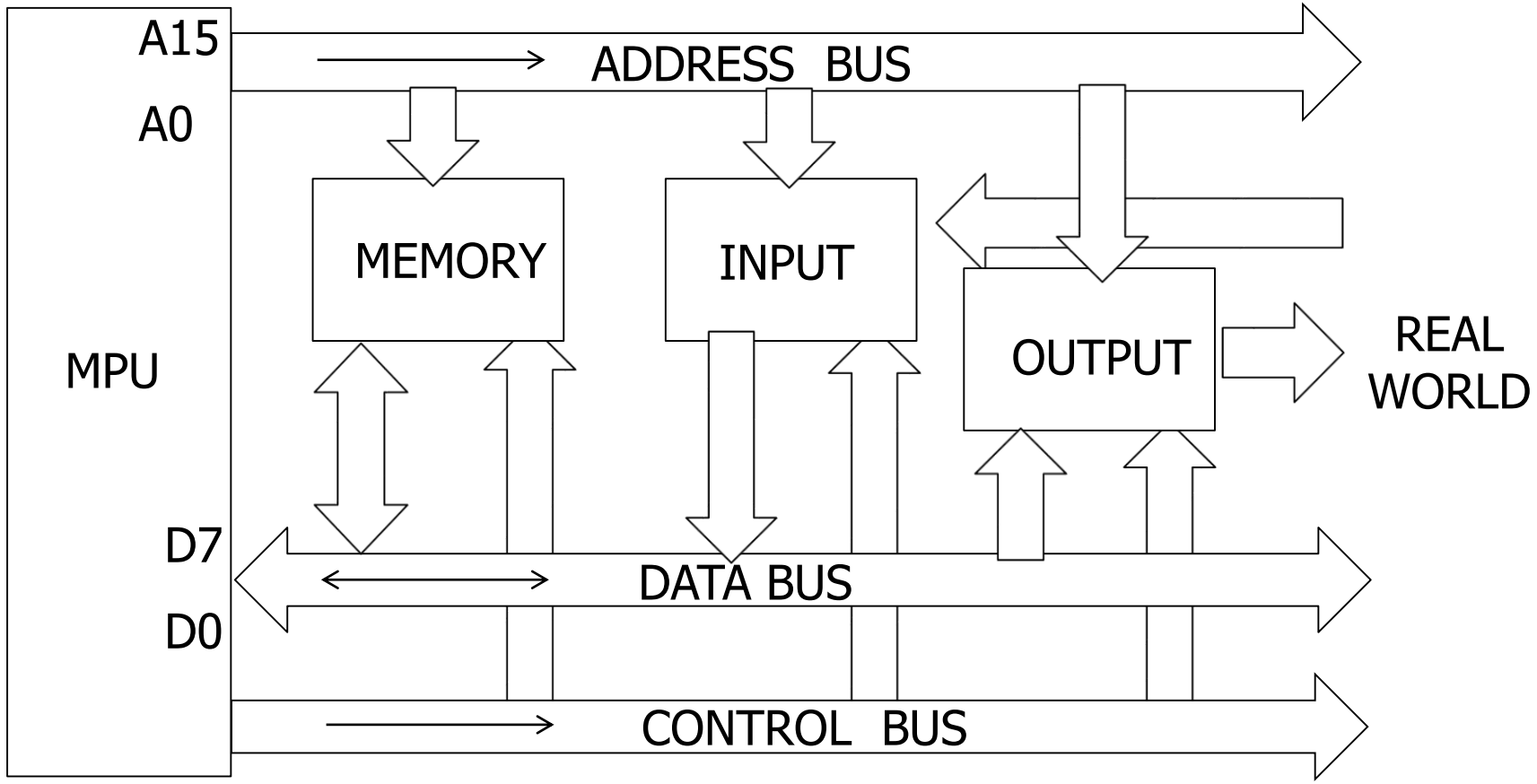


4. System Bus:

- The system bus is a communication path between the microprocessor and peripherals.
- **Bus is a group of conducting lines**
- It's a collection of lines that carries data, address and control signals.
- Three types:
  i. Address Bus,
  ii. Data Bus
  iii. Control Bus

System Bus





MPU = Microprocessor Unit

BUS STRUCTURE

i. **Address Bus:**

- It carries the address of a particular location.
- **Size of the address bus** decides the maximum no. of locations the processor can access i.e., n-bit address bus → 2^n memory locations
- 8086 has 20 bit address bus
- 20 bit address bus → 2^{20} = 10,48,576 memory locations
- The memory address range in hex: from 00000H to FFFFFH

BUS STRUCTURE

ii. **Data Bus :**

- It **carries the data** to be transferred.
- 8086 microprocessor has 16 bit data bus
- It can transfer 16 bits in one operation
- Therefore it is a 16 bit microprocessor

BUS STRUCTURE

iii. **Control Bus:**

- It carries control signals that would cause any operation.
- RD, WR etc.

Applications of Microprocessor

- Microprocessor is a multi-use device which finds applications in almost all the fields. Here is some sample applications given in variety of fields.

- **Electronics:**
  - Digital clocks & Watches
  - Mobile phones
  - Measuring Meters
- **Mechanical:**
  - Automobiles
  - Lathes
  - All remote machines

Applications of Microprocessor

- **Electrical:**
  - Motors
  - Lighting controls
  - Power stations
- **Medical:**
  - Patient monitoring
  - Most of the Medical equipments
  - Data loggers
- **Computer:**
  - All computer accessories
  - Laptops & Modems
  - Scanners & Printers
- **Domestic:**
  - Microwave Ovens
  - Television/CD/DVD players
  - Washing Machines

End