GCA S4 13

Computer Organization

SEMESTER - IV

BACHELOR OF COMPUTER SCIENCE

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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COURSE INTRODUCTION

Computer organization is the design of abstracted computer components, such as the CPU and memory system and architectures. Learning of computer architecture comprises knowledge of the conceptual design and fundamental operational structure of a computer system. This course comprises of the the following ten units:

Unit - 1 introduces you to the basic organization of the computer. The block level description of the functional units are described in this unit.

Unit - 2 describes different digital components. Topics like combinational circuits, sequential circuits, flip flops, counters and registers are discussed in this unit.

Unit - 3 describes different data representation systems. Different types of number system like decimal, binary, octal and hexadecimal are discussed in this unit.

Unit - 4 introduces us to instruction sets and addressing modes. The instruction format, types of instruction and addressing models of 8085 microprocessor are described in this unit.

Unit - 5 deals with input output organization. Different I/O techniques like programmed I/O, interrupt driven I/O and direct memory access are discussed in this unit.

Unit - 6 gives us an introduction to cache and virtual memory. Different types of mapping like direct mapping, associative mapping and set-asociative mapping are described in this unit.

Unit - 7 introduces us memory access. Memory read and memory write operations along with the concept of handshaking is discussed in this unit.

Unit - 8 deals with I/O processor and interfacing with I/O devices. I/O processor along with priority encoder is discussed in this unit.

Unit - 9 deals with parallel processing. Pipelining and its different hazards are described in this unit.

Unit - 10 deals with CISC and RISC architectures. The CISC and RISC architectures are discussed in detail along with examples in this unit.

Each unit of these blocks includes some along-side boxes to help you know some of the difficult, unseen terms. Some “EXERCISES” have been included to help you apply your own thoughts. You may find some boxes marked with: “LET US KNOW”. These boxes will provide you with some additional

interesting and relevant information. Again, you will get “CHECK YOUR PROGRESS” questions. These have been designed to self-check your progress of study. It will be helpful for you if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with “ANSWERS TO CHECK YOUR PROGRESS” given at the end of each unit.

UNIT 1: BASIC ORGANIZATION OF THE COMPUTER

UNIT STRUCTURE

1.1 Learning Objectives
1.2 Introduction
1.3 Basic Organization of the Computer
1.4 Block Level Description of the Functional Units
1.5 Let Us Sum Up
1.6 Further Readings
1.7 Answers to Check Your Progress
1.8 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- describe the basic organization of computer
- learn about the functional characteristics of computer
- describe the concepts of different cycles of program execution such as fetching, decoding and execution

1.2 INTRODUCTION

This is the first unit of this course. In this unit, we will discuss the basics of the organization of computer. An effort is made to discuss the concept of different cycles of program execution such as fetching, decoding and execution. The organization of CPU, and Control Unit have also been discussed in this unit. In the next unit, we will explore the different combinational circuits and sequential circuits. Concepts related to counters and registers are discussed in the next unit.

1.3 BASIC ORGANIZATION OF THE COMPUTER

The basic organization of a typical computer is shown below in figure 1.1.

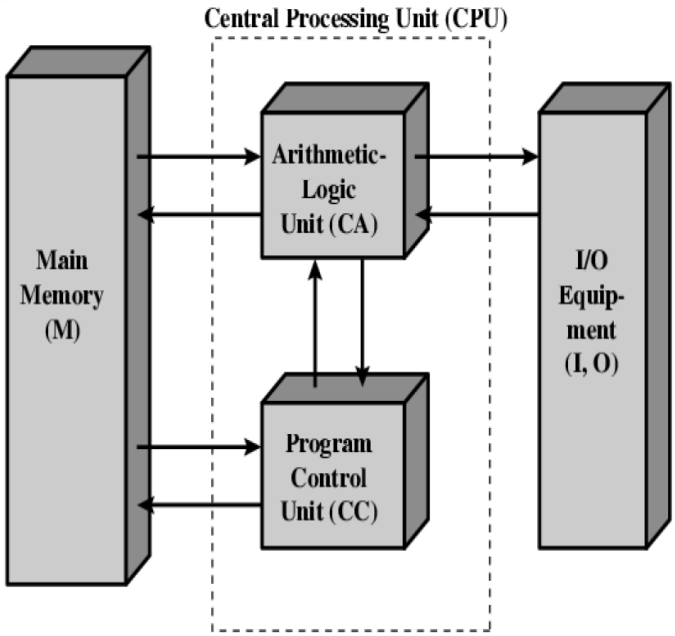
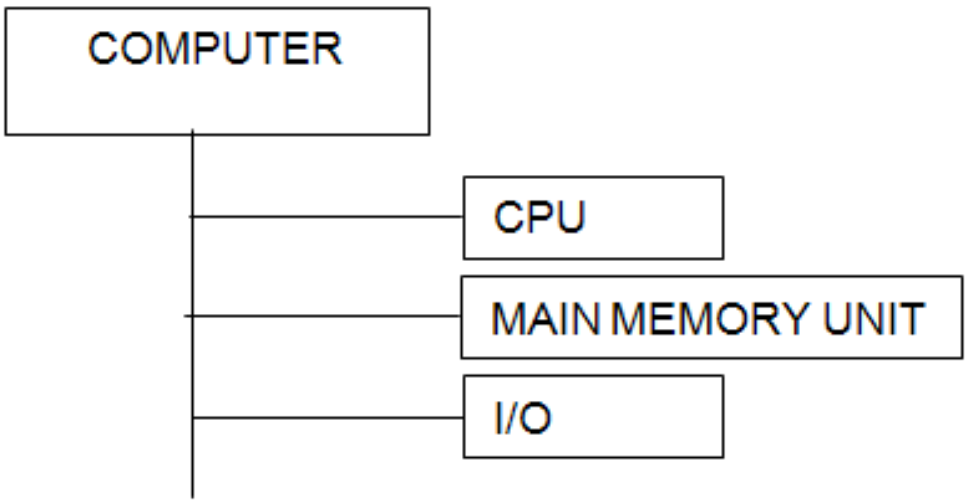


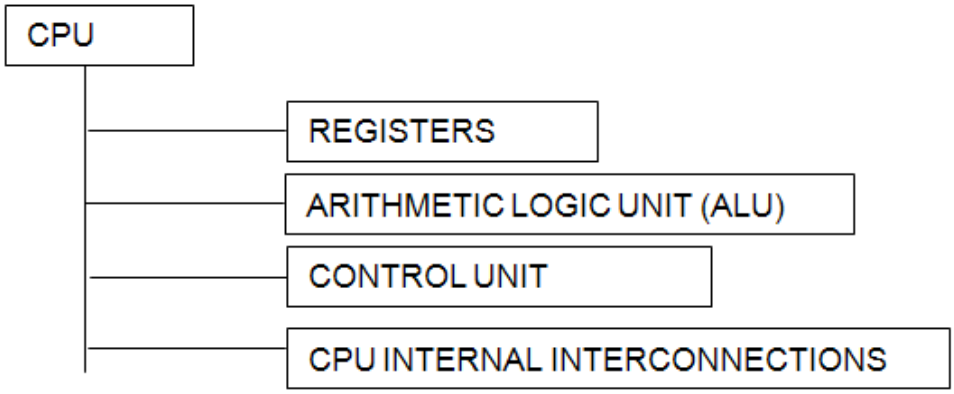
Figure 1.1: Basic Organization of a typical computer

From the above figure, which represents the basic block diagram of a computer, we find that the computer consists of basically three parts, namely, the Central Processing Unit i.e. CPU, Main Memory Unit, and the Input and Output devices. The basic organization of a typical computer is illustrated below in a simple form.



Organization of CPU:

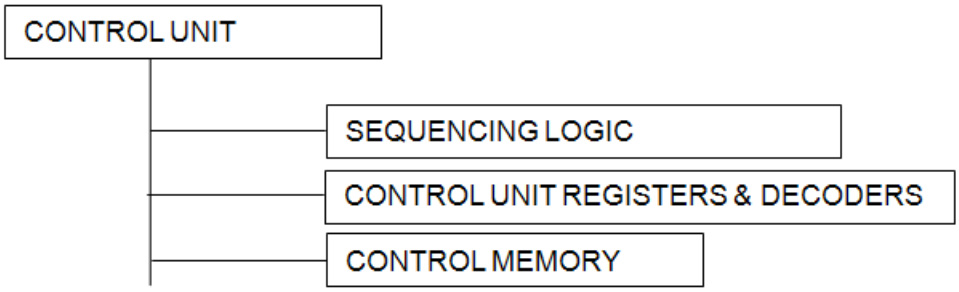
The organization of a typical CPU is as follows:



There are different types of **Registers** involving here, namely, Accumulator, Temporary Register, Instruction Register, Flag Register, General Purpose Register (GPR), Program Counter etc. Arithmetic Logic Unit (ALU), performs arithmetic and logic operations and needs some components such as:

1. Registers to store arguments or operands and results
2. Buses to carry data from registers to the ALU and results back to the register unit
3. Two registers for accessing memory with associated buses
4. An instruction unit to get instructions from computer memory as needed. This includes a program counter, which always points to the address of the next instruction to be accessed and a register called instruction register (IR).
5. A control unit that instructs the ALU on what to do.

The organization of a typical **Control Unit** is as follows:





CHECK YOUR PROGRESS

Q1. Computer consists of basically …….. parts.

Q2. The names of basic parts of a typical computer are ……

Q3. The names of the parts involved for the organization of a typical CPU are ……

Q4. GPR stands for ……..

Q5. Is there any need of a control unit in ALU? Answer briefly.

1.4 BLOCK LEVEL DESCRIPTION OF THE FUNCTIONAL UNITS

From the block level description, there are five functional units of the computer from the program execution point of view. They are:

1. Input unit
2. Output unit
3. Memory unit
4. Arithmetic and Logic unit
5. Control unit

The diagram representing the basic functional units of a computer is shown below:

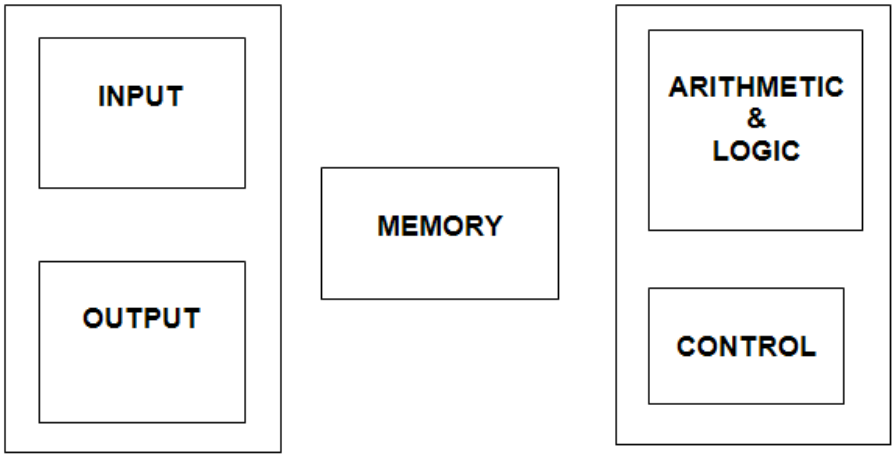


Figure 1.2: Block Representation of Basic Functional Units of a Computer

The users or programmers supply information through some electromechanical devices such as key-boards, mouse etc. and all the information is to be accepted by the Input unit.

The received information is either to be stored in memory or to be used by the ALU directly to perform the desired arithmetic or logical operation. If received information is to be stored in memory first, then the desired operation will happen in the latter (whenever necessary).Output unit will display the result. Control unit is responsible to control the entire task to happen in each and every block of the computing system.

FETCH, DECODE AND EXECUTE CYCLE

Programs i.e. set of instructions along with the data, on which instructions are to be executed are stored in memory. They are to be brought from memory into the CPU. To fetch an instruction and necessary data from memory, and to execute it, there are some necessary steps that a CPU has to carry out. These necessary steps constitute **Instruction cycle**. There are two cycles in an instruction cycle, one is Fetch cycle and other is Execute cycle.

In **Fetch cycle**, the Opcode (which specifies the operation to be performed, for eg. ADD, SUB etc.) is to be fetched from memory by the CPU. To fetch an instruction from memory, again there are some steps, And these steps constitute a Fetch cycle. Execute cycle is constituted by the steps need to carry out data from memory and to perform the operation specified in the opcode of an instruction.

Therefore we can say that,

Instruction cycle = Fetch Cycle + Execute Cycle

An instruction is to be fetched from memory by the processor at the beginning of each instruction cycle. Program Counter (PC) holds the address of the instruction to be fetched next. The fetched instruction is to be loaded into a register known as Instruction Register (IR). The processor has to interpret the instruction and to perform the required action. From fetching to execution of instruction can be described as follows:

- **Instruction Fetch :** Read instruction from memory location
- **Instruction Operation Decoding:** Analyze instruction to determine the type of operation to be performed and the **operand(s)** (data on which operation is to be performed)
- **Operand address calculation :** The memory address of the data is to be calculated if data are not supplied directly from input
- **Operand fetch:** Fetch the operand from memory or read it from I/O
- **Data Operation:** Perform the operation according to the instruction
- **Operand Store:** Write the result into memory or out to I/O



CHECK YOUR PROGRESS

Q6. There are …… numbers of functional units in a computer

Q7. The names of functional units in a computer are ……

Q8. There are …….. cycles in an instruction cycle, one is ……. cycle and other one is ……..cycle GPR.



1.5 LET US SUM UP

- The computer consists of basically four parts. The names of basic parts involving the organization of a typical computer are: the Central Processing Unit i.e. CPU, Main Memory Unit, Input and Output devices and the System Interconnection.
- There are different types of Registers involved, namely, Accumulator, Temporary Register, Instruction Register, Flag Register, General Purpose Register (GPR), Program Counter etc
- Buses carry data from registers to the ALU and the results back to the register unit.
- An instruction fetch unit is needed to get instructions from computer memory. This includes a program counter, which

always points to the address of the next instruction to be accessed.

- A control unit instructs the ALU on what to do. To fetch an instruction and the necessary data from memory, and to execute it, there are some necessary steps that a CPU has to carry out. These necessary steps constitute instruction cycle.
- There are two cycles in an Instruction cycle: one is Fetch cycle and other is Execute cycle.



1.6 FURTHER READINGS

1) Mano, M. M. (2006). Computer systems architecture.

2) Hamacher, V. C., Vranesic, Z. G., Zaky, S. G., Vransic, Z., & Zakay, S. (1984). Computer organization (Vol. 3). New York et al.: McGraw-Hill.



1.7 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Four

Ans to Q No 2: CPU, Main Memory Unit, Input, Output, System Interconnections

Ans to Q No 3: Register, ALU, Control Unit, CPU, Internal Interconnections

Ans to Q No 4: General Purpose Register

Ans to Q No 5: Yes

Ans to Q No 6: 5 (five)

Ans to Q No 7: Input, Output, Memory, ALU, Control Unit

Ans to Q No 8: Two, Fetch, Execute



1.8 MODEL QUESTIONS

Q1. Draw the basic block diagram of a typical computer.

Q2. Explain the basic organization of a computer.

Q3. Write the names of the basic parts of a typical computer.

Q4. Write the names of the parts involved for the organization of a typical CPU.

Q5. Explain the basic concept of the organization of an ALU.

Q6. Write the names of the parts involved for the organization of a typical control unit.

Q7. How many numbers functional units are there in a computer? Give their names.

Q8. Define Instruction cycle, Fetch cycle and Execution cycle.

Q9. Describe the steps involved from fetching to execution of instruction.