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COMPUTER ORGANISATION AND ASSEMBLY LANGUAGE PROGRAMMING

M.C.S.-12

Chapter Wise Reference Book
Including Solved Sample Papers

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Sample Preview of the Solved Sample Question Papers

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QUESTION PAPER

Exam Held in

February – 2021

(Solved)

COMPUTER ORGANISATION AND ASSEMBLY LANGUAGE PROGRAMMING

M.C.S.-12

Time: 3 Hours] [*Maximum Marks: 100*

(*Weightage: 75%*)

Note: *Question No.* ***1*** *is* ***compulsory****. Attempt any* ***three*** *questions from the rest.*

Q. 1. ***(a)*** **Perform the following computation using binary 2's complement notation, assuming the register size to be of 8 bits. Also check for occurrence of overflow:**

(i) **– 63 + 74**

Ans. Convert – 63 to binary number using 2's complement

Represent – 63 to 8 bit

– 63	1 1 0 0 0 0 0 1	(2's Complement of 63)
– 74	0 1 0 0 1 0 1 0	
11	(1) 0 0 0 0 1 0 1 1	

Discard carry bit, that is overflow condition.

(ii) **– 128 + 39**

Ans. – 128 + 39

– 128	1 0 0 0 0 0 0 0	Perform simple binary addition No carry in to the Fig and bit and carry out of the sign bit
+ 39	0 0 1 0 0 1 1 1	
– 89	1 0 1 0 0 1 1 1	

(iii) **+ 86 + 42**

Ans. + 86 + 42

– 86	0 1 0 1 0 1 1 0	Simple Binary Addition, there is no carry out of sign bit
+ 42	0 0 1 0 1 0 1 1	
128	1 0 0 0 0 0 0 0	

(b) **Explain the meaning of 'minterm' in the context of digital logic circuits. Make the truth table and simplify the following Boolean function in SOP form using K. maps. Also draw the logic diagram:**

$F(A, B, C) = \sum (0, 1, 4, 6, 7)$

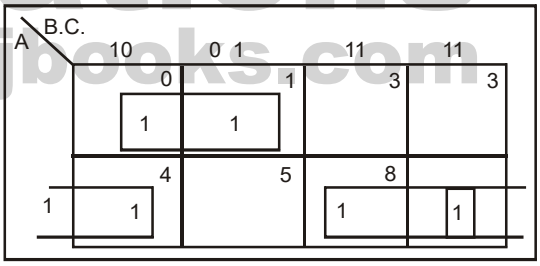
Ans. Minterm : If a product of SOP expressionss contains every variable of their function either in the or complement from then it is defined as a minterm or standard product.

This minterm will be true only for one combination of input values of the variables.

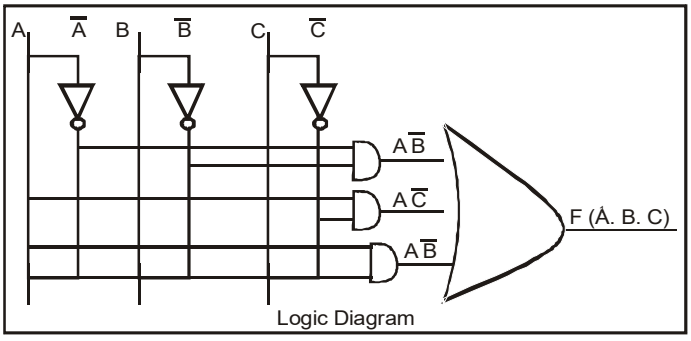
For example, in the SOP expression

$F(A, B, C), = (A, B, C) + (\overline{A}, \overline{B}, C) + (A - B)$

Given $F(A . B. C) = \sum (0, 1, 4, 6, 7)$ using K. Map for 3 Variables



$F(A. B. C.) = \overline{A}\,\overline{B} + A\,\overline{C} + A\,B$



Logic Diagram

***(c)* The main memory of a computer is of 64 K words size having a word size of 16 bits. The cache of this computer also has a block size of 16 bits having 256 blocks. Answer the following questions if direct mapping scheme has been followed:**

Ans. Given main memory has 64k = 64×1024
$= 2^6 \times 2^{10}$
$= 2^{16}$ words

Cache memory has a block size of 16 bits having 256 blocks.

***(i)* Size of tag and index fields of cache address.**

Ans. Cache address consists of Index and tag part. Index and tag together make main memory address. Index part addresses cache memory and tag part represent the most of the main memory address.

In this case address main memory we need 16 bit (2^{16}) and to address cache memory we need 8 bit (2^8)

So Index is 8 bit wide and tag 8 bit wide (16-8-8).

***(ii)* In which address of cache a main memory address (AFBA) can be found?**

Ans. AFBA = 1 0 1 0 1 1 1 1 1 0 1 1 1 0 1 0
Word of set = 1010 = 10 (A)
Line = 1 1 1 1 1 0 1 1 1 0 1 0 = 15 11 10 (FBA)
tag = 1010 = 10 (A).

***(iii)* What will be the action of memory management system if the stated memory address is not found in cache location?**

Ans. If memory addresses is not found in cache location it is called the miss cache.

***(d)* What is an Interrupt? Explain any one technique that can be used to determine which device has issued the interrupt.**

Ans. The term interrupt is an exceptional event that causes CPU to temporarily transfer its control from currently executing program to a different program which provides service to the exceptional event. It is like you asking a question in a class. When you ask a question in a class by raising hands, the teacher who is explaining some point may respond to your request only after completion of his/her point. Similarly, an interrupt is acknowledged by the CPU when it has completed the currently executing instruction. An interrupt may be generated by a number of sources, which may be either internal or external to the CPU.

Interrupt Condition	Occurrence of Event
Interrupt are generated by executing program itself (also (called traps)	● Division by Zero. ● The number exceeds the maximum allowed. ● Attempt of executing an illegal/privileged instruction. ● Trying to reference memory location other than allowed for that program.
Interrupt generated by clock in the processor	● Generally used on expiry of time allocated for a program, in multi-programming operating systems.
Interrupts generated by I/O devices and their	● Request of starting an Input/Output operation. ● Normal completion of an Input/Output operation. ● Occurence of an error in Input/Output operation.
Interrupts on Hardware failure	● Power failure ● Memory parity error.

***(e)* Assume that an instruction has been fetched in Instruction Register (IR) of a computer, and has been decoded. R register DR is to be used for fetching the operand and AC register is to be used for calculation. Write and explain the various micro-operations for the purpose of execution of the instruction:**

Add AC, A

Where A is memory location which has the operand the address of A is presently stored in MAR.

Ans. Step 1: Fetch Instruction

Execution cycle starts with fetching instruction from main memory. The instruction at the current program counter (PC) will be fetched and will be stored in instruction register (IR).

Step 2: Decode Instruction

During this cycle the encoded instruction present in the IR (instruction register) is interpreted by the decoder.

Step 3: Perform ALU Operation-ADD

Sample Preview of The Chapter

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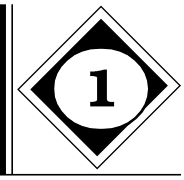

What is a Computer?

1.1 Introduction

Computers have today become an integral part of our daily life. We find them everywhere making human life more comfortable and easy to cope with.

Charles Babbage, an English mathematician in 1820s, first proposed the idea of computer. He even designed Analytical Engine, the forerunner of modern day computers. However, Babbage was far ahead of his times and he was unable to realize his dream. Almost seven decades after the death of Babbage, von Neumann took up his ideas and built the modern day computer in 1949.

In this chapter, we discuss at length the von Neumann Architecture of a computer. While describing it we will study the logical structure of a computer, the concepts of Instruction Execution and Interrupt. We will discuss the basic components of a computer and their uses. In addition, we will also review the historical development of modern computer through its five generations in last six decades, and what lies ahead for computers as intelligent systems and possessing artificial intelligence.

1.2 What You Will Learn?

- ✓ How was the modern PC conceived?
- ✓ Architecture of a von Neumann PC.
- ✓ Basic function of a computer.
- ✓ Key elements of a computer.
- ✓ The difference between data and information.

1.3 The von Neumann Computer Architecture

In late 1940s, American scientist von Neumann first proposed a simple structure for a general-purpose computer. The structure was called von Neumann Computer Architecture.

1.3.1 Definition of a Computer

The Illustrated Computer Dictionary defines a computer as "*The device capable of solving problems or manipulating data by accepting data and performing prescribed operations (mathematical or logical) on the data, and supplying the results of these operations.*"

The Oxford dictionary similarly defines a computer as "*An automatic electronic apparatus for making calculations or controlling operations that are expressible in numerical or logical terms.*"

1.3.2 Basic Function of a Computer

The basic function of a computer is to execute a given program. A program is a sequence of instructions, which operates on the data supplied, to perform certain tasks such as finding a sum or drawing a picture. The computer accepts data or programs, supplied by its user and controls the execution of the program.

In executing the program computer uses numerous logic circuits made of electronic components. In addition, every computer has a special unit, called Arithmetic Logic Unit (ALU), which performs the task of data processing and control.

1.3.3 What is Data?

Data in digital computers are represented by the binary language of two symbols 0 and 1. These symbols are called binary digits or bits. Every 0 or 1 in computer data is one bit. The problem is that the data we use in real life are in the form of decimal digits from 0 to 9 and various characters such as alphabets, arithmetic operators (*e.g.* +, -, x, % etc), logical operators (*e.g.* =, >, < etc.), and special characters (*e.g.* @, (), Ø, etc.). Computer scientists have devised a mechanism for representing these data in binary form (or binary language). In this representation, a character is formed by eight bits. This means 2^8 =256 different characters can be represented and used uniquely in binary form.

The eight bits together are called one byte. Thus, one byte represents one character in computer language. In general, computers use two or four bytes to represent numbers (both negative and positive) internally.

1.3.4 Arithmetic Logic Unit (ALU) and Control Unit (CU)

As we have stated above the main job of a computer is to perform instruction execution. The instructions are interpreted by the Control Unit (CU) of the computer and executed by its Arithmetic and Logic Unit (ALU). The ALU performs the arithmetical and logical functions. The role of control unit is to determine the operations to be done by the ALU.

The control unit receives instructions in binary form and interprets them to generate control signals. The control signals tell the ALU to do specific arithmetic or logic functions on the data. Thus, by changing control signal desired operation can be executed on the data. It is also possible to obtain operations to be performed on the data by providing a set of control signals. Therefore, for a new operation what is needed is just a change of the set of control signals.

A program is a sequence of instructions or codes. Each code is an instruction for the computer. The control unit interprets it and creates related control signals such that the necessary operation is carried out on the data.

1.3.5 The CPU

The Arithmetic Logic Unit (ALU) and the Control Unit (CU) together form the Central Processing Unit (CPU) of the computer. The CPU is the most important hardware component of any computer system, and is even called as its brain.

Every CPU has its own data processing capability. This capability is decided by the size of its registers. The registers are CPU's storage areas in which all the arithmetic and logical works are done. The size of a register defines the amount of data that can be processed in the register. The speed of processing is faster with increasing register size.

1.4 Data and Information

Data and information are two different entities. In general, data is what we supply to the computer. After computer's processing of data what we get as output is the information. Thus, by definition, information is processed data.

Data is the input given to a computer and information is the output obtained from the computer.

Data is in a raw form and may be unorganized and not much useful for drawing conclusions. This data is processed by the computer by following given instructions. After processing, data becomes more intelligible, organized and useful as information.

1.5 Input/Output Devices

We have stated above that the data and instructions are put into computer. Naturally, they come to computer from external environment, and input devices are used to do that. These devices send the data to the computer system. The computer as per the instructions accompanying them processes the input data. After the processing, computer gives its results.

These results are presented in a proper format by the output devices. These devices are together called Input/Output (I/O) devices. Commonly used input devices are keyboard, mouse and scanner. Similarly, the common output devices are monitor and printer.

1.6 System Interconnections

Obviously, to transfer data from one component of the computer to another component the two components have to be interconnected. In fact, the entire computer system internally needs interconnections. The most popular and used structure for interconnections is the Bus structure.

1.7 Memory

Memory of a computer system is the temporary storage area needed to temporarily hold instructions and data. Such an area is required because though input devices feed data and instructions to the computer only sequentially; the program itself may not be executed sequentially. Jumps and looping instructions (breaking the sequence) often occur in programming. In such a situation there has to be a place where data and

instructions can be put on hold till the program needs them.

The memory area or unit stores data in memory cells in groups of 8 binary digits (bits) or 16 bits or 32 bits and so on. These cells or bits are called as memory locations. Each memory location has a unique location address and can be used separately or independently. The CPU can fetch contents of any memory location by referring to its address.

Memory is measured in bytes. One kilobyte actually means 1024 bytes (roughly 1000 bytes). A megabyte (MB) memory is equal to slightly more than one million bytes. Also, a giga byte (or GHz) stands for 2^{30} bytes.

The memory capacity of a computer is defined by the amount of information that can be stored in the main memory. It is measured in MB or GB.

1.8 Key Elements of von Neumann Architecture

Neumann was the first scientist to clearly state that the most fundamental function performed by a computer is the execution of a program. This consists of

1. Execution of one or more instructions that tell about how an operation is to be alone, and
2. The data on which the operation is to be carried out.

To perform the above tasks Neumann built an electronic computer, which had the basic elements shown in following figure:

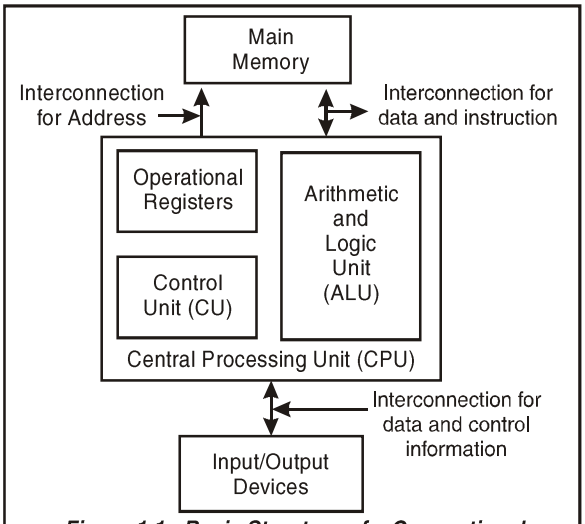

Figure 1.1 : Basic Structure of a Conventional von Neuman Computer

(a) In the von Neumann machine the Control Unit (CU) interprets each of the instruction and data received, and generates necessary control signals.

(b) Next comes the Arithmetic Logic Unit (ALU). It does the arithmetical and logical operations in specially provided storage areas called operational registers. The operations are carried out as per the instructions of the control unit. The size of the register defines the processing capability of the CPU. Size actually refers to the maximum amount of data/information that can be held in a register at any time for processing. Processing speed goes up with increasing register size.

(c) The von Neumann architecture provides for an input/output system of I/O devices for sequential data input and display of output in proper form and format.

(d) Data and information within the computer system are transferred from one component to another with help of system interconnections. A popular interconnection structure is the Bus interconnection.

(e) Neumann also used main memory in his architecture. In this, instruction and data are stored at the time of program execution. The data transfer path between the CPU and the memory is very important, and the amount of data that can be exchanged between the two is directly dependent on the size of the bus that links them.

(f) Neumann had indicated that same memory can be used to store data and instructions. When put to such use, the data can be treated as data that is to be processed, and instructions can be treated as data that can be used for generation of control signals.

(g) The von Neumann computer uses the stored program concept. This means the program and the data are placed in the same memory unit for execution. Earlier computers used separate memories to store programs and data. Entering and modifying such programs was a time-consuming and difficult task

since the programmer had to manually enter them by setting on/off switches, plugging and unplugging many of them in the process.

1.9 Von Neumann Bottleneck

As can be seen in Figure 1.1 in the von Neumann machine there is only a single path between the main memory and the control unit. This constraint is called as von Neumann bottleneck.

1.10 Solved Questions

Q. 1. Define a computer.

Ans. The Oxford dictionary defines a computer as "*An automatic electronic apparatus for making calculations or controlling operations that are expressible in numerical or logical terms.*"

Q. 2. What functions are performed by the ALU and CU?

Ans. The main job of a computer is to perform instruction execution. The instructions are interpreted by its Control Unit (CU) and executed by its Arithmetic and Logic Unit (ALU). The ALU performs the arithmetical and logical functions. The role of control unit is to determine the operations to be done by the ALU.

Q. 3. What is von Neumann bottleneck?

Ans. In the von Neumann machine there is only a single path between the main memory and the control unit. This constraint is called as von Neumann bottleneck.

■■