CONTENTS

Chapter 1	**INTRODUCTION TO COMPUTERS**	**1**
1.1	History of Computers	1
1.2	Data, Information and Program	8
1.3	Hardware and Software	10
1.4	Types of Computers	15
	Summary	21
	Exercises	22
Chapter 2	**NUMBER SYSTEMS**	**25**
2.1	Introduction	25
2.2	Bits and Bytes	26
2.3	Decimal Number System	27
2.4	Binary Number System	28
2.5	Hexadecimal Number System	29
2.6	Decimal to Binary Conversion	30
2.7	Conversion of fractional decimal to binary	34
2.8	Conversion of Decimal to Hexadecimal	35
2.9	Octal Representation	36
2.10	Representation of signed numbers	37
2.11	Binary Arithmetic	42
2.12	Boolean Algebra	48
	Exercises	61
Chapter 3	**COMPUTER ORGANIZATION**	**64**
3.1	Basic Components of a Digital Computer	64
3.2	Central Processing Unit	68
3.3	Arithmetic and Logic Unit – ALU	72
3.4	Memory Unit	74
3.5	Input and Output Devices	78
	Summary	96
	Exercises	98

CHAPTER 1

INTRODUCTION TO COMPUTERS

1.1 History of Computers

1.1.1 Introduction

A computer is a tool and partner in every sphere of human life and activity. Computers are bringing many changes in industry, government, education, medicine, scientific research, law, social service and even arts like music, movies and paintings. The areas of application of computers are confined only by the limitation on creativity and imagination.

What is a computer? A child might define a computer to be an instrument capable of producing a combined effect of radio, movie and television. This definition is close but still does not visualize the power and capabilities of a computer.

Fig. 1.1 Computer

A computer is an electronic machine, capable of performing basic operations like addition, subtraction, multiplication, division, etc. The computer is also capable of storing information, which can

usually be explicitly encoded in a set of computer language instructions that manipulate data.

A computer **program** (or set of programs) is designed to systematically solve a problem. For example, a problem to calculate the length of a straight line joining any two given points.

The programmer must decide the program requirements, develop logic and write instructions for the computer in a programming language that the computer can translate into machine language and execute. Hence, problem solving is an act of defining a problem, understanding the problem and arriving at workable solutions.

In other words, problem solving is the process of confronting a novel situation, formulating connection between the given facts, identifying the goal of the problem and exploring possible methods for reaching the goal. It requires the programmer to coordinate previous experience and intuition in order to solve the problem.

1.3 Hardware and Software

1.3.1 Introduction

A computer system has two major components, hardware and software. In practice, the term hardware refers to all the physical items associated with a computer system. Software is a set of instructions, which enables the hardware to perform a specific task.

1.3.2 Computer Hardware

A computer is a machine that can be programmed to accept data (i*nput*), and process it into useful information (o*utput*). It also stores data for later reuse (*storage*). The *processing* is performed by the hardware. The computer hardware responsible for computing are mainly classified as follows:

1.3.3 Computer Software

Software refers to a program that makes the computer to do something meaningful. It is the planned, step-by-step instructions required to turn data into information. Software can be classified into two categories: System Software and Application Software.

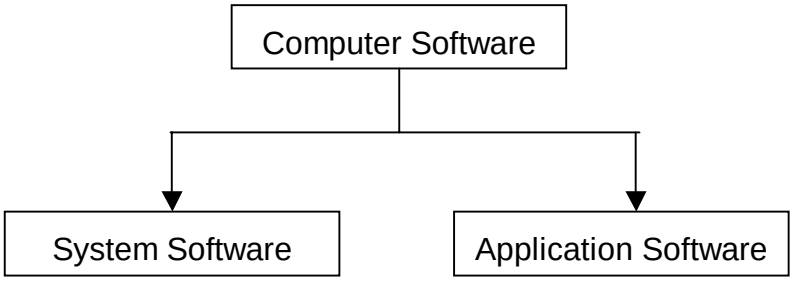


Fig. 1.14 Software Categories

System software consists of general programs written for a computer. These programs provide the environment to run the application programs. System software comprises programs, which interact with the hardware at a very basic level. They are the basic necessity of a computer system for its proper functioning. System software serves as the interface between hardware and the user. The operating system, compilers and utility programs are examples of system software.

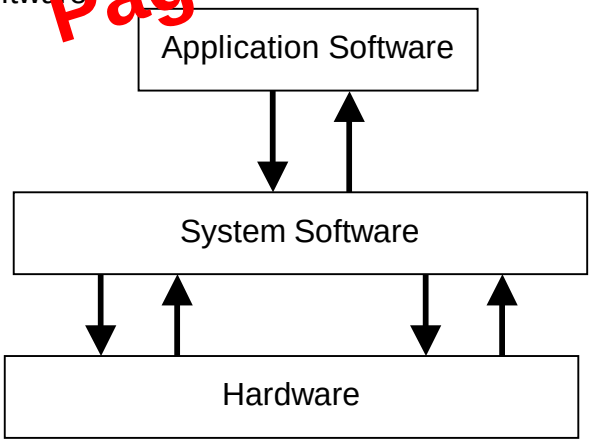


Fig. 1.15 System Software

Summary

- A computer is an electronic machine, capable of performing basic operations like addition, subtraction, multiplication, division, etc.
- Abacus is the first known calculating machine used for counting.
- The Rotating Wheel Calculator was developed by Blaise Pascal, which is a predecessor to today's electronic calculator.
- Charles Babbage is called as the father of today's computer.
- The first generation of computers used vacuum tubes for circuitry and magnetic drums for memory.
- The second generation of computers witnessed the vacuum tubes being replaced by transistors.
- The third generation computer used the integrated circuits.
- The microprocessor brought forth the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip.
- Data is a collection of facts from which information may be derived.
- Information is a collection of facts from which conclusions may be drawn.
- Algorithm is defined as a step-by-step procedure or formula for solving a problem
- A computer program (or set of programs) is designed to systematically solve a problem.
- A computer system has two major components, hardware and software.
- The *processing* is performed by the hardware.
- Software refers to a program that makes the computer to do something meaningful and classified as System Software and Application Software
- System software consists of general programs written for a computer.
- An Application Software consists of programs designed to solve a user problem.

- Analog Computer is a computing device that works on continuous range of values.
- A digital computer operates on digital data such as numbers.
- A hybrid computing system is a combination of desirable features of analog and digital computers.
- Super computers process billions of instructions per second.
- Mainframes are capable of processing data at very high speeds – hundreds of million instructions per second.
- The mini computers were developed with the objective of bringing out low cost computers.
- The invention of microprocessor (single chip CPU) gave birth to the micro computers.
- The micro computers are further classified into workstation, personal computers, laptop computers and still smaller computers.

Exercises

I. Fill in the blanks

1) _____ is considered to be the father of today's computer.
2) _____ invented the Slide Rule.
3) The first generation of computers used _____for circuitry and _____ for memory.
4) Integrated circuits were used in _____ generation of computers.
5) _____ refers to the physical items associated with a computer system.
6) The hardware devices attached to the computer are called _____.
7) _____ refers to programs that make the computer to do some thing.
8) Software can be classified into _____ and _____ software.
9) An _____is an integrated set of specialized programs that is used to manage the overall operations of a computer.

The decimal equivalent of the fractional binary sequence can be estimated in the same manner. The exponents are negative powers of two for digits on the right side of the binary point. The binary equivalent of the decimal point is the binary point. Thus the decimal value of the fractional binary sequence 0.1011_2 is:

$$0.1011_2 = 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} + 1 \times 2^{-4}$$
$$= 0.5 + 0 + 0.125 + 0.0625$$
$$= 0.6875_{10}$$

2.5 Hexadecimal Number System

Hexadecimal representation of numbers is more efficient in digital applications because it occupies less memory space for storing large numbers. A hexadecimal number is represented using base 16. Hexadecimal or Hex numbers are used as a shorthand form of binary sequence. This system is used to represent data in a more compact manner. In the hexadecimal number system, the binary digits are grouped into sets of 4 and each possible combination of 4 binary digits is given a symbol as follows:

0000 = 0	1000 = 8
0001 = 1	1001 = 9
0010 = 2	1010 = A
0011 = 3	1011 = B
0100 = 4	1100 = C
0101 = 5	1101 = D
0110 = 6	1110 = E
0111 = 7	1111 = F

Since 16 symbols are used, 0 to F, the notation is called hexadecimal. The first ten symbols are the same as in the decimal system, 0 to 9 and the remaining six symbols are taken from the first six letters of the alphabet sequence, A to F. The hexadecimal sequence $2C_{16}$ has the decimal equivalent:

$$2C_{16} = 2 \times 16^1 + C \times 16^0$$
$$= 32 + 12$$
$$= 44_{10}$$

2.7 Conversion of fractional decimal to binary

The decimal fractions like 1/2, 1/4, 1/8 etc., can be converted into exact binary fractions. Sum of powers method can be applied to these fractions.

$$0.5_{10} = 1 * 2^{-1} = 0.1_2$$

$$0.25_{10} = 0 * 2^{-1} + 1 * 2^{-2} = 0.01_2$$

$$0.125_{10} = 0 * 2^{-1} + 0 * 2^{-2} + 1 * 2^{-3} = 0.001_2$$

The fraction 5/8 = 4/8 + 1/8 = 1/2 + 1/8 has the binary equivalent:

$$5/8 = 1 * 2^{-1} + 0 * 2^{-2} + 1 * 2^{-3}$$
$$= 0.101_2$$

Exact conversion is not possible for the decimal fractions that cannot be represented in powers of 2. For example, 0.2_{10} cannot be exactly represented by a sum of negative powers of 2. A method of repeated multiplication by 2 has to be used to convert such kind of decimal fractions.

The steps involved in the method of repeated multiplication by 2:

· Multiply the decimal fraction by 2 and note the integer part. The integer part is either 0 or 1.

· Discard the integer part of the previous product. Multiply the fractional part of the previous product by 2. Repeat the first step until the fraction repeats or terminates.

The resulting integer part forms a string of 0s and 1s that become the binary equivalent of the decimal fraction.

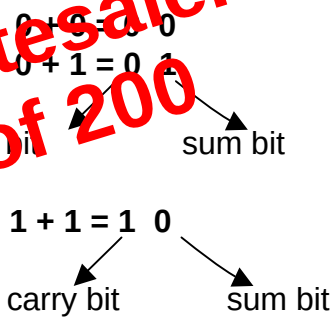
2.11 Binary Arithmetic

Digital arithmetic usually means binary arithmetic. Binary arithmetic can be performed using both signed and unsigned binary numbers.

2.11.1 Binary Addition – Unsigned numbers

When two digits are added, if the result is larger than what can be contained in one digit, a carry digit is generated. For example, if we add 5 and 9, the result will be 14. Since the result cannot fit into a single digit, a carry is generated into a second digit place. When two bits are added it will produce a sum bit and a carry bit. The carry bit may be zero.

Example:



The sum bit is the least significant bit (LSB) of the sum of two 1-bit binary numbers and the carry bit holds the value of carry (0 or 1) resulting from the addition of two binary numbers.

A Boolean expression is a combination of Boolean variables, Boolean Constants and the above logical operators. All possible operations in Boolean algebra can be created from these basic logical operators. There are no negative or fractional numbers in Boolean algebra.

The operation AND yields true (binary value 1) if and only if both of its operands are true. The operation OR yields true if either or both of its operands are true. The unary operation NOT inverts the value of its operand. The basic logical operations can be defined in a form known as Truth Table, which is a list of all possible input values and the output response for each input combination.

2.12.1 Boolean operators (functions)

AND operator

The AND operator is defined in Boolean algebra by the use of the dot (**.**) operator. It is similar to multiplication in ordinary algebra. The AND operator combines two or more input variables so that the output is true only if all the inputs are true. The truth table for a 2-input AND operator is shown as follows:

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

The above 2-input AND operation is expressed as: **Y = A . B**

OR operator

The plus sign is used to indicate the OR operator. The OR operator combines two or more input variables so that the output is true if at least one input is true. The truth table for a 2-input OR operator is shown as follows:

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

The above 2-input OR operation is expressed as: **Y = A + B**

NOT operator

The NOT operator has one input and one output. The input is either true or false, and the output is always the opposite, that is, the NOT operator inverts the input. The truth table for a NOT operator where A is the input variable and Y is the output is shown below:

A	Y
0	1
1	0

The NOT operator is represented algebraically by the Boolean expression: **Y = $\overline{A}$**

Example: Consider the Boolean equation:

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

D is equal to 1 (true) if A is 1 or if ($\overline{B}$. C) is 1, that is, B = 0 and C = 1. Otherwise D is equal to 0 (false).

The basic logic functions AND, OR, and NOT can also be combined to make other logic operators.

Simplify the following Boolean Expression

$\overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,B\,\overline{C} + \overline{A}\,B\,C + A\,\overline{B}\,\overline{C}$

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

$= \overline{A}\,\overline{C} + \overline{A}\,B\,C + A\,\overline{B}\,\overline{C}$

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

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

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

$= \overline{A}\,\overline{C} + \overline{A}\,B + A\,\overline{B}\,\overline{C}$ (one minimal form)

In the given Boolean Expression, if the second and third terms are grouped, it will give

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

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

$= \overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,B + A\,\overline{B}\,\overline{C}$

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

$= \overline{B}\,\overline{C} + \overline{A}\,B$ (most minimal form)

2.12.4 DeMorgan's Theorems

Theorem 15: $\overline{A + B} = \overline{A}\,\overline{B}$

Theorem 16: $\overline{AB} = \overline{A} + \overline{B}$

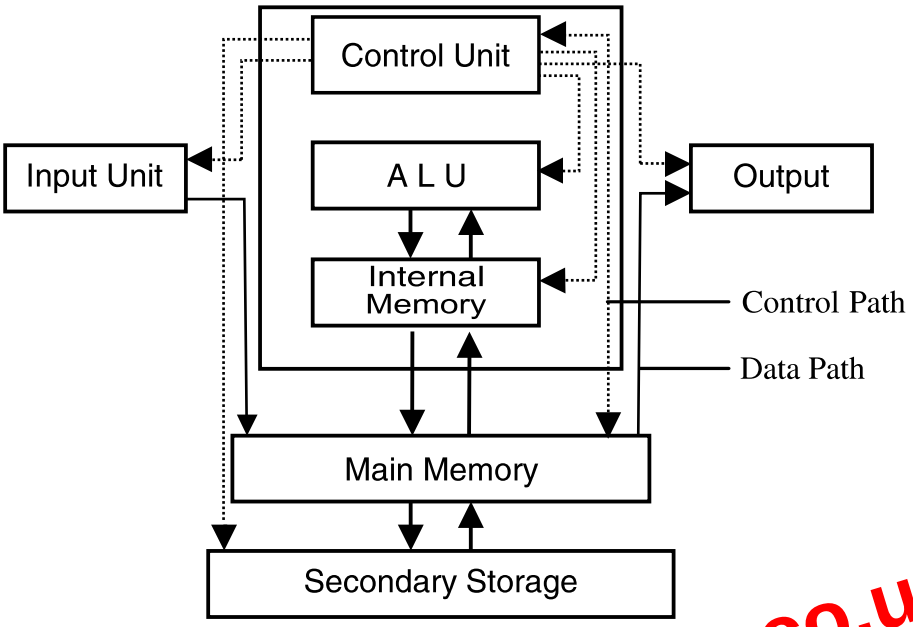


Fig. 3.3 : Functions of a CPU

3.2.2 Working with Central Processing Unit

The CPU is similar to a calculator, but much more powerful. The main function of the CPU is to perform arithmetic and logical operations on data taken from main memory. The CPU is controlled by a list of software instructions. Software instructions are initially stored in secondary memory storage device such as a hard disk, floppy disk, CD-ROM, or magnetic tape. These instructions are then loaded onto the computer's main memory.

When a program is executed, instructions flow from the main memory to the CPU through the bus. The instructions are then decoded by a processing unit called the instruction decoder that interprets and implements the instructions. The ALU performs specific operations such as addition, multiplication, and conditional tests on the data in its registers, sending the resulting data back to the main memory or storing it in another register for further use.

To understand the working principles of CPU, let us go through the various tasks involved in executing a simple program. This program performs arithmetic addition on two numbers. The algorithm of this program is given by

(i) input the value of a
(ii) input the value of b
(iii) sum = a + b
(iv) output the value of sum

This program accepts two values from the keyboard, sums it and displays the sum on the monitor. The steps are summarized as follows :

1. The control unit recognizes that the program (set of instructions) has been loaded into the main memory. Then it begins to execute the program instructions one by one in a sequential manner.

2. The control unit signals the input device (say, keyboard) to accept the input for the variable 'a'.

3. The user enters the value of 'a' on the keyboard.

4. The control unit recognizes and enables to route the data (value of a) to the pre-defined memory location (address of 'a').

5. The steps 2 to 4 will be repeated for the second input 'b'. The value of 'b' is stored in the memory location (address of 'b').

6. The next instruction is an arithmetic instruction. Before executing the arithmetic instruction, the control unit enables to send a copy of the values stored in address of 'a' and address of 'b' to the internal registers of the ALU and signals the ALU to perform the sum operation.

7. The ALU performs the addition. After the computation, the control unit enables to send the copy of the result back to the memory (address of 'sum').

8. Finally, the result is displayed on the monitor. The control unit enables to send the copy of the values of the address of 'sum' to the monitor (buffer) and signals it. The monitor displays the result.

9. Now this program execution is complete.

The data flow and the control flow of CPU during the execution of this program is given as,

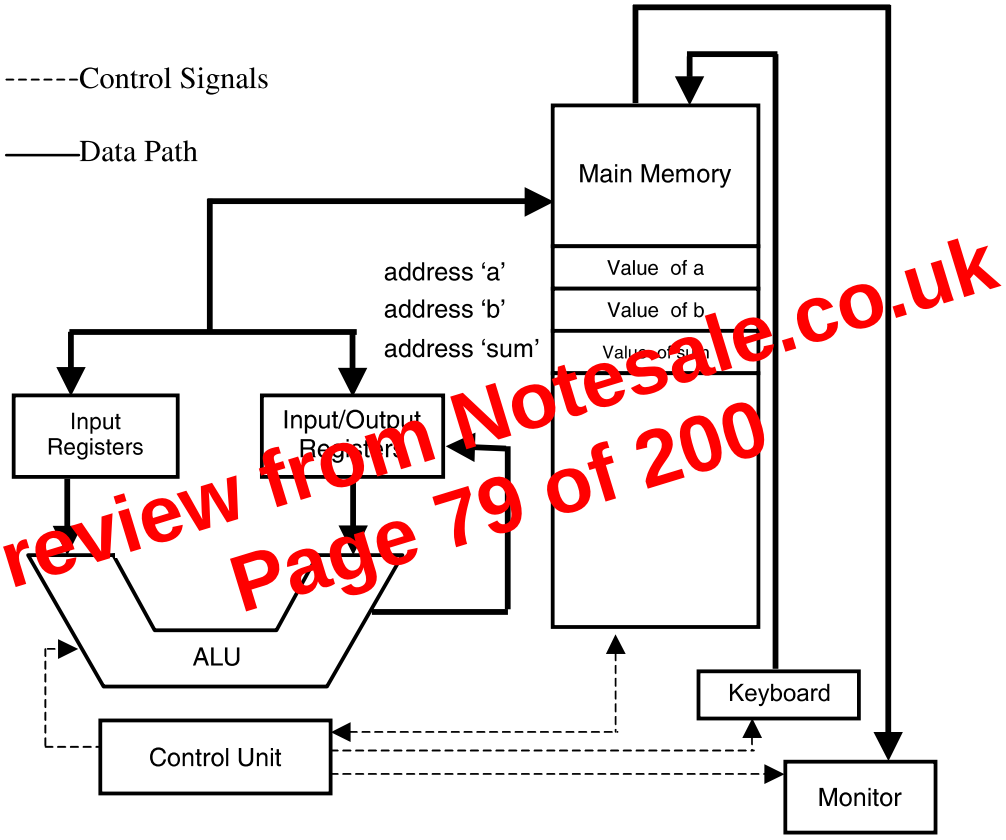


Fig. 3.4 : Working Principles of a CPU

Fig. 3.7 Memory Unit

There are different types of memory. They are Random Access Memory (RAM), Read Only Memory (ROM), Programmable Read-Only Memory (PROM), Erasable Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM).

Random Access Memory - RAM

RAM is the most common type of memory found in the modern computers. This is really the main store and is the place where the programs are stored. When the CPU runs a program, it fetches the program instructions from the RAM and carries them out. If the CPU needs to store the results of the calculations it can store them in RAM. When we switch off a computer, whatever is stored in the RAM gets erased. It is a volatile form of memory.

Read Only Memory - ROM

In ROM, the information is burnt (pre-recorded) into the ROM chip at manufacturing time. Once data has been written into a ROM chip, it cannot be erased but you can read it. When we switch off the computer, the contents of the ROM are not erased but remain stored permanently. ROM is a non-volatile memory. ROM stores critical programs such as the program that boots the computer.

Notes Taker

Notes taker is a device that captures natural handwriting on any surface onto a computer. Using an electronic pen, the **notes taker** displays the user's handwritten notes, memos or drawings on the computer, and stores the image for future use.

Fig. 3.20 Notes Taker

Microphone

Microphone serves as a voice input device. It captures the voice data and input to the computer. Using the microphone along with speech recognition software can offer a completely new approach to input information into your computer.

Speech recognition programs, although not yet completely exact, have made great strides in accuracy as well as ease of use. The voice-in or speech recognition approach can almost fully replace the keyboard and mouse. Speech recognition can now open the computer world to those who may have been restricted due to a physical handicap. It can also be a boon for those who have never learned to type.

Fig. 3.21 Microphone

Optical Disk

Optical disks are a storage medium from which data is read and to which it is written by lasers. The optical disk is a random access storage medium; information can be easily read from any point on the disk. CD-ROM stands for Compact Disk - Read Only Memory.

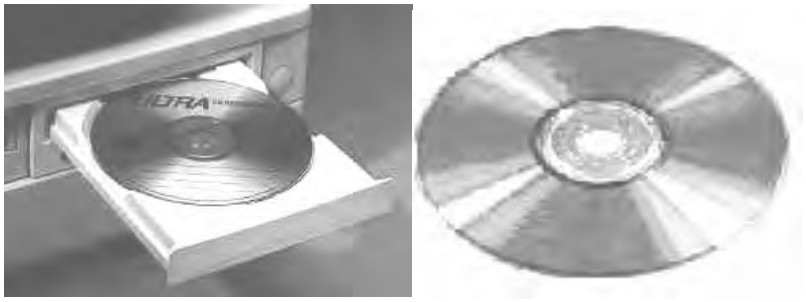


Fig. 3.34 Compact Disk

It is now possible to have CD-ROMs where tracks of information can be written onto them by the user. These are called read/write CD-ROMs and these are becoming a popular and cheap method for storage.

Summary

* Computers are often compared to human beings since both have the ability to accept data, store, work with it, retrieve and provide information.

* A computer system is the integration of physical entities called hardware and non-physical entities called software.

* The hardware components include input devices, processor, storage devices and output devices.

* The software items are programs and operating aids so that the computer can process data.

* A computer uses input devices to accept the data and program.

* In modern computers, monitors and printers are the commonly used output devices.

* CPU is the brain of any computer system. It consists of arithmetic and logic units, control unit and internal memory (registers).

* Control unit controls all the hardware operations, ie, those of input units, output units, memory unit and the processor.

* The arithmetic and logic units in computers are capable of performing addition, subtraction, division and multiplication as well as some logical operations.

* In the main memory, the computer stores the program and data that are currently being used.

* All modern computers use the stored program concept. This concept is due to John Von Neuman.

* The smallest unit of information is a single digit called a ‘bit’ (**b**inary dig**it**), which can be either 0 or 1.

* The secondary memory is the memory that supplements the main memory. This is a long term non-volatile memory.

* The most common input device is the keyboard.

The truth table for NAND gate is

Input		Output
A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

Table 4.6 Truth Table for NAND Gate

Bubbled OR Gate

The logic circuit of bubbled OR gate is

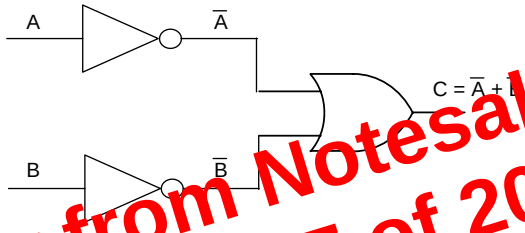


Fig. 4.11 Logic Circuit of Bubbled OR Gate

The output of this circuit can be written as

$$C = \overline{A} + \overline{B}$$

The above circuit can be redrawn as the bubbles on the input, where the bubbles represents the inversion.

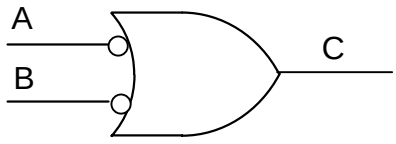


Fig. 4.12 Logic Symbol of Bubbled OR Gate

Using combinations of logic gates, complex operations can be performed. In theory, there is no limit to the number of gates that can be arranged together in a single device. But in practice, there is a limit to the number of gates that can be packed into a given physical space. Arrays of logic gates are found in digital integrated circuits.

The logic gates and their corresponding truth tables are summarized in the following table.

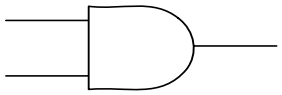
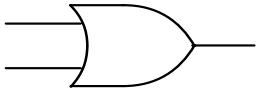
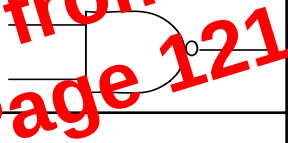
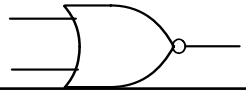
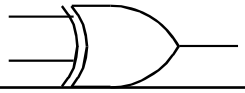
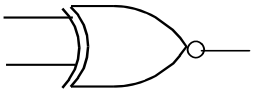
Logical Gates	Symbol	Truth Table
AND		A B A B 0 0 0 0 1 0 1 0 0 1 1 1
OR		A B A+B 0 0 0 0 1 1 1 0 1 1 1 1
NOT		A A 0 1 1 0
NAND		A B AB 0 0 1 0 1 1 1 0 1 1 1 0
NOR		A B A+B 0 0 1 0 1 0 1 0 0 1 1 0
XOR		A B A+B 0 0 0 0 1 1 1 0 1 1 1 0
XNOR		A B A B 0 0 1 0 1 0 1 0 0 1 1 1

Table 4.10 summary of Logic Gates

Converting a Truth Table to a Boolean Function

There are many ways to do this conversion. A simplest way is to write the boolean function as an OR of minterms. A minterm is simply the ANDing of all variables, and assigning bars (NOT) to variables whose values are 0.

For example, assuming the inputs to a 4-variable boolean function as A, B, C, and D the minterm corresponding to the input 1010 is : $A \bullet \overline{B} \bullet C \bullet \overline{D}$. Notice that this minterm is simply the AND of all four variables, with B and D complemented. The reason that B and D are complemented is because for this input, B = D = 0. As another example, for the input 1110, only D = 0, and so the corresponding minterm is $A \bullet B \bullet C \bullet \overline{D}$.

For example let us write a boolean function for the following truth table

Input			Output
A	B	C	D
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

To do this problem, we first circle all of the rows in the truth table which have an output D = 1. Then for each cirlced row, we write the corresponding minterm. This is illustrated in the table below.

Step 1: Statement of the problem . Given above.

Step 2: Identify inputs and outputs. It is clear from the statement of the problem that we need two inputs, say A and B, and one output, say C. A block diagram for this system is

Step 3: Formulate truth table. The truth table for this problem is given below. Notice that the output is 1 if only one of the inputs is 1. otherwise the output is '0'.

Input		Output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

Step 4: Convert the truth table to the minterms for the rows in the truth table that have output '1'

Input		Output	Minterm
A	B	C	
0	0	0	
0	1	1	$A\ \overline{B}$
1	0	1	$\overline{A}\ B$
1	1	0	

By ORing the minterms, we obtain the boolean function corresponding to the truth table as

$$D = (\overline{A} \bullet B) + (A \bullet \overline{B})$$

The boolean realization of binary addition is shown in the truth table. Here A and B are inputs to give a sum S and a carry C.

Input		Sum	Minterms Of S	Carry	Minterms of C
A	B	S		C	
0	0	0	-	0	
0	1	1	$\bar{A}.B$	0	
1	0	1	$A.\bar{B}$	0	
1	1	0		1	A.B

The boolean functions corresponding to the sum and carry are

$$S = \bar{A} \cdot B + A \cdot \bar{B}$$
$$C = A \cdot B$$

Which can be realized using logic circuit as,

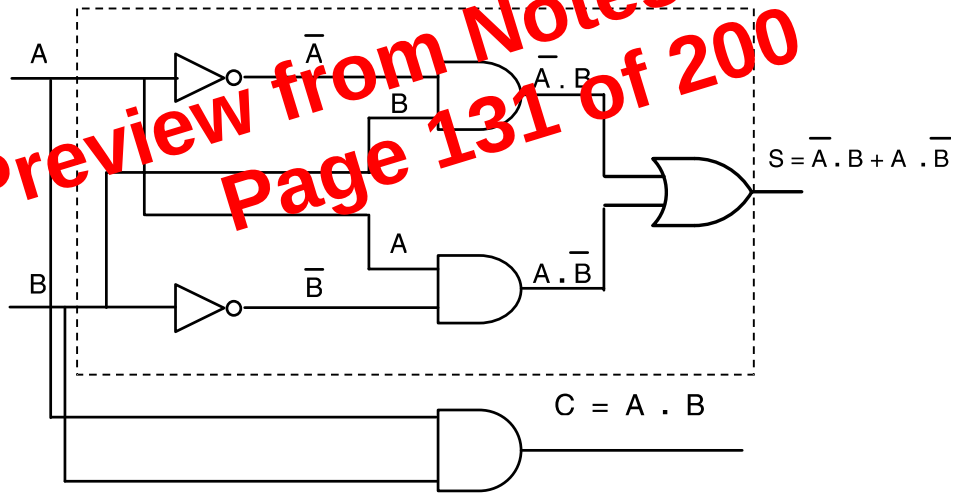


Fig. 4.19 Logic Circuit of Half Adder

$$= \cancel{A\bar{A}C_1} + ABC_1 + \bar{A}\bar{B}C_1 + \cancel{B\bar{B}C_1} + \bar{A}B\bar{C}_1 + A\bar{B}\bar{C}_1$$

(Since, $A\bar{A} = B\bar{B} = 0$)

$$= S$$

Also

$$C_2 = \bar{A}BC_1 + A\bar{B}C_1 + AB\bar{C}_1 + ABC_1$$

$$= (\bar{A}B + A\bar{B})C_1 + AB(C_1 + \bar{C}_1)$$

$$= (A \oplus B)\ C_1 + AB$$

Hence

$$S = (A \oplus B) \oplus C_1 \text{ and}$$

$$C_2 = (A \oplus B)\,C_1 + AB$$

To realize the full adder we need two 2-input XOR, two 2-input AND gates and a 2-input OR gate.

Hence the full adder can be realized as.

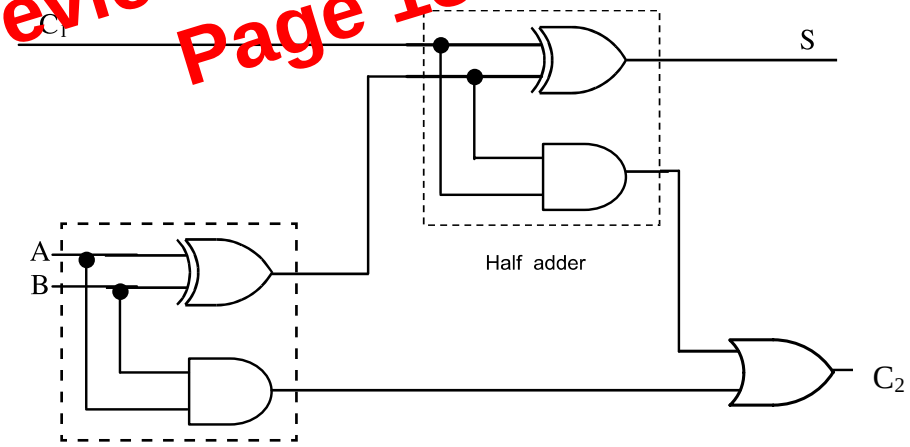


Fig. 4.20 Logic Circuit of Full Adder

Placing Components

Components like logic gates are placed in the workspace by

i) Selecting **component** from **Place** menu.
ii) Right clicking on the workspace and select **place components** or **Ctrl+W**.

Selecting Components

Click on the component to highlight it .Once highlighted the options in the 'Circuit ' menu will apply to that component.

To select several components drag a box around them. All selected components will be highlighted.

Copying Components

To copy a component select it and then choose **'Copy'** from the 'Edit' menu (or <cntrl> C). Then select paste (or <cntrl> V). Copies of the component will appear in the middle of the drawing area. They can then be moved to their required positions.

Modifying components

i) Select the components and then choose the available options from the 'CIRCUIT' menu.

ii) Double click on the component. A window will be opened which gives the parameters for the component which can be customized. Change the values as required and then click on 'Accept'.

Moving Components

To move components on the drawing select it and drag it to a new position and drop it. Any wires connected to it will be dragged with it.

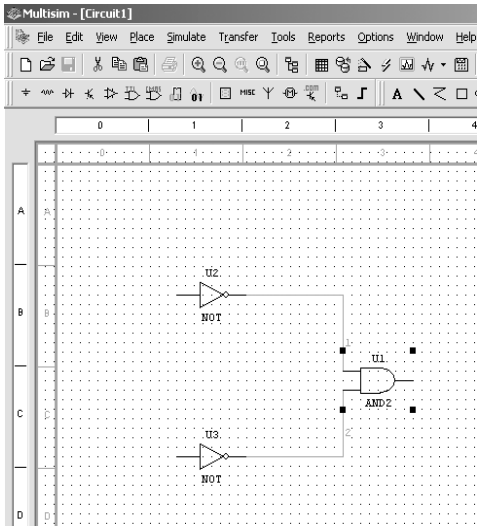


Fig. 4.28 Construction of a Logic Circuit

4.6.5 The Logic Converter

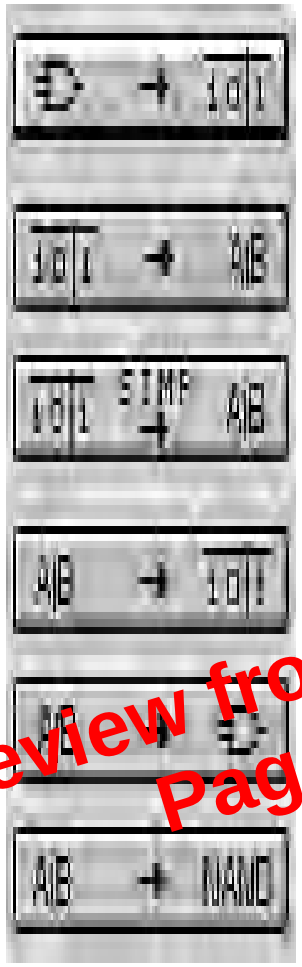
MultiSim provides a tool called the **logic converter** from the **instrument bin**. With the **logic converter**, one can carry out several conversions of a logic circuit representation.

1. Logic Circuit ➔ Truth Table
2. Truth Table ➔ Boolean Expression
3. Truth Table ➔ Simplified Boolean Expression
4. Boolean Expression ➔ Truth Table
5. Boolean Expression ➔ Logic Circuit
6. Boolean Expression ➔ NAND-gate only logic circuit

One can connect it to a digital circuit to derive the truth table or Boolean expression the circuit represents. One can also use it to produce a logic circuit from a truth table or boolean expression.

To open the **logic converter**, click on the **simulate** menu, **instruments** and then **logic converter** as shown in fig. 4.29.

The converting options available in the logic converter are as follows:



Descriptions:

⇔ Convert Logic Circuit to Truth Table

⇔ Convert Truth Table to Boolean Expression

⇔ Convert Truth Table to Simplified Boolean Expression

⇔ Convert Boolean Expression to Truth Table

⇔ Convert Boolean Expression to Logic Circuit

⇔ Convert Boolean Expression to NAND-gate only logic circuit

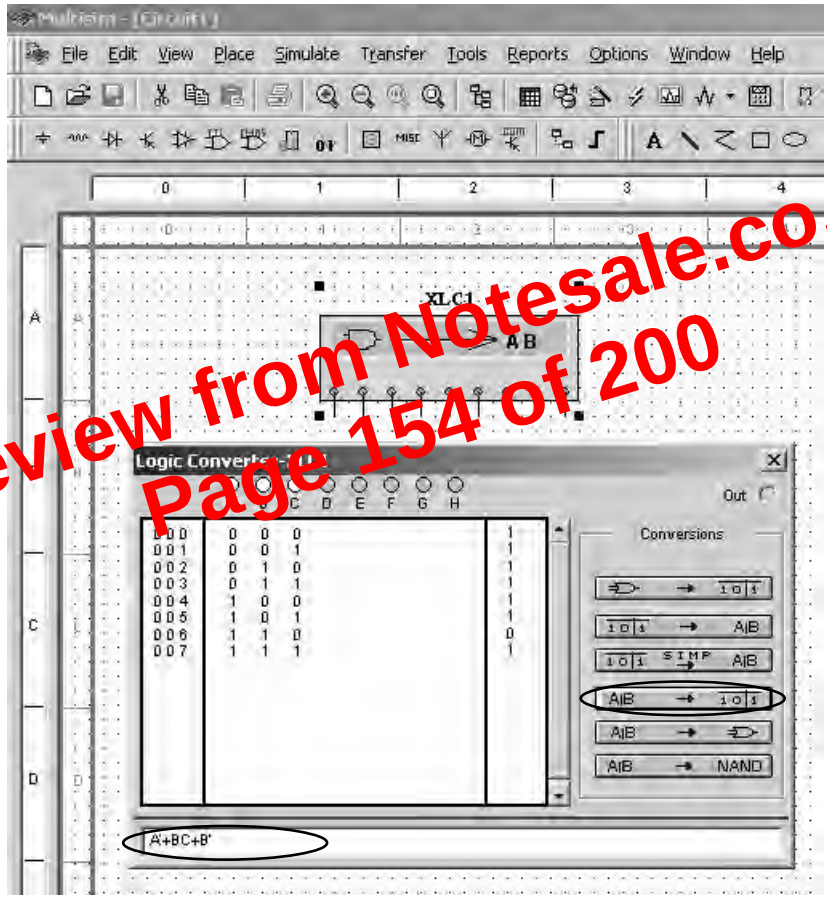
4.6.6 Converting a logic circuit To a truth table

1. Construct the circuit by drawing the components (logic circuit).

4.6.9 Converting a Boolean Expression to Truth Table

Once you have a boolean expression, the logic converter can transform it into a truth table. Click the 'Boolean Expression to Truth Table' button  after entering the Boolean expression A' + BC + B' in the logic converter.

The truth table will be displayed in the logic converter as shown below.



CHAPTER 6

COMPUTER COMMUNICATIONS

6.1 Introduction

Communication is the desire of man. When human voice became inadequate, ancient civilizations devised drum codes and smoke signals to send information to far off distances. These primitive methods have given way to sending messages through electronic pulses. A stand-alone computer communicates very efficiently by connecting it with other computers. Data in a computer is transmitted to another computer located across continents almost instantaneously using telephone, microwaves or radio links. The long distance communication link between a computer and a remote terminal was set up around 1965. Now networking has become a very important part of computing activity.

6.2 Network

A large number of computers are interconnected by copper wire, fiber optic cable, microwave and infrared or through satellite.

A system consisting of connected nodes made to share data, hardware and software is called a Computer Network.

6.3 Some Important Reasons for Networking

- **Sharing of resources:** Primary goal of a computer network is to share resources. For example several PCs can be connected to a single expensive line printer.

- **Sharing information:** Information on a single computer can be accessed by other computers in the network. Duplication of data file on separate PCs can be avoided.

The computer communication should ensure safe, secure and reliable data transfer.

Safe	:	The data received is the same as the data sent
Secure	:	The data being transferred cannot be damaged either will fully or accidentally.
Reliable:		Both the sender and the receiver knows the status of the data sent. Thus the sender knows whether the receiver got the correct data or not.

6.6 Types of Network

The following are the general types of networks used today.

- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)

A network connecting systems and devices inside a single building or buildings close to each other is called Local Area Network (LAN) (Fig.6.1). Generally LANs do not use the telephone network. They are connected either by wire or wireless. Wired connection may be using twisted pairs, coaxial cables or Fiber Optic cables. In a wireless LAN, connections may be using infrared or radio waves. Wireless networks are useful when computers are portable. However, wireless network communicates slowly than a wired network.

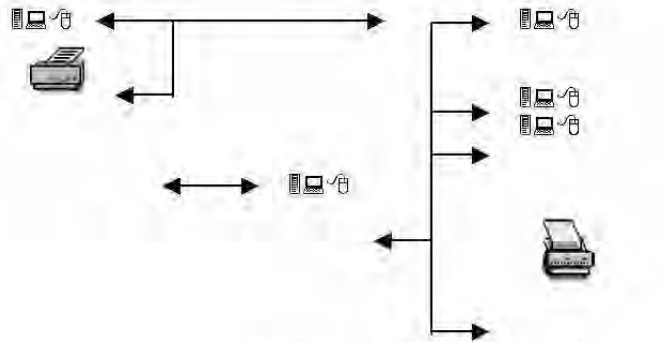


Fig. 6.1 Local Area Network

6.11 Forms of Data Transmission

Data is transmitted in two forms

1. Analog data transmission
2. Digital data transmission

Analog data transmission is the transmission of data in a continuous waveform. The telephone system, for instance, is designed for analog data transmission. Analog signals are sometimes modulated or encoded to represent binary data.

Digital data transmission is the widely used communication system in the world. The distinct electrical state of ‘on’ and ‘off’ is represented by 1 and 0 respectively. Digital data transmission as shown in Fig.6.6 is faster and more efficient than analog. All computers understand and work only in digital forms

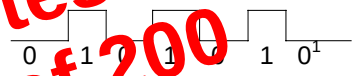


Fig 6.6. Digital Data Transmission

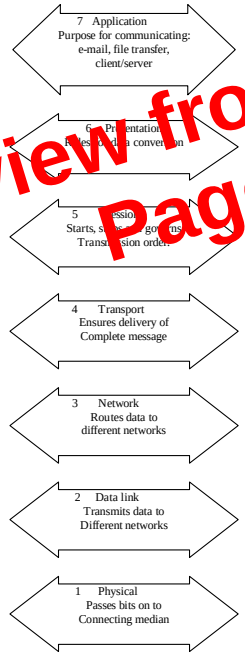


Fig 6.5. Seven Layers of Protocols

vacancies. There are sites relating to specific job and profession also. Some of these sites charge a fee for the services while others are free.

6.22 Intranet and Extranet

Many organizations have Local Area Network that allows their computers to share files, data, printers and other resources. Sometimes these private network uses TCP / IP and other Internet standard protocols and hence they are called intranet. All the Internet services such as web pages, email, chat; usenet and FTP are provided on the intranet to serve the organization. Creating a web page on the intranet is simple because they use only Word-Processing Software One of the main consideration of the intranet is security. The sensitive company data available on the intranet is protected from the outside world.

Taking intranet technology a few steps forward extranets are useful in the business world. Intranet connecting selected customers, suppliers and offices in addition to the internal personnel, is called extranet. By using extranet business organizations can save telephone charges. For example a car manufacturing company can extend their intranet to their dealers and customers for support and service.

EXERCISES

I. Fill in the blanks:

1. _____is a typically two or more LANs connected together across a wide geographical area.

2. _____network computers and other communication devices are connected in a continuous loop.

3. In a high speed network _____cables are used.