CHAPTER 5 Computer Architecture

Overview

 Van Neumann and his team proposed design of a stored program computer. According to his design sequence of instructions (called Program) and the data are stored in the memory of the itiaehine. -me machine ready the instructions one by one and executes these instructions accordingly. This seemingly simple design is proved to very powerful and general purpose. IL is the basis of Inost modern day

If we consider the architecture Of the  stored program machine the following are 1m st important components

Control Unit (CO; The control unit reads instructions from the menwry and decodes these instructions. This unit uses other components of the convuicr to execute the instructions given to (he

A tithmetie and Logical Unit AS the general-purpose computer can perform different arithmetic operations on data so it has a special unit that  electronic circuite to perform thc basic arithmetic and logical operations on the data. This is called the Arithmetic and I.ægival Unit or ALU-

Main Memory: Tlle stored program computer has anotl•.ea very important component that is use to store program and data while these are being executed, This unit is known as 'he Main Memory of computer Son-etimes we also call it the working area of the computer

VO Uoit; This handles processor's communication with fis peripherals, For example, Disc drive. nwniior, printer etc. There are registers to hold the data coming in or going 001 and a peripheral device selection unil which determines which interface to send the data to. As the data and instructions should be in the memory before the cornputer can stan executing it so to place data and instructions in the menu•ry this stored program computer \*Igo has somc 110 devices.

Bus Interconnection; This is another important component of the basie architecture and this eornponent is used to connect different parts of the eornputc-r together.



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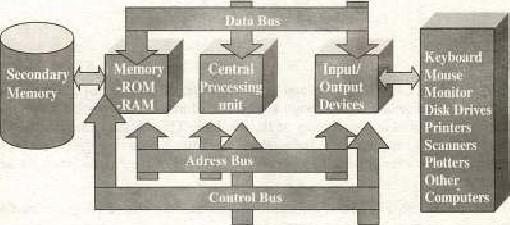
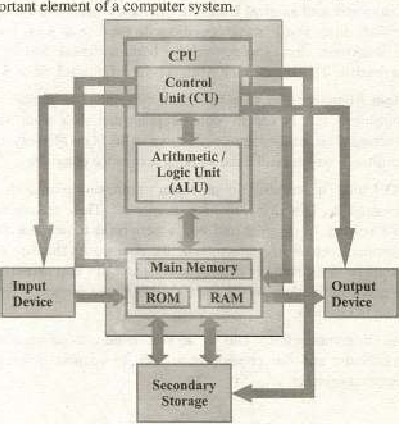


Figure SÄ: Architecture of nuim Components of Computer

##### The CPU

The CPU is the brains ofthe eornpulec. In terms of eomputing power. the CPU is thc most important clcmcnt a computer systcm.

13 COmptder

"Ille CPU is centrally on the motherboard, Since the CPU carries out a large share of the work in the computer; data pass continually through it. The data come from the RAM and units (keyboarl drives etc.), Anec processing, the data is send back to RAM and the units,

"Tie CPU continually receives instructions to be executed. Each instruction is

-a data processing order, The work itself consists mostly of calcularions and data

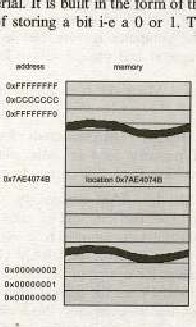


On large machines, CPUs require one or more printed eireuit boards. On personal computers arpd small workstations. the CPU is housed in single chip called microprocessor, Two typical components of a CPU are:

The arithmetic logic unit (ALCO: The ALU part of a computer that performs all arithmetic computations, such as addition and nuiltiplication, argil comparison operations. •Ime ALU is one component of CPU. 

The control unit(CU}, which extracts instruction from mennry and decodes and executes them, calling on the ALU when necessary.

Main Memory: As mentioned earlier, a computer executes a program its main nrrnory, uhich is another very important component of the stored program computer. A computer cannot work without having sone kind Of main memory in it, In these section. we will learn more different types Of used in and their Working.

Mostly the. modern computer men.ory is built in thc form of a chip of a semi conductor material It is built the form of thousand or even millions of cells each capable of storing bit i.c a 0 or 1, This is shown in figure 5.3. belo w.



These cell\*' are logicålly organized into groupof8 hits called a byte, Each byte in the metr.ory- has a unique number assigr,ed it is called the address of that byte- This scheme of arranging cells into a byte bytes, into rremory chip is shown in the figure 5.4 below.

Main Memory

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Address of IOC p | 000075 | | | | | |
|
|
| gutter |
|  |
| IOC program |  | Re read | e Address |  |  | BFteCount |
|  | 'Write  controUsenge/jump | | | |
|  |
| Startio Chn\* Sub Chn# |

Figure 5.4: Main

From. this figure. it is obvious that a memory is sequence of bytes, Also  Cru or any other component Of the computer can access any byte from the memory by specifying its addless., Different bytes of the main memory can be accessed directly at random the memory is build from electronic components so accessing any parl of the aue:mory takes equal amount of time. So the main memory is direct access storage dcvicc, As no mechanical movement is involved in accessing any byte of (he memory so the main memory of the computer is very fast as compared go other storage devices like the magnetic and optical disks. There are 'wo types of main

RAM (Random Access Memory): li is usually build by using two different t ec hnolo gies.

DRAM CDynamie RAM): DRAM stands for dynamic random access tnenx'ry, a type of memory used ill computers, Dynamic Random Access Memory must ha ve an electric current maintain electrical state

SRAM (Static RAM): In SRA.M technology, the metmr•y cells are made form digital gates and each cell can hold its value without any need to refresh data as long as power is supplied to it. As no refreshing is required to SRAM, these chips are faster than the DRAM chips also u!ilize less power, Because Of these reasons the design Of SRAM chip is more complex than the design of DRAM chips- Hence the SRAM chip is lnore expensive than DRAM chip. [n most rnodern computers this technology is LLsed build very fast roemory inside a CPU. This memory is known as the cache menwry.





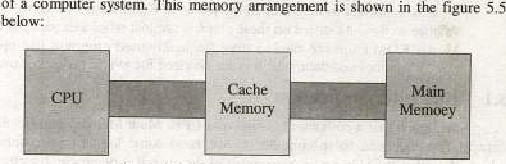
Cåc'he memory usually has a very small size as compared to the main memory in the computer but plays a very important role in increasing the performance of a computer system. This mermry

Figure SS: Mernory arrangements

Il is important to note that the main rrwrnory is volatile (unstable) and the contents of the memo" are lost as soon as the electricity supply is cut-off The CPU can not only read the data stoned in RAM but can write data in the RAM. so RAM is read/write memory. It is used to store all dala and instruction of a program while it is being cxccuted,

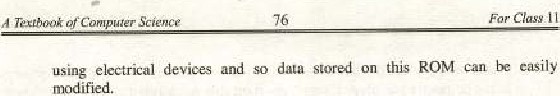
ROM (Read Only Memory): AS is ObViOijS from this the contents stored in this rncmorycan be read but new data can not written onto so it is read only. The manufacturer of the ROM writes the data and programs permanently it und this data and programs cannot be changed afterwards, ROM contains frequently used ifistrcvctions and

Another commonly faund form of ROM is PROM (Programmable Read Only Memory). This form of ROM is initially blank and the user or manufacgurer can write data onto it by using special devices. Once the program/data is written anto PROM it can be changed or altered. It is obvious that kind of ROM will be used for storing user made programs and data and the dala should have a very long life time as the data written onto this kind of ROM can not be changed, 

Another important form Read Only Memory is EPROM (Erasable Programmable Read Only Memory). Like- PROM it is initially blank. Programs and data can he written on it by the manufacturer Orby the used by using special deyices. Unlike PROM, the data written on it can be erased by using speeial devices using ultraviolet rays. So data'program written on it can  changed and new data can also be added on this form of ROM. As the data writlen on this kind of ROM can be changed data that is to be updated eau be writlen Onto it hut frequently Changing data should not be written 011 this

ROM.

Yet another form of ROM is EEPROM (Electrically Erasable Programmable Read Only Memory): This kind orROM can Tv-written by



It is important note thit all the forww of-ROM described above are nonlütile so the data stored on these chips is not lost when electricity is cut-off. Mostly ROM chips ate used to store frequently used programs like operating system routines and data, which is not changed for longer periods of time

#### 5.1 Bus Interconnection

We knowthat a computer consists or a CPU. Main Memory and I/O unitr For data to flow between these components need sort\* kind of interconnections, which i' another very imporcang component of the o verall co Inputer architecture.

"Illese components are interconnected by using a Of parallel lines (Condueling Wires). Each of these lines can be used to transfer a sequence of bits from one component of Lhc computer to the other component. This set of parallel lines is called BUS, This kind of i bus i' shown in the figure 5.6 tElow:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | |  |  | | Electronic   Clock | pulse | |  |  | |  |

Figure S.6: Bus interconnection

Generally a computer has more than one bus interconnection- The bus used to  the main components of a computer is callcd the system Bus Generalpurpose computers have u 10-100 line system bus. The system bus is divided inio three rnain categories

Control Bus:: These lines are used to transmit different commands from one component to the other. Far example. if the CPU  data from the main memory; it will use control bus to send thc memory read command to the main memory of the computer. The control bus is also used to transmit  other control signals like ACKS (Acknowledgement signals), For example

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when CPU give command to the main writing data, memory sends a Signs] to the CPU after writing the data successfLil]y so that the CPU can move forward and perform some more actions. few cornmonly used commands and their purpose ale given in the table

|  |  |
| --- | --- |
| ORY WRITE | This command is used to wöte some data to a given location in the main memory. |
| ORY | This Cammand is used to read some data from a given location in the main memory, |
| WRITE | nis command is used to write some data to given output device. |
| RE AD | This coinmand is used to read some data frum a given input device, |
| US  VEST | This command is used to request foc a control on the bus so that the requesting device can use it (o - data. |
| US GRANT | This command is uscd by thc bus controller to indicate the„gram of 'he bus a device. |
|  | This command is used deliver information thal the data was read by the devices. |

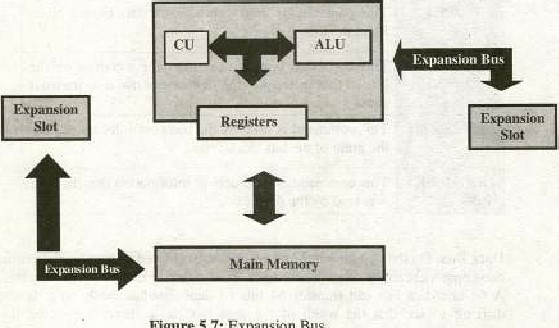
Data Bus: On the System bus 32 or 64 lines are reserved to transfer data from one component the other. These lines are commonly known as the data bus. A 64-line data bus can tramsfer 64 bits of data simultaneously so it is not difficult to see thal the width of the data bus has direct impact on the performance of the computer ,

Address Bus: As we know that many components are connected to one another through the system bus so it is important assign a unigue ID to each component. This ID is called the address of that component. When a computer component wants to communicate with another. it uses of the syszem bus lines to specify the desiination component by using its address. These lines are commonly known as the address bus, Not only the address is used to identify different components of a system but it is also used specgy different mcrn6fY locations Within the main me:mry,



For exalT1ple; if the CPU wants io write some data at a location 9872 in the main memory it places the address main nwmory ard location (ie\_ 9872) on the address bus, WIEn the main memory sees its address on the address bus it reads the data from the data bus and writes it to thc specified location with in the nuin rte rnory.

As the number of eotnponents concreted to the system bus flore eoi•rwonents will be trying to use the system bus simultaneously. This will slow-down the computer as components will have to wail longer get access to the bus. To solve this problem only the major cornponents of the computer are  to ibe system bus and rcrnai.ning components are conneceed another bus usually known as  expansion TIE expansion bus is connected to the system bus. This is shown figure 5-7 below-



Figure

5.7:

Expansion

Bus

## 5.2 TheVOUnit

The 1,10 Unit is another very important component ef a computer. Now a days we have many input/output devices like keyboard, mouse, disks etc. All these devices are very different from one anotlver in their organization. Also these devices can handle different data-transfer rates and suppon different data formats, Because of all these differences il is impractical to connect all these devices directly to system



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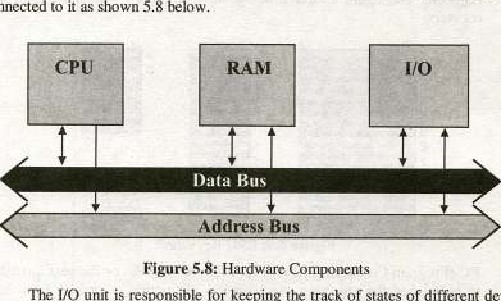
will

tuke a lot of CPU time and will fill t.lx system bus capacity.

 To avoid these difficulties, a special haguwar component I/O unit is p•ed

Only the VO unit is connected to the bus and the processor and all other devices are

I/O unit is responsible for keeping the track of suites attached wfth it. It is also responsible for compensating the speed difference between the processor and the I/O devices. IWO Ways of transferring data from the peripherals into the computer,



connected

different

devices

Interrupts: In this scheme the processor issues the command 10 the VO devices. When the devices get ready, they generate an interrupt signal for the processor, On sensing this signal, 'he processor suspends all other processing and performs the L'O operation. The disadvantage of this scheme is chat it



reduces the over all performance of the processor.

DMA: The second scheme is DMA, In this scheme „the processor issues (be  eon:unan.d and gecs busy in some other useful task. The special hardware gets the data from the I/O device and uses the system hus to pkwe if in the main memory. It is useful note that the data is transfused when the processor does not need the system bus. So the processor does nol have to wait for the I/O operation to complete \_ The disadvantage of this scheme is that  it is rrwre corrwlex and extensive,as hardware is needed,

### 5.2-1 CPU Registers

 program is stored in the main Ilk'lnory of the computer on -contiguous memory locations, The data is also loaded into computer's before the processing starts then the control is given to the CPU.

The CPU needs storage areas where the data can be Stored temporarily, As these storage areas. are used frequently, so for efficiency these special. purpose ternporary storage are pJovided within the CPU for enhancing  performance of CPU. These special purpose storage are called registers, The figure 5.9.given below shows the most commonly used CPU registers,

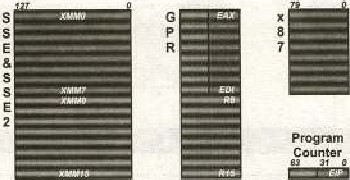


Figure SS: CPU Register

PC (Program Counter): This register holds the address of next instruction to be fetched for execution, As soon this instruction fetched, its value is incrcmentcd so that it still has the address of next instruction.

IR (Instruction Register): Once the instruction is fetched it is stored in the IR Where this instruction is decoded, 

MAR (Memory Address Register): When the CPU wants to store some dåta in the or reads the data from memory. it places the addres of the required memory location in the MAR.

MBR (Memory Buffer Register): The CPU uses this register to store data coming from the memory or going to the memory,

Stack Pointer: To understand the purpose of this register it is important to understand very importanc daw structure 'Arrangement of dalai called a

GPR(Ge'ieral Purpose Register'); These registers are called EBX. ECX. EDX and can he used for any mathematical or logical operations, These are used for arithrnetie and data mjvement purposes, Each can be divided into an upper case and lower byte called AH, AL BH. BL CH. CL DEI. DL respectively. A stand for Accumulator. B for base. C for count and D for data Each of these registers can alternately he used as one byte, two byte. or rour byte registers, AL ( 1 byte AH byte ',AX ( 2 byte EAX (4 byte ).We can acces+16 bit or g bit,

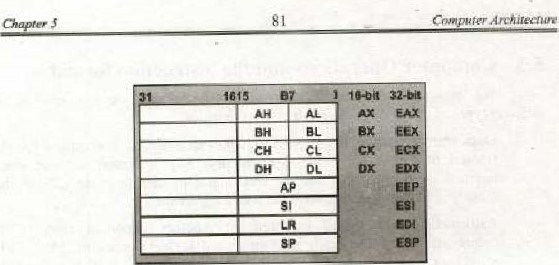


Figure 5.10: purpose Registers

AX (Accumulator Register)t Used far arithmetic and data operations.

BX (Base Register): Used for arithmetic and data nnvem.enc and special addres sing abilities.

CX (Counter Register): Used for counting purpose. Aets as a counter for repeating Ot looping.

DX (Data); Has specialrole in division and multiplication.

or Segment Registers: The address or segment register is a group of 4. times registers named CS€ DS. E.S. SS. The segment register used base location far program instruction. data, and the stack.

CS(C0de Segment) The CS register holds the base location of executable instructions (code) in the program.

DSOata Segmenth DS register ik the default base location for memory variables\_ The CPU calculates the offsets of variables using current value

ES(Extra Segment): The ES register is an additional base location for the yariables.

|  |
| --- |
| Cede'Segment h hhh |
| Seg hhhh |
| Segment hhhh |
| St—Gk Segment (SS) |

SS(Stnck Segment); The SS register contains the base location Of the Current program stack.

Each has 2-byte. These registers are called egment register and are used in conjunction With eitlær the Ip register '01 two iru:iex registers DI and Sl to address various areas of cornputer menwry .CS is the primary register or index register used to fetch instruction in eonyunetion with the IP register. DS is the primary register. used to pint out data in the conupuiec memory along with the DI ar SI registers.

### 5.3 Computer Operations and the instruction format

We knaw the basic architecture of computer, now we will learn about different types of operations performed by the computer ,

Data trunsfer instructions: All CPUs provide different instructions for the tracsfer of data from and to memory, A programmer can use these instructions to bring data into the CPU And copy data from the CPU to the main memory„ Instructions have the following frtmat.

Arithmetic and Logical instructions: Another important category of operations a CPU can do is Arithmetic and logical operations. Most CPU provides the basic arithmetic operations of add, subtract, multiply and divide for signed numbers and floating point numbers, Logical operations of comparing two numbers. performing XOR of number, shifting and rotating a  number are sort\* common form of logical operations provided by the CPU-

VO Instructions: Every CPI-I provides if users with the operations of reading data from a peripheral device and writing data to peripheral device. To use these operations a programmer may use input and print commands provided CPU.

Control Transfer; In real world programs, to the CPU must be repeated a number of TO support such operations, all CPUS provide its programmers with control flow operations some examples of these operations

Jump , Jumpa (Jump if zero)

Instruction set: Each CPU pm vides its users with a number Bf instructions so that the users perform different operation supported by the CPU. The set of all instrucqions provided by CPU is commonly known as the instruction sei of that CPU. In this section we will takc an overview of the instruction set provided by the n»st modem CPU manufacturers and see how these instructions are used to solve different problems. Most commonly the CPU provides the following instructions to the

### 5.4 Instruction Format

A computer will usually have a variety of instruction Code forriiatSE It is the function of the control unit within the CPU to interpret instruction code and provide the necessary control functions needed to process the instruction.

Each instruction for the CPU is specified by giving.

* A code for instructio n {opcode),
* Addresses of the operands.

Although other things (like addressing are also Fified but in most general instructÅ'n is in the format given in the figure

4 bits 6 bits 6 bits



Zero-Address Instruction Format: The name "\*erg-address" is given to this type of oomputer because of the absence of an address field in convutational instructions. A stack-organized computer does not use an addless field for the instructiocus ADD and MUL The PUSH and POP instruction. iwwever, need an address iWd to specify operand that communicatk'n with the stack.

Instruction For-nut;  instructions use an implied accumulator (AC' register for all data manipulation. For nulltiplication and division there is a need tor second register.

Two-Address Iwtruetion Format: For two addresses instruction, each address field can again specify either a Bbssible register or a urn»ry address. Two-address instructions are the unst comtmn in commercial conVuters. Examples of such instructions ave MOV, ADD. CMP and BIS.

Three Addre• Instruction: Computer with three-address instruction formats ean use each address field to specify either a processor register or memory operand. advantage Of three-address that it results in short programs when evaluating arithmetic expression. The disadvantage is that the binary-coded instructions required too many bits to Sl\*eify three addresses,  instmction formats in the convuter ale restricted to eitlw three register address fields or two register address fields and one memory address field.

Fetch-decode-Execute ey&: Now that you know the basic architecture let us see how the CPU enacts the instructions, specified in a program.

When we want to execute a sequcxe Of instructions those instructions./data are first Of all loaded into the main metmry of the computer by using VO device. Ome these instructions have Iren loaded into main address of the first instruction is copied into the program counter and control is given to CPU. TIE CPU following steps:

Fetch Instruction: The CPU reads the value of PC and the instruction poiMed to by PC into instructkyn register. 



Jixrboök

This fetching of instruction involves the following steps:

* -Copy the contcntsofPC into the MAR and request read.
* Copy the data read from the memory into MBR and instruction then in the IR. Inclement PC so that it pain's to the ncgt

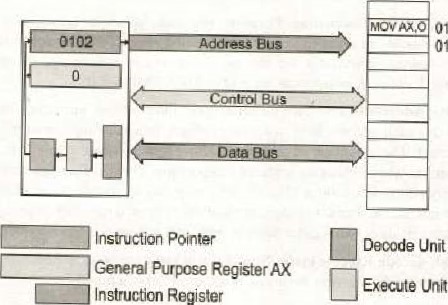


Decode Instruction; Once the fetching ofinstruetion is completed the CU decodes the instruction by analyzing the opcode of the instruction. It also reads the values gi operands specified in the instruction, Decoding means activating the appropriate circuit to execute the instruction.

Execute Instruction: After decoding the instruction the processor executes the instruction by using the activated circuit. Then the results of the execution are written back to registers and memory,

The CPU repeatedly docs these steps, These steps are known as Fetch.

Decode-Execute Cy Cle,



0100

0102

figure 5.11 ; Fetch-Dec-ode-Execute

#### 5.5 Software

The term software is used fov a sequence of instruction given to the computer to perform a specific task. Software consists of the step-by-step instructions that tell the computer what to do. general, software is divided into applications software end software. Applications software. which may be customized or packaged.

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performs useful work on generäl.purpose tasks, Syszem software. which includes operating system, enables the application software to interact the computer.

Application Software: Application software is defined as software thal can perform useful work on general-purpose tasks, It may be cither customized or packaged.

* Customized software is sonware designed ror a particular customer, The program can be developed by a single computer professional ptognmmer ot by team orprogrammers depending upon tlr requirements.
* Package g•ttware is t.lw kind of "off" the "self' program developed for sale to the -general public, Package software includes word processing, spreadsheet. database manager. graphics, communications programs. Illese are the software development by experts in high/low level languages for non-experts\_ It is to facilitate all the fields of life,

##### 5.5.1 Operating Systems

It is obvious that to solve some problem on a computer a programnter Will Write instructions, But Other than writing instructions for Solving the problem every programmer will also have to write instructions for the following tasks,

* Read data from the input dev ices
* Show results on the output devices
* Perform rnemory managetnent tusks (n•ore details
* Organize data on the storage devices. 

These tasks are very complex and only expert programmers can write these instructions. From this discussion it is obvious that only expert programmers gan write programs and use computers. To overcome this difficult situation some programs (instructions) can be written only once and can he stored in the computer so that ever-y programmer docs not have write these instructü3ns but rather use the stored instructions, This of programs evolved ard became what is known as an operating system (OS). We can define an OS as a set of programs running in the backguvund on a computer system and providing 811 environment in which other programs can be executed and the computer system can be used emeiently.

[n this section we will discuss the main functions of an operating system see how thc OS provides these facilities. Some of the pmgrams are stored in the pmcessor nrnu:jry and provide the basic utilities 10 the users. The remaining programs are stored on the hard disk or backing store of the computer and are loaded in memory of computer when these are needede Any programmer or user trying to use computer system now does not nccd to write instructicjns for performing the comrnon tasks but can issue

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command to the OS and OS can do the rest. So we tan visualize as if the OS is sitting bet».cen The hardware aud the application program or user. This is shown in the figure below, this figure it is obvious that the OS will not only provide programs for doing different tasks but will also provide an interface its users (i.e. programs, programmers etc)

Application programs



Programmers

Functions of Operating Systems: In this section We will discuss the Innin furætionality provided by the OS to its users,

Manage Hardware Resources: The operating system must provide programs for managing the hardware resources ofthe computer like disks. memory, and CPU.

Memory Manngemeni: ITI the stored pmgratn computer every program has to be loaded into thc computer's Main rnemory during dwexecution- If there are loaded in the mcmory, as is time-sharing is used. the program and its data must protected from Elic of other programs.

Load and Execute programs: As we know that a program has to loaded into ll•æ main memory helOrv the proccssor can execute it. The OS provides the facility of easily loadipg a program into "Envyand starts its execution,

Data Security: The OS must also protect the user data against illegal access and modification.

Plvvid.ing interface to the users: The OS must provide an interiaee between the and the computer and also between software and the computer. Most Operating systems provide the following two types or interfaces to their users,

 Commwnd prompti In such\_intcrfaces the users cornrnunieate with the operating syscem by typing commands using a keyboard. Each command given to the OS activates onc or the many programs in the OS. Example of such an interface is -the command promptprovided by MS-DOS to its users. 

Graphical User Interface (GUI): The GUI interface consists Of Window, Menus, Icons and pointers. The user of the system communicates with the OS by selecting commands from the menus o: by selecting different Icons with ibc pointing de•.icc. MS-Windows is a well-known example of the OS with a GUI interfacc. [n MS-Windows the user selects commands by using a l:rwvse and a



### 5.6 The Translators and their functions

#### Interpreters and Compilers

In the early days of computers the programs had 10 be written in machine code. The machine code instructions are the instructions provided the instruction set of the nuchine and these codes are represented by a binary pattern in the computer. To write a program (he programnjer had to write the instructions in binary, This was a very complex task and even writing very simple progranus took Jog time, It was very difficult to produce correct pmgrarrls as detecting errors programs and correcting these errors (Debugging the program) was 'very difficult. A program that produces the binary instruction for a given assembly language program js called an Assembler.

Each assembly instruction maps to a single machine instruction so it is very easy to translate program written in assembly language to machine code. Writing programs in assembly languagc is very easy but is still a tedious Work and took a long

The program that translates a high-level language program into machine language is called a «'mpiler. Orne a program has been translated into machine code it can be loaded into che main memory and executed by the CPU. The high-level language version of the program is usually called the source code resulting machine code program is the object code. The relationship between the source code and the object oode is shown in the figure below:

Source CadeObject Code ( High -Level(Machine

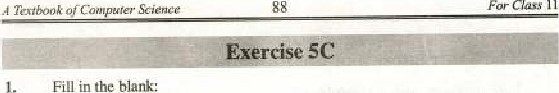
Language)Langu age)

A more appropriate definition of d compiler is that it is aprograrn that lakes as input high-level language program and generates an object program. This object prograln may or may not be the absolute nmchine code.

Another useful translator is "an interpreter. AH interpreter takes as input high-level, language program and performs the following actions.

* It repeatedly reads instructions (one a time) and translates it to machine Code.
* It then e rhe instruction

One difference between -a compiler and an is that a compiler converts each instruction only olive but an interpreter may translate an instruction several times. Clearly if an instruction has \*ornc error interpreter can easily identify it. Also an interpreted program runs slower than a compiled program as once a program is compiled it does not any furthcr translation but the original program has to be translated every tLtnc it is executed by an interpreter And Some instructions will be translated several times.



For

11

Fill

in

transmitted in both directions



DMA

stands

for

(iii) The lexical analyzer also commonly known as

(ivi The \_reads the instructions from the n•enÜry and decodes these instructions.

 rhe —interface consists Of Window, Menus. Icons and pointers. EEPROM stands for

'(vii) Stack



register

is

used

(yiii) DRAMs require refreshing to rnaintain data storage,

—language developed for business applications.

used in mathematical or logical operations,

(xii)

1. Initial work on the internet was done in system.
2. The instructions that are used to transfer data from one unit to anottær during program execution arc called

(xvj registers are used in nuthematieal and logical operation.

2, Choose the correct answer.

Data and p togramnot being used by computer are stored in;

Secondary storage (h) eache• (e) Primary storage (d) printer A set of instructions that run computer are:

(a) hardware (b) document. (c) CPUs (d) software

(iii) The program that contains instructions to operate a device is called.

la) Device driver (b) Device operator Device linking (d) Device system

CPU is an example or:

(u) software (b) Aprogram (g) hardware (d) output unit

 The address of instguction under the proccSSOr execution is contained wiihim

1. Program Counter (b) Cunvnt Instruction registerv Memory Address register (d) register

A computer drives its ha Sic Strength from

 S p:eed (b) Menory

Cc) Accuracy (d) All ofahove

The arithmetic/ logic unit performs following actions

(u) Control cornputer operations

1. Perform arithntetic fLrnetions such as addition and subtraction etc.

(e) Perform comparisons such as greater than. than

Cd) Bothb and e

(viii) Which is a storage device

 CPU (b) Clock Floppy disk (d) Bus

(ixi Which cornponcnt is responsible for comparing the contents of tux) pieces of dala



Compuler

(a} ALU (b)  Memory None

Which one is faster

 RAM (b) Cache (c) Register (d} Hard disk

1. Write T for true and F for false statement

 Bps stands for byw per seeond.

Ciii lil simplex transmissir.)n mode. communication can direc lions.

(iii) Random access "lemory is volatile mernory.

(ivi Operating system is an application program.

External buses and internal busesare similar.

 Accumulator register is used to control stacks in the computer.

* 1. LIFO st ands for Last-in-first-off.
  2. Expansion slot is a place where an expression card is fitted.

(ixi Static Ram holds the data as long as power is supplied to it.

'Tb.e clock or the Vicks once in one\_second just like an ordinary clock.

VDU is an input device.

1. What is CPU? Describe briefly

S. Explain the architecture ofcomputer system.

6. Differentiate beiueen the fo Ilowing, PROM and EPROM

Address B Lis and Control Bus (iii) Serial Parallel Ports (ivi Linker and Loader

CU ALU

 D ifferentiate b/w Compiler and Interpreter. 

1. How to transfer data from CPU to memory explains in Stepst
2. Define the different types of RAM,
3. Define the general-purpose registers.

Deserihe the Bus and its types,

1. Define the machine Instructions,
2. Differentiale between Fetch instruction and Dee,ode instruction. Differentiate between ROM RAM.



0)

Direct

Access

(ii)

Full

 Graphical User  Wi) Electrically Erusablc programmable Read Only M emory

 Minintaning StackPenodic COBOL  General Pu-rposc

(Kii Digital v ersati]e disk (xii) Busie Input-output System C%iii) Unix (xiv) Read•'Write Instruction



Purps•c

 0)  Cii) d(ivi

Wii) d

3.(ivi F

(vil V Wii) F (vii0F (ixi F

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| --- |
| CHAPTER 6 |

Copyright The

#### Overview

Security is a system of safeguards designed co protect a cornputer system and •data from intentional and wcidental damage or access by unauthorized persons.

How does a computer system detect whether you are the person who should  allowed access to it? Various means have been devisui to give access to authorized For this, We have four approaches, as discussed below: 

What you have: You may have a key, badge roken, arpiasric card-ro give you physical access 'he lacked-up server room or eompu/er building.

What you know: Standard user-ids passwords or Some special com bmafion ofnwnbers are given rhe users ro [ogon The machine.

* What you d m Normally, the users put their signatures om the documents  c:enfinn dreiv tegicimaey as an aulhorized user,
* What you are: Some measure' are biometrics biologica/ means ofidenåificatioß i.e.fingerprints, voice recognition, eye

6.1 Virus and Antivirus issues:

To fully understand the concept of a virus (or worm), first recall the eon.eept ot a computer program, what can a program do, and how a program is executed? A program is a sequence of instructions given to a computer. These instructions are for some sort of processing, By processing we mean performing arithmetie and lagicai operations an the data in the eornputer nwmory. Inanipulating data is storing and arranging two data item to see if they are equal not, and transmitting data is sending data front one computer to sc)rne other computer On network Of Via internet. A Virus is program that -attaches itself with other executable files by mcdifying them so that the virus program is also loaded and executed with execution of these programs. A Virus usually



Chapre,•

Seeupåryr

(i) Some use the above mentioned rechnique.v for individual 's identification,

Loss hurdHiure is w major problem i" itself.' il -can be recovered by insurance. and ile hurdp,ure can be replaced. The if big issue, as if it ha.' beh backed up properly cun be reimtatled in ease of loss. The ecrual problem lies in doss

It' dificgft t impossible} to recover compager .Éy$1em4.

performs destructiye operation by deleting or nodifying on the storage devices attached to the eonvuter, [t is very important to 60te that a vi:rus is a set of instructions so it cannot physically destroy a hardware (a common miseoneeptio n).

We can formally deseeibe a virus "A destructive program containing code that Can generate copies Of itself Glid attaches itself With Other SO that it is automatically executed when those programs are executed"-

It is important co know exactly how a virus reaches from one computer to another, As the virus attaches itself with files present on a system so the only way, a virus can reach from one computer to mother. is when some data is exchanges between these computers either through usb, disks, or the network,

##### 6.1.1 Cauges of Viruses

Following are the n%ans through Which a virus reaches from one computer to another.

* Email; Nov days, of the virus programs spread by attaching thcnmseivc5 with email rncssages. When a uscr øpcns such an infectcd '-nessager the virus is also loaded inio the computers memory and attaches copies of itself with many files. Then this virus gets itself attached with email nessage sent from the infected computer and infects other



* Networks: Another way oi spreading virus is by using Internet and ather networksv For example when you download same executable file or data from the Internet or from a shared disk on the Network\* the infected files may be attached with the downloaded dala that ultirnately infects the computer.

Removable storage media: One important means of exchanging data is through the use of removable media like memory cards CDs and flash devices. So, when you copy the data from one computer to another by using a media, the infected files may get transfened.

* Pirated Software: Another imponant but not so common way the virus infects your computer is through the use of pirated software. Sone companies may intentionally put sore virus program into their software. This program will only activatc when it does ruöt find sorl:r files like license files on your computer.

##### 6.12 Types of Virus

Fo are some important types of Viru

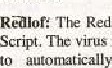
* Boot sector virus: We know mal •disk is divided into tracks and sectors. The disk on which the operating system has been loaded, has a program in its fiest sector called the boot sector, When the computer IS turned on, the program in boot sector is automatically loaded into the This program then loads the 01\*rating system into the memory alter performing some initial tasks- The boot sector virus modifies the program in the boot sector and is into memory whenever computer ig turned on. The virus is attached with the executable files i.e. .exe, ,eom an files- When tie user uses these executable files, the Virus attached With these files also activated and theo it infects other files and also destructive commands and destroys data files
* Chemobai Virus : The famous chernobål virus deletes all the Microsoft office files and also the partition information the disk hence causing a rnajor loss Of data,
* bomb; l\*'gic bomb, differ front Other viruses in that tley are set to go off at a certain dateand time. Adisgcuntled programtner, ror a defense contractor created a bomb in a program that was supposed to go off two months aner he left. Designed to crasc in inventory tracking systeuw the bomb was discovered only by eharkc.



1.0'"'

* Trojan horse: the Trojan horse covertly places illegal, destructive instructions in the middle of a legitimate program, such as 8 computer game, Once you run the program, the Trojan horse goes to work, doing its damage while you ate blissfully unaware, An example Trojan horse is

###### Formate

* Redlof virus is polymorphic virus. written in Basic virus relics an the Microsoft ActiveX Cornponent vulnerability execute itself. executed the Virus locates Foldeis.htt and infects that file. the Folder\_htt is part of Microsoft Windows Active Desktop feature, It searches the hard-drive and loeates infectable files and appends itself to (hem-
* Some viruses may make unnoticeable changes hence corrupting the data being I I •ed and some viruses may even make data unusable.



* A virus program detect some spccisl information like passwords, Or any sensitive data and send it to other uscr network. For

example a virus program may read the Pin code or eredit eard number entered hy a user and then send this information 10 another user.

* Another interesting thing Virus do is that it may resources unavailable to the users. For example. a virus after copying Itself on ell computers on a network Start sending data on network so that other users cannot use the 'EX work.

6.1.3 How to safeguard against viruses?

Following are the few ways following which you can save your computers from getting infected by a virus. Never open unknown email messages, and also scan (for virus) all email messages even if you know the sender the message, You should also minimize the data transfer L\*tween computers through the use of floppy disks and other removable media. While using the Internet. do download free. ware programs without first checking it for virus. Always usc a virus detecting software i.e. Norton. McAfee, Dr, Solomon' s, toolkit or IBM's antivirus progranl.s to dctcct and to dcletc the infected programs from your sys(em, You should periodically update programs as more and more viruses are discovered over the time. so older versions of these programs may not detect the new viruses, Another important way save yoursclf from thc dcqcuccion of virus attack is thal you should always keep backup of your data, The back-up be useful if' virus deletes your data or rnOdifies it,



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##### 6.2 DATA SECURITY

The organization Obtaining the data i' responsible for the security Of data and will liable to prosecution for the lapses in the security of data and updating it improperly\_

You use Internet to connect to a network in any part Of the world and sCc any data on that network. Today organizations heavily upon fast con.puter processing and if some enters their network and make it unavailable the working of the entire organizat'on will halv Many organization store data of their custonwrs online for providing fast services, Far example a credit card company may put data of its customers online. A bank providing online services will be using online data storage for the records. A university may provide the facility of viewing results online, People take online exams like GRE, GAT etc. As it is elear from the above examples. some really sensitive data is available online, All these • advances in data manipulation have given birth to a new issue known as Data Security. If some unauthorized user views or obtains this data, the whole organization may suffer irrepairable losses ultimately, 

It is obvious from the above discussion that the security of data is necessary for the existence of many organizations and for kinds of online ser,'iees. Ta understand the process of making the data secure' lei us first see in whal ways data can misused if not secured properly. In recent years€ the computer technology has become available to everybody at a wry cheap eost Also specialized software packages are producing all kinds af solution at a very low price- The result of all the advancement in the technology and its affordability has made it possible to use Computers in all fields of life. For example computers are being used to monitor weather conditions. to monitor defense projecls in controlling sensitive process like contmlling atomic etc, Business people using eolnpu:ers for performing calculation, keeping records of employees. recording of customers transactions and provide them belier services throughout the country or world. Hospitals are keeping patient records, sorted and updated by using different criteria. Schools and universities are keeping all records of students, examinations, accounts. libraries etc on a computer to provide instantaneous acccss of data to administrators and the students. You name any field of life god computers are there to be used, to efficiently process data accordingl y\_

Internet has connected millions of computers and people together and it has made possible the e-commerce, In-conunerce etc, Now you can purchase books, clothes, and al] kinds oi stuff online, by using credit cards. In today's world, online markets are available for all kind of shopping like software. hardware, electronics' medical equipment etc.



C.opyr/gh/

The

In today•s warld many networks are connected together and zre sharing kinds of inforuuation amongst the users, using email. SMS and progrurns for instantaneous communication across the worldL

###### 6.11 Security Violations

Following are some the ways in which the seeuriiy of data may be Vio lated.

* So nvone may break into the computer room and take away all storage devices housing sensitive datu-
* Unauthorized users may take access to personal data of sorrmne and then use it to gain some advantage. For example if someone gets access to your credit card number then he can use it to do online shopping your account.
* An unauthorized user nuy use an Online mail server; like mail.yahoo.eom to view email message of other users hence causing privacy issues.

e Sorneone can send a virus onto a network causing the network to become very Slow Of even unusable.

* Some users may gain unauthor'ized access to bank accounts ard Iransier a large an'RBuOt of 'twney from other accounts 10 his personal account ,
* A person may make a computer go busy by sending many requests eo that computer twcomes iitiavailable to authorized users. This is called denial of service situation,

6.2.2 Security Threats

Following are the main threats Data Security:

* Some authorized Liger of data may unintentionally delete or change sensi:ive data. There are two solutions to this problem. Firstly. the users must be assigned proper rights to 'Pinimize such events, Only the authorized users with certain rights l:nay b: allowed to delete or data after following a step-by-step process. Secondly, periodic backup of data should be taken to recover from this sort of situation.
* Another solution to these types pf problems is thal proper protection should be used to use resource, A log file should also rnaimain.ed to keep track of all the activities on the datalfiles,
* Some strong encryption algorithm should used, so that if sorneone gets access to the data, he she should not he åh]e to make any sense out of it.
* The solution to infected data is that virus scanning software should used to sean all data coming inlo (be organization,
* Computers and all backing storage devices Should he Placed in locked rooms with only authorized access to these resources.
* authoriped users must be asked changc their passwords periodically. Very short and common passwords should be avoided.

6.2.3 Data Protection

As discussed in the teginning of this Chapter, many organizations gathered data about thcir employees customers. Some of this data is needed for (purely) efficiently processing business transactions. For a hospital having data about the discasc history of patients, All the personal data kept by different organizations may by disclosed by the organilation for some legal punnses. For example in 'he hospital the medical researches may use patient personal data. like his medical history, or any other fields to draw some conclusions. Bul if the hospital management distributes that data somewhere else; then this may make the patient feel embarrassment e.g. in case when the patient has sortie mental disorderor has a bad history. The data protection rules refer to such i' niefinS Illat any person21 data kepi by some organization should never be disclosed to unauthorized persons / Organization under any cireunistances-

6.2.4 Privacy Issue

An indiQidual has a right to see the data kept about him. For this, he has the right to submit an application to view dual data any lime.

He also has the right stop tbc processing Of his data by the organizalion. He also has a right to claim a compensation from the organization for uny kind of disclosure of data disallowed by the law.

No worker of the organization allowed to disclose or use the data kept by its organization and if he tails to abide by, be is committing a

It is elear from this discussion that protection tries to minimize the misuse of personal infornwtion to provide safeguard against such crime Also an organjyation collecting data should collect only the data adequate necessary for its working and should not collect Lin. necessary

The following points should be considerd to ensure die individual's privacy.

* The organization is responsible for keeping the data updated
* The organization should keep data for the specified period of time only and can DOI keep it th±n \_nccesary.
* At no point during the processing of data. the rights of the subject Should Ee violated.
* The organization is responsible for all kinds Of security Of data.

#### 63 Data Protection Legislation and Copyright Issues

The data legislation is b:ing improved wid. the time and may include many nujrc laws far the protection of data in future bur the underlying hæs.ic principle (legislation) are same Tor all new laws,

##### 6.3.1 Legislation

The data protection legislation defines laws that ensure data protection. Many countries have defined the data protection legislation and ill some advanced western countries; this law is enforccd properly as well. The data protection legislation of differcni countries is based on -same basic principles. In this seclion, we will discuss these basic principles so you can get soil\* idea of why data protection vac;l is needed. The detailed Data Protection Acts will not IR given il is beyond the Scope Of this course,



The principles of Data Protection Acts are as follows;

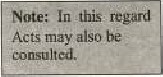
The purpose Of keeping and distrusting personal data must be clearly defined by organization obtaining that data.

The indi\*idual about whoni data is kept, must be inforrned about the identity of the organization / individual, The processing is necessary to fulfill of the contract between two pajties The processing is\_required by law or is necessary to czu-ry out interest of the individual

##### 6.4 Important Privacy Acts

The 1980 Privacy Protection Act.

prohibits agents of federal government from making unannounced, searches of press office if no one there is suspectednf a crime.



which

The 1984 Cable Communications Policy Act, which restricts cable cornpanies'ili the collection and sharing of information about 'heir customers, It was  first piece of legislaiion to regulate the use of information. which is processed on computcr, The Protection Act 1984" IS intended to protect the individual from unauthorized use and disclosure of personal information held Oti a Computer system, It consists or the following eight principles:

The införmation be containcd in  shall be obtained and the data shall be processed, fairly and lawfully,

* Personal data be held only for one or nwre specified and lawful



* Personal data held for any purvose shall not IN used or disclosed in any manner incompatible with that puqx.se or those pupposes.
* Personal data held for any purpose shall adequate. relevant not excessive in relation to that purpose oc those purposes.
* Personal data shall be accurate and. where necessary, kept up to date,

Personal data held for any purpose or purposes shall oot kept for longer than is necessary for that purpose or those purposes i

* An individual shall entitled, at reasonable intervals and without undue delay or expcaSc. to bc by data user whether he holds personal data of which that individual is the subject\* to have access to any such data, and here appropriate, to have such data corrected or erased.
* Appropriate security measures shall be taken against unauthorized access to. orædterutjon, disclosure, accidental loss, Ot destruction of personal data

Securj@; Cop»vighå und Law

The 19M Computer Security Act, which makes aciions that affect the computer s&lirity files and telecommunication illegal.

The 1988 Video Privacy Protection 1988. prevents rciailCTS disclosing a pzson's video renial records wllhour a court order; supporters want the same and AliOthcr step in that direction is the

Matching and Privacy Protection Aet of 1988, •which prcvcnts the gcvernrw.nt from comparing cetain recards Lin an attempt find a match, must comparisons are still unregul ated,

The Computer Misuse Act 1990 to make provision for securing computer material against unauthorized access or modification; and for connected purposes, The Computer Misuse Aci 1990 was passed to deal with the problem of hacking of computer systenw In the early days of the problem wasn't taken very seriously — it was seen as mischievous behaviour, rather than as smrrthing, which could cause serious loss or prohlcnw to cornpanics. organizations and individuals, However, with developments in technology the issue has become more serious and  legislation was introduced to recognize three key offences:

* Unauthorized access to computer material.
* Unauthorized access with intent to commit or facilitate commission of further Offences.
* Unauthorized nwdifieaLion of mputer material.

The 1998 Data Protection Act came into force early in 1999 and covers how information about living identifiable persons is used. It is much broader in scope t]un  earlier act, bul does contain some provision for a transitional E\*riod for compliance new requirements. The 1998 Act applies tot

* computerised personal data ;
* personal data held in structured manual files



It applies to anything at all done to personal data ("proee"ing"), including collection. use, disclosure, destruction and merely holding personal data



### 63 The CopyrightAct

The principal law governing software piracy is the 'Copyright Act 1976", Some anxndnlenls were made in this in 1983 and now software piracy is believed to be a punishable crime involving huge armunts of penalties. It is justified because software is believed to he an '"intellectual property' that has tren developed and brought into market after a lot of effort and cost. So, its future financial intcrcsis must  made sure by the concerned legal authorities.



|  |
| --- |
| -Exercises |

1. Fill in the blanks:
   1. Making illegal copies of copyrighted software is
   2. A special program that can detect and rem:jve viruses from computer is



* 1. Software that is available free for a limited period is

(0) When the virus starts to impact on data, it is known as— IR stands for\_ is a sofiware used for data•ompression (vii) The right to use software on the computer is called

Software is a of person who developed it.

1. se the correct option;

A Virus prOgram is usually hidden in  The operating system only

* + 1. An application program Only
    2. The disk drive
    3. The operating System Of application programs

Most computer crimes arecommitted by

* + 1. Hackers
    2. international spies

(C) Highly trained Computer consultants

(d) Company insiders Who have no extraordinary technical ingenuity

(iii) Types gi software that can freely distributed wilhout violating copyright laws are called

Shareware (b) Public do

(c) Copy protected 

Ci apter 6 Security. Copyright and

Inforrnation is

* + 1. A marketable commodity
    2. Can be Stolen uhile leaving the original d
    3. Should be free, according to the original hacker ethic (d) All of above

 A yirus that replicates itself is called a

(a) Bug (b) worm

(e) Vaccine 

(Vij Another name for free software

(a) Encrypted software Copy protected software

(c) Public dolnain software (d) Shareware

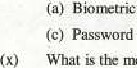
* 1. Another name for anti virus is
     1. Vaccine 

(c) Trojan horse (d) DES

|  |  |  |
| --- | --- | --- |
|  | (a) Internal components  Locks and cables  (c) Software  these |  |
|  | A secret word or numbers to typed io a keyboard Can take place are called | any activity |

* 1. Security protection for personal cornputerS ira•lude

data (b} Data encryption

(d) Private word riicjgt computer crime or these listed below

* + 1. Extortion Of bank funds (b) IRS database sabotage (c) putting people on junk Inailing lists (d) Software piracy

1. Write T for true and F for false staletnenls: (i) Software error can result in data loss
   1. Any person can change password
   2. All viruses activate in exactly the same manner

(ivi A fill backup means that once a week you can perform a complete





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IR stands for intellectual rights

A computer virtjs is part Of hardware

Wii) Passwords, auditöf Checks and separation Of employee functions are protection tcchniques

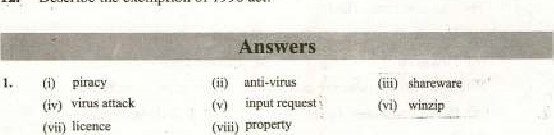
(viii) No one has ever been able to read encrypted messages without key

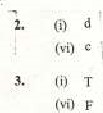
It is legitimate to nuke a copy of software for backup purpose

 The computer fraud and abuse act of 1984 defines software piney as

 What is computer virus?

1. Define the software.
2. How viruses may damage computer system?
3. Define Data protection Piraey Lets.
4. Describe the Legislation and Copyright Issues.
5. Define the types of viruses.
6. What is a password?
7. Write the names and define briefly the antivirus,
8. Describe the exemption of 1990 act,



(viii) d



fix)

(iiij 

(vii) T