INTRODUCTION TO INFORMATION TECHNOLOGY – STAGE-2

SECTION "A" – HARDWARE

Q. 2 (a) BASIC ORGANIZATION OF A COMPUTER SYSTEM:

All computer systems perform the following five basic operations for converting raw input data into useful information and presenting it to a user:

1. **Inputting:**

   Process of entering data and instructions into a computer system.

2. **Storing:**

   Saving data and instructions to make them readily available for initial or additional processing as and when required.

3. **Processing:**

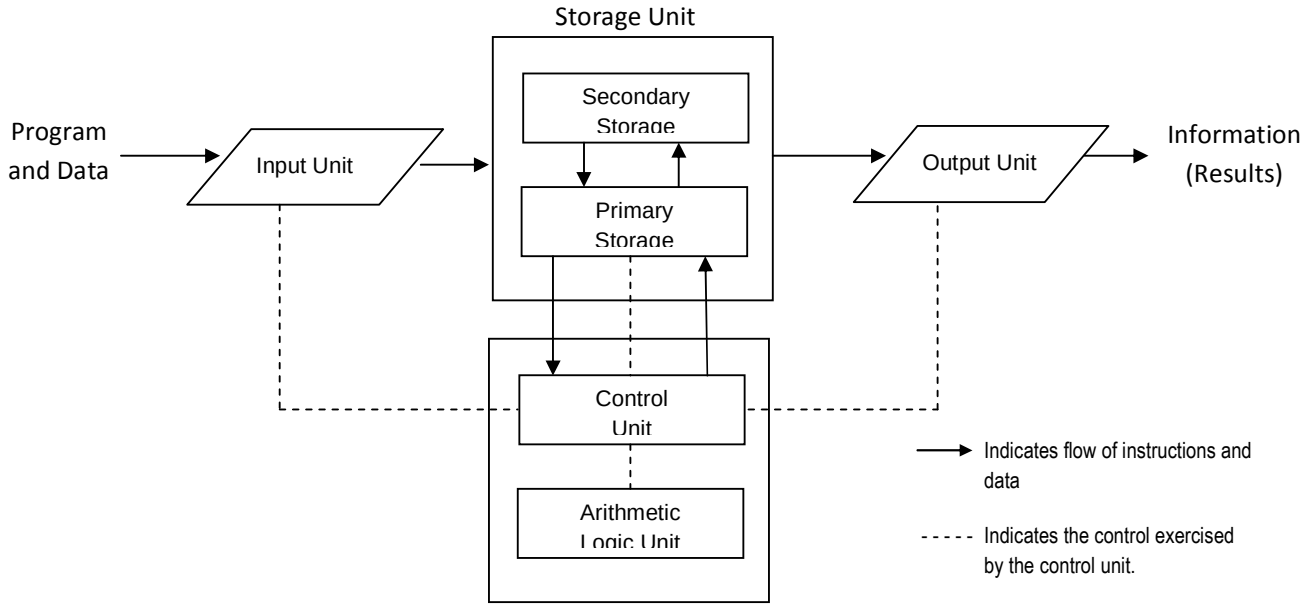
   Performing arithmetic operations (add, subtract, multiply, divide, etc.) or logical operations (comparisons like equal to, less than, greater than, etc.) on data to convert them into useful information.

4. **Outputting:**

   Process of producing useful information or results for a user, such as printed report or visual display.

5. **Controlling:**

   Directing the manner and sequence in which the above operations are performed.



Basic organization of a computer system

Internal architecture of computers differs from one system model to another. However, basic organization remains the same for all computer systems. Figure shows a block diagram of basic computer organization. Solid lines indicate flow of instruction and data, and dotted lines represent control exercised by control unit. It displays the five major building blocks (functional units) of a digital computer system. These five units correspond to the five basic operations performed by all computer systems.

(b) (i) IMPACT AND NON-IMPACT PRINTERS:

Dot-matrix printers are impact printers because they print by hammering the pins on inked ribbon to leave ink impressions on a paper. Hence, they can be used to produce multiple copies by using carbon paper or its equivalent. Due to impact printing, dot-matrix printers are noisy as compared to non-impact printers.

Dot-matrix printers are normally slow with printing speeds ranging from 30 to 600 characters per second. However, they are cheap in terms of both initial cost of operation. Hence, they are preferred by individuals and organizations for generating printed outputs if the speed and quality of printing are not important factors. They are also used for applications requiring multi-copy output such as shipping forms and invoices that rely on impact printing for generating multiple copies.

Inkjet printers are non-impact printers because they print by spraying ink on the paper. Hence, they are quieter in operation. Being of non-impact type, they cannot be used to produce multiple copies of a document in a single printing.

A color inkjet printer usually comes with two ink cartridges – black and tri-color. The tri-color cartridge contains red, blue, and yellow colors in a package that can mix appropriate amount of these colors with black from the other cartridge to get any desired color with saturation. This makes it possible to get multi-colored and photo-quality output from inkjet printers.

Inkjet printers are slower than dot-matrix printers are with printing speeds ranging from 40 to 300 characters per second. Typically, an inkjet printer is more expensive than a dot-matrix printer. They are preferred if speed of printing is not an important factor.

Drum printers are impact printers because they print by hammering on a paper and inked ribbon against the characters embossed on the drum.

(ii) STORAGE UNIT:

Data and instructions entered into a computer system through input units have to be stored inside the computer before actual processing starts. In short, a storage unit holds (stores):

1. Data and instructions required for processing (received from input devices).
2. Intermediate results of processing.
3. Results for output, before they are released to an output device.

Storage unit of all computers is comprised of following two types of storage:

Primary Storage:

Primary storage of a computer, also known as its main memory, is used to hold pieces of program instructions and data, intermediate results of processing, and recently

produced results of those job(s) on which the computer is currently working. Primary storage can hold information only while computer system is on. As soon as the computer system switches off or resets, the information held in primary storage is erased. Moreover, primary storage normally has limited storage capacity because it is very expensive. Primary storage of modern computer systems is made of semiconductor devices.

Secondary Storage:

Secondary storage of a computer, also known as its auxiliary storage, is used to take care of the limitations of primary storage. Secondary storage is much cheaper than primary storage and it can retain information even when a computer system switches off or resets. Secondary storage holds the program instructions, data, and information of those jobs on which the computer system is currently not working but needs to hold them for processing later. Magnetic disk is the most commonly used secondary storage medium.

Q. 3 (a) ADVANTAGES AND DISADVANTAGES OF CISC AND RISC PROCESSORS:

CISC Processors:

CPUs with large instruction set, variable-length instructions, and a variety of addressing modes are said to employ CISC (Complex Instruction Set Computer) architecture. Since CISC processors possess so many processing features, they make the job of machine language programmers easier. However, they are complex and expensive to produce. Most personal computers of today use CISC processors.

RISC Processors:

In early 1980s some CPU designers realized that many instructions supported by a CISC-based CPU are rarely used. While working on simpler CPU design, the designers also came up with the idea of making all the instructions of uniform length so that the decoding and execution of all instructions becomes simple and fast. These design ideas resulted in producing faster and less expensive processors. CPUs with a small instruction set, fixed-length instructions and reduced references to memory to retrieve operands are said to employ RISC (Reduced Instruction Set Computer) architecture. Since RISC processors have a small instruction set, they place extra demand on programmers who must consider how to implement complex computations by combining simple instructions. However, RISC processors are faster for most applications, less complex, and less expensive to produce than CISC processors because of simpler design.

(b) CACHE MEMORY:

Use of main memory helps in minimizing disk-processor speed mismatch to a large extent because the rate of data fetching by a computer's CPU from its main memory is about 100 times faster than that from a high-speed secondary storage like disk. The overall performance of a processor can be improved greatly by minimizing the memory-processor speed mismatch. Cache memory (pronounced "cash" memory) is commonly used for this purpose. Its an extremely fast, small memory between CPU and main memory whose access time is closer to the processing speed of CPU. It acts as a high-speed buffer between CPU and main memory and is used to temporarily store very active data and instructions during processing. Since cache memory is faster than main memory, processing speed is improved by making the data and instructions needed for current processing available in the cache.

(c) (I) ADVANTAGES AND LIMITATION OF OPTICAL DISKS:

Advantages:

1. Cost-per-bit of storage for optical disks is very low because of their low cost and high storage density. Additional cost benefit comes from the fact that some optical disks can be erased and reused many times.
2. Use of a single spiral track makes optical disks an ideal storage medium for reading large blocks of sequential data such as audio or video.
3. Optical disk drives do not have any mechanical read/write head to rub against or crash into the disk surface. This makes optical disks more reliable storage medium than magnetic tapes or magnetic disks.
4. Optical disks have data storage life in excess of 30 years. This makes them better storage medium for data archiving as compared to magnetic disks.
5. Since data once stored on CD-ROM/WROM disks becomes permanent, the danger of stored data getting inadvertently erased/ overwritten is not there.
6. Due to their compact size and lightweight, optical disks are easy to handle, store, and port from one place to another.
7. Audio CDs can be played on a computer systems to be also used as music systems, whenever desired.
8. A computer having a DVD drive can be used to play DVDs allowing it to be used for watching videos such as movies.

Limitations:

1. CD-ROM and WORM disks are read-only (permanent) storage medium. Data once recorded, cannot be erased. Hence, they cannot be reused.
2. Data access speed for optical disks is slower than magnetic disks.

3. Optical disks require more complicated drive mechanism than magnetic disks due to the need to have laser generating source and detection lens that require precision engineering and careful handling.
4. Since optical disk is a removable media, it is prone to scratches, dust, sticky prints (including fingerprints), etc. while handling. Hence, they need careful handling.
5. When used for off-line storage, they should be labeled properly for easy identification.

(ii) DISK ARRAY:

A disk array is a set of hard disks, hard disk drives, and a controller mounted in a single box. All the disks of a disk array form a single large storage unit. A disk array is commonly known as a RAID (Redundant Array of Inexpensive Disks). The term inexpensive comes from the fact that each of the medium-sized hard disks in the disk array is much less expensive than a single large hard disk.

Although RAID systems were originally developed to provide large secondary storage capacity with enhanced performance, today they are also popular due to enhanced reliability. Enhanced reliability is achieved in RAID units by taking advantage of the presence of multiple disks.

(iii) ELECTRONIC PEN:

It is a pen-based point-and-draw device. A user holds the pen in his/her hand and points with it directly on the screen to select from the displayed menu items or icons. A user can also draw graphics directly on the screen with it. Another type of electronic pen comes with a special pad. The pen is used on the pad as an ink pen would be used on paper. Movement of electronic pen causes the graphical cursor on screen to move. Applying pressure on tip causes same action as left button-click and keeping the tip pressed for a short duration causes same action as right button-click of a mouse. Some electronic pens have a button on the side that is pressed to cause same action as right button-click of a mouse.

(iv) FLASH MEMORY:

EEPROM is also known as flash memory because of the ease with which programs stored in it can be altered. Flash memory is used in many new I/O and storage devices like USB (Universal Serial Bus) pen drive and MP3 music player.

SECTION "B" – SOFTWARE

Q. 4 (a) ADVANTAGES AND DISADVANTAGES OF CREATING CUSTOMIZED SOFTWARE IN-HOUSE:

If none of the available pre-written software packages meet the specific requirements of a user (an organization or an individual), it become necessary for the user to create a customized software package. If the user has an in-house software development team, the software package can be created in-house. However, if such a team does not exist in-house, the user must get it created by another organization by placing an order for it.

Following are the advantages and limitations of ordering a customized software package rather than developing it in-house:

1. The user need not maintain its own software development tea. Maintaining and managing such a team is expensive, and may not be justified for an organization not needing to develop software on a regular basis.
2. It is easier to carry out changes in the software, if an in-house team develops it. For ordered customized software, the user needs to depend always on the vendor for carrying out the changes, and the vendor may charge separately for every request for change.

Following are the advantages and limitations of developing a customized software package in-house rather than getting it developed by an outside party:

1. It is easier to carry out changes in the software, if it is developed in-house.
2. Developing software in-house means a major commitment of time, money, and resources because an in-house software development team needs to be maintained and managed.

(b) CHARACTERISTICS OF A GOOD PROGRAMMING LANGUAGE:

There are some popular high-level languages, while there are others that could not become so popular in-spite of being very powerful. There might be many reasons for the success of a language but one obvious reason is its characteristics. Several characteristics believed to be important for making a programming language good are:

1. **Simplicity:**

   A good programming language must be simple and easy to learn and use. It should provide a programmer with a clear, simple, and unified set of concepts that can be grasped easily. The overall simplicity of a programming language strongly affects the readability of the programs written in that language, and programs that are easier to read and understand are easier to maintain. It is also easy to develop and implement a compiler or an interpreter for a simple programming language. However, the power needed for the language should not be sacrificed for simplicity. For example, BASIC is liked by many programmers because of its simplicity.

2. Naturalness:

A good language should be natural for the application area for which it is designed. That is, it should provide appropriate operators, data structure, control structures, and a natural syntax to facilitate programmers to code their problems easily and efficiently. FORTAN and COBOL are good examples of languages possessing high degree of naturalness in scientific and business application areas, respectively.

3. Abstraction:

Abstraction means the ability to define and then use complicated structures or operations in ways that allow many of the details to be ignored. The degree of abstraction allowed by a programming language directly affects its ease of programming. For example, object-oriented languages support high degree of abstraction. Hence, writing programs in object-oriented languages is much easier. Object-oriented languages also support reusability of program segments due to this feature.

4. Efficiency:

Programs written in a good programming language are translated into machine code efficiently, are executed efficiently, and acquire relatively less space in memory. That is, a good programming language is supposed with a good language translator (a compiler or an interpreter) that gives due consideration to space and time efficiency.

5. Structured Programming Support:

A good programming language should have necessary features to allow programmers to write their programs based on the concepts of structured programming. This property greatly affects the ease with which a program may be written, tested, and maintained. Moreover, it forces a programmer to look at a problem in a logical way so that fewer errors are created while writing a program for the problem.

6. Compactness:

In a good programming language, programmers should be able to express the intended operations concisely without loosing readability. Programmers generally do not like a verbose language because they need to write too much. Many programmers dislike COBOL because it is verbose in nature (lacks compactness).

7. Locality:

A good programming language should be such that while writing a program, a programmer need not jump around visually as the text of the program is prepared. This allows the programmer to concentrate almost solely on the part of the program around the statement currently being worked with. COBOL and to some extent C and Pascal lack locality because data definitions are separated from processing statements, perhaps by many pages of code, or have to appear before any processing statement in the function/procedure.

8. Extensibility:

A good programming language should also allow extension through simple, natural, and elegant mechanism. Almost all languages provide subprogram definition mechanism for this purpose, but some languages are weak in this aspect.

9. Suitability to its Environment:

Depending upon the type of application for which a programming language has been designed, the language must also be made suitable to its environment. For example, a language designed for real-time applications must be interactive in nature. On the other hand, languages used for data processing jobs like payroll, stores accounting, etc., may be designed to be operative in batch mode.

(c) DIFFERENCE BETWEEN SYNTAX ERRORS AND LOGIC ERRORS IN A COMPUTER PROGRAM:

Generally, the following two types of errors occur in a computer program:

1. Syntax Errors:

Syntax error occur when the rules or syntax of a programming language are not followed. Such program errors typically involve incorrect punctuation, incorrect word sequence, undefined terms, or misuse of terms. For example, the FORTAN statement C = (A + B/2 has a syntax error; the missing closing parenthesis that should be placed in the appropriate place depending on the logic of the program. A program cannot be successfully compiled and executed until all its syntax errors have been corrected.

2. Logic Errors:

Logic errors occur when we make errors in planning the program's logic or while converting the logic into program code. They cause the program to produce incorrect result or behave unexpectedly. A program free of syntax errors but having one or more logic errors will be successfully compiled and executed but will not produce correct result or will not behave as expected. For example, if a FORTAN instruction should be 'A = B + C' but has been coded as 'A = B – C', it is an example of a logic error because the result produced by the program will not be correct. Similarly, if one has wrongly entered 999999 (only six 9s) instead of 9999999 (seven 9s) as the sentinel value for *Rollno* in the instruction for detecting the end of last record, the program will expect more records even after the last record.

Q. 5 (a) DIFFERENCE BETWEEN SOURCE PROGRAM AND OBJECT PROGRAM:

Object Program:

A fully compiled or assembled program that is ready to be loaded into the computer. It results from translation of a source program by a language processor.

Source Program:

A program written in a symbolic or high-level language such as assembly language, COBOL, BASIC, etc.

(b) DIFFERENTIATE BETWEEN COMPILERS AND INTERPRETERS:

Compiler:

A computer can execute only machine language programs directly. Hence, a high-level language program must be converted (translated) into its equivalent machine language program before it can be executed on a computer. This translation is done with the help of a translator program called compiler. Hence, a compiler is a translator program (much more sophisticated than an assembler is) that translates a high-level language program into its equivalent machine language program. A compiler is so called because it compiles a set of machine language instructions for every program instruction of a high-level language.

A compiler can translate only those source programs that have been written in the language for which the compiler is meant. For example, a FORTARAN compiler can only translate source programs written in FORTRAN.

Interpreter:

Interpreter is another type of translator used to translate a high-level language program into its equivalent machine language program. It takes one statement of the high-level language program, translates it into machine language instructions, and then executes the resulting machine language instruction immediately. That is, in case of an interpreter, the translation and execution processes alternate for each statement encountered in the high level language program. This differs from a compiler that merely translate the entire source program into an object program, and is not involved in its execution. The input to an interpreter is a source program, but unlike compiler, its output is the result of program execution instead of an object program.

After compilation of a source program, the resulting object program is saved permanently for future use, and is used every time the program is to be executed.

ADVANTAGES COMPILERS HAVE OVER INTERPRETERS:

The main disadvantage of interpreters over compilers is that they are slower than compilers when running a finished program. This is because each statement is translated every time it is executed from the source program. In case of a compiler, each statement is translated only once and saved in the object program. The saved object program can be executed many times whenever need, and no translation of any statement is required during the execution of the program. As the interpreter does not produce an object program, it must perform the translation process each time a program is executed.

SECTION "C" – NETWORK & SECURITY

Q. 6 (a) (i) ASYNCHRONOUS AND SYNCHRONOUS MODES OF DATA TRANSMISSION:

Asynchronous Transmission:

In asynchronous transmission, data is transmitted character by character at irregular intervals. That is, a sender sends a character at any convenient time and receiver accepts it. For instance, transmission of data from a terminal to a computer is asynchronous because during data entry by an operator, time between successive keystrokes varies.

Asynchronous transmission is well suited to many input devices. Its advantage is that it does not require any local storage at sender or receiver end, because transmission takes place character by character. Hence, it is cheaper to implement. However, if line cost is high, underutilization of line becomes a matter of concern because transmission line is idle during time intervals between transmission of any two characters.

Synchronous Transmission:

In synchronous transmission, a group of characters is blocked in same way as records are blocked on magnetic tape. A header and trailer are then added to each block to convert it into a frame. The header contains synchronization information used by the receiving device to set its clock in synchronism with sender end clock. It also contains information to identify the sender and receiver. The header is followed by a block of characters containing actual message to be transmitted.

Primary advantage of synchronous transmission is its efficiency. It has much higher data transmission rates than asynchronous transmission, because it eliminates need for individual start-up bits for each character. Its main disadvantage, however, is need for local buffer storage at both sender and receiver ends to assemble blocks, and need for accurately synchronized clocks at both ends. Hence, synchronous equipments usually cost more.

(ii) MODULATION AND DEMODULATION:

Digital and Analog Data Transmission:

When data is propagated by means of electrical signals, the signals may be in either digital or analog form. An analog signal is a power range that varies continuously. Amplitude of an analog signal is measured in volts and its frequency in hertz. Higher the frequency, the more number of times it crossed the time axis. On the other hand, a digital signal is a sequence of voltage pulses represented in binary form.

Computer generated data is digital, whereas telephone lines used for data communication in computer networks usually carry analog signals. When digital data has to be transmitted on an analog facility, they must be converted to analog form first. Modulation is the technique of converting a digital signal to its analog form, and demodulation is the reverse process of converting an analog signal to its digital form.

Analog versus Digital Transmission:

When analog signals are transmitted over long distances, they become weak and distorted as they travel. Hence, amplifiers are used at periodic intervals along analog communication lines between modems to amplify (strengthen) weak analog signals.

Today, signals are also transmitted in digital mode. In this case, modems are not

needed. When digital signals are transmitted over long distances, repeaters are used at periodic intervals along digital communication lines to strengthen weak digital signals.

Digital transmission of digital data is preferred to analog transmission of digital data due to following reasons:

1. Lower cost
2. No modems required
3. Higher transmission speeds possible
4. Lower error rate (higher reliability)

FORMS OF MODULATION:

There are three forms of modulation:

- Amplitude modulation;
- Frequency modulation;
- Phase modulation.

(b) (i) COMMUNICATION PROTOCOLS:

A *protocol* is a set of formal operating rules, procedures, or conventions that govern a given process. A *communication* or *network protocol,* therefore, describes rules that govern transmission of data over communication networks. These rules provide a method for orderly and efficient exchange of data between sender and receiver, and for proper interpretation of controls and data transmitted as raw bits and bytes. These rules are embedded in data communication software.

Some of the functions performed by these protocols are: • Data sequencing • Data routing • Data formatting • Flow control • Error control • Precedence and order of transmission • Connection establishment and termination • Data security and • Long information.

(ii) (a) MODEM:

A special device called *modem* (**mo**dulator/**dem**odulator) is used to carry out the process of modulation and demodulation (conversion of digital data to analog form and vice-versa). Hence, when an analog facility is used for data communication between two digital devices (say two computers interconnected by a telephone line), two modems are required, one near each device.

When you want to use a modem with your computer to allow it to communicate with any other computer via telephone line, following factors should be considered:

1. **Transmission speed:** Higher the modem's transmission speed, the better it is because it can communicate faster. Transmission speeds of earlier modems were 300, 1200, or 2400 bps. Modems available now can operate at 9600, 14400, or 28800 bps.
2. **Internal versus external:** Modems are of two kinds, internal and external. An internal modem is an optimal add-on circuit board that plugs into one of computer's expansion slots. It gets its power from computer's expansion bus. It is manufactured and supplied by computer manufacturers. An external modem, on the other hand, is a separate box containing circuiting and logic to module data signals. It has its own power supply, on/off switch, and front-panel LCDs to indicate

its status. For this reason, external modems are slightly more expensive. An external modem is connected to a computer via serial port.

3. **Facsimile facility:** Some modems, known as FAX modems, are capable of emulating of a FAX machine in addition to performing functions of a regular modem. A computer equipped with a FAX modem can send/receive text and images as a FAX to/from a remote FAX machine, or another computer equipped with a FAX modem. FAX modems can be of external or internal type.

(b) WIRELESS NETWORKS:

One of the most challenging and interesting recent trends is integration of computing equipment and devices by using wireless communication technologies. Resulting networks, known as *wireless computing systems,* enhance functionality of computing equipment by freeing communication from constraints of wired computing systems.

Types of Wireless Computing Systems:

Wireless computing systems are classified broadly into two categories:

1. **Fixed wireless systems:** These wireless computing systems support little or no mobility of their computing equipment. For example, a LAN can be set up using wireless technology to get rid of hassles of cables. The LAN will work as a conventional wired LAN except for the difference that it does not need any cabling and the communication bandwidth may be much lower.
2. **Mobile wireless systems:** These wireless computing systems support mobility of computing equipment used to access resources of wireless network. In turn, these systems support mobility of users and allow mobile users to access information from anywhere and at anytime. Resulting computing environment is often called *mobile computing* or *nomadic computing.* It no longer requires a user to maintain a fixed position in network, and enables almost unrestricted user mobility. Computing equipment used commonly in mobile wireless systems include smart phones, personal digital assistants (PDAs), and pagers with Internet access.

(c) THE OSI MODEL:

Initial computer networks had their set of standards and conventions that were hardware dependent. Each manufacturer used to develop its own communication protocols for its networks. Hence, data communication protocols of one network were not compatible with any other network. Moreover, standards of same network architecture also kept changing from time to time.

International Organization for Standardization (ISO) recognized this problem and established a subcommittee to develop an international standard for network architectures. Result of this subcommittee's recommendations was the *Open System International* (OSI) model that is a framework for defining standards for linking heterogeneous computers in a packet switched network. Hence, standardized OSI protocols made it possible for any two heterogeneous computer systems, located anywhere in the world, to communicate easily with each other. The OSI model is also designed in a highly structured way.

THE END