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BBA BANKING

THIRD YEAR

PAPER – XII : BANKING TECHNOLOGY

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BBA BANKING

THIRD YEAR

PAPER – XII : BANKING TECHNOLOGY

(Core Subject)

UNIT - I

Technology in Banking – Need – Benefits – Issues involved in technology – orientation of banks.

UNIT - II

Computer technology in banks: What is a computer? Brief history of computers of early computers – Generations of computers – Uses of computers.

UNIT - III

Hardware: Anatomy of computer – CPU – Main memory- Peripheral controllers – Peripherals.

UNIT - IV

Software : Need for software – What is software? Types of software – Systems software – Operating systems – Language translators – Programming languages.

UNIT - V

Technology based products in banking – ATMs – Home Banking MICR cheques Electronic Funds Transfer (EFTs) – Internet Banking – Real Time Gross Settlement (RTGS) – Security considerations.

BOOKS RECOMMENDED

- Bajwa K.S. - Bank Mechanisation, Skylark publications.
- Srivatsava - Computer applications in Banks, BTC, RBI.
- Sanjay Soni and Vinayak aggarwal - Computers and banking sultan cohand & Sons.

UNIT – I

INTRODUCTION TO INFORMATION TECHNOLOGY

The term *Information Technology* often used in a broader sense to include Information systems as well as Information Technology. However, Information Technology is mainly a synthesis of developments in the field of computer science and the developments in telecommunication technology.

The developments in the telecommunication technology in the first-half of twentieth century led to installation of worldwide telephone systems, radio and television networks and later development of satellite-based telecommunication. The continuous research and development efforts in telecommunication made communication more efficient, reliable, cost effective and also increased the coverage as the technology matured.

The developments in computer technology started in second half of the twentieth century with limited use of computer for data processing. The rapid developments in all technologies making up different components of the computers led to unprecedented growth in computer industry. This development led to mass scale spread of powerful computing resources at a very affordable price to the users and trend in use of computers shifted from users approaching central computers for data processing to computers moving to the users desk for all activities like word processing and note preparing, data processing, data analysis, trend and pattern analysis as well as scenario building.

The Information technology is a logical development arising out of confluence of these two technologies which has narrowed down the differences between collecting, storing and processing information and transporting the information elsewhere thereby driving the geographical distances to irrelevance. The key components of IT include:

1. Computer hardware including CPU, memory chips, storage disks, device drivers and peripheral devices such as VDUs, Printers, multimedia devices, communication controllers etc.
2. Operating Systems such as DOS, UNIX and WINDOWS which act as an interface between the application programmes and computer hardware.
3. Software Packages and Development tools which are used for developing applications to store and process data. Various database systems, relational databases, front end tools, programming languages are some of the examples of this type.

4. Networking systems which enable computers at different locations to communicate with each other for file transfers, job processing and resource sharing. These include networks operating with in a limited area to networks which spread across the world
5. Telecommunication systems such as analogue and digital networks, satellite networks which provide media for data transmission and networking for cooperative processing of data and resource sharing.

The information technology is a term used to indicate developments in the field of computers and the telecommunication. It covers development in computer hardware, operating systems, software packages, networking and telecommunication. As IT can used to speed up the human thinking process by data storage, analysis and communicating the ideas based on the analysis. It has an impact on almost all organs of society as well as the individual. It has changed the physical production using process controllers, robotics as well as mental production like engineering designs. IT has played a key role in the defence services, government and social services, education and research, trade and travel services, etc. It has also influenced the management of organisation with its ability to store, process and present data for managerial decision-making, control and follow up. The national and world economics have benefited by use of IT by improved production at reduced cost and better utilisation of resources due to which individuals in the society are also benefited. However, use of IT have led to the problems of privacy as the information is collected and stored without any valid reason to store such information, possible misuse of data and problems arising out of integrity of the stored information. At the same time, introduction of IT has also created new vulnerabilities like unauthorised access to sensitive data, malacious attack on information assets, sophisticated computer crimes, etc. These threats require new ways to secure the information and new legislation relating to protection of information assets, transacting over IT services and protection of individual privacy.

The Information and Information technology are two separate but interrelated assets of an organisation and has an important role in strategic planning of the organisation. It is therefore necessary to understand the relationship between socio-economic conditions, the characteristics of technology to abstract capability of organisation into tradable goods and services. The IT can be used to improve the productivity and performance, change organisation of functions, gain competitive advantage or develop new business. The Information system planning need to take into account different aspects to prepare plan for business development using IT applications.

The IT is playing an important role in the international business with its ability to increase the interaction among different people around the world, spreading information about goods, services and technology available in different parts of the world which can be traded for mutuaL benefits. It has also helped in global investment from capital surplus countries to capital deflict countries by providing very essential IT support for global financial services like banks, insurance, stock exchanges which helps in promotion of global business.

The current trend in IT indicates continued thrust of overall improvement in hardware, operating systems and user interface software, application software, database technologies, networking and telecommunication. However, now the thrust of IT development is more on development) expert systems and Artificial intelligence which can emulate human thinking process and help taking decisions. The future developments in IT are more likely to be guided by social sciences as the IT would increasingly be used for solving organisational and social issues.

TECHNOLOGY IN BANKING

Banking industry provides financial services to the customers such as acceptance of deposits, giving loans, providing facilities for transfer of funds, giving financial guarantees, providing foreign exchange facilities, etc. All these services are basically information processing services with cash operations forming the only physical process again based on information processing. The currency notes or cash itself is a banking service in the form of promissory notes issued by the central banking authorities. The advent of Information technology has changed the way in which the data is processed. Therefore, almost all services provided by the banks including the concept of money or credit are influenced by the information technology thereby opening new opportunities as well as posing new threats before the banking industry. We shall attempt understanding this impact from basic functions of banking to the concept of money and monetary policies of central bank.

IMPACT ON TRANSACTION PROCESSING IN THE BANK

As handling volume of transactions was the first priority for the development of information technology was useful as well as other banking transactions taken up by banks on their own to improve their profitability. The IT was first therefore used for transaction processing which required a lot of manual records of transactions to be kept, cheques to be processed, interest to be calculated and funds to be transferred. The first stage of computerisation involved transaction processing the maintaining accurate accounts of all the transactions. The first IT applications in banking therefore, were ledger posting

machines to post the transactions. The clearing of cheques issued by bank customers for the settlement is another transaction intensive operation in Banking, traditionally, it was done by manual sorting and exchanging of cheques among the banks. The automation of this work was another priority application of IT in banking sector. The introduction of MICR (magnetic Ink Character recognition) cheque clearing for cheque sorting and settlement was introduced in 1950s. The MICR cheque processing was done for clearning house operations and involved computers, magnetic encoders as well as electromechanical reader sorters.

These applications were offline or batch mode processing of transactions wherein the transactions were entered after they were done at the counter. The phase started in 1950 and has since continued with banks increasingly resorting to dataware housing to store their data and even cross border processing of their transactions to reduce the cost.

RETAIL BANKING & ONLINE BANKING SERVICE

After the banks were successful in using IT for transaction processing and accounting, the focus shifted from improving customer services to its retail customers for their cash transactions. The focus was on instantaneous processing of transactions, giving quick credit and quick delivery of customers funds using online computer systems. These systems also improved the speed of transaction processing and built essential banking controls and checks in the computer systems.

There were four generations of online systems as under:

a) 1965 -1970: The focus during this time was online balance checking and updation of the balances with tellers at the counter accessing centralised computers.

b) 1970 -1980: During this phase, the banks have developed applications for online specialised transactions like foreign exchange and stock market transactions. This was also the time when Distributed Data Processing was introduced with data residing at different computers at different locations so that customer could access their funds even from different locations.

c) 1980-1990: During this phase, automation was done at the branch level with local processing and the banks had thousands of online terminals. The transactions were also stored in data centres having Distributed Databases and these databases were interconnected to each other using communication lines. The computer networks connected both local and long distances spread computers in the banks. Decision support systems were also developed during this period.

d) 1990 onwards: During this current phase, the banks have developed networks which spread across the globe and also have provided computer based access to bank's customers for their transactions. During this period, the banks have developed expert systems for quicker decision-making and IT has become a strategic consideration in the planning process.

The retail banking segment comprising all types of depositors and borrowers of the bank was targeted for better service in terms of quicker cash delivery or transfer of funds, faster sanctions of credit lines, improved reporting to customers for their transactions and accounting balances, etc.

The IT applications in clearing houses have made it possible to execute bulk payments of corporates like interest or dividend payments. In developed countries, regular government payments such as pension or social security benefits are made through clearing houses without a need for any paper instruments. This service known as 'credit clearing', credits the accounts of banks which in turn credit to their customers. At the same time, routine collection services like electricity bills, telephone bills could be executed through debit clearing service.

The banks in turn could reduce the cost of transaction processing for their retail banking due to automation of routine and tedious activities like cheque handling & clearing, execution of standing instructions. The speedy processing of customers' details and transactions as well as appraisal of credit needs led to quicker credit sanctions. Further, the banks could also improve the supervision of their loan assets by analysing the transactions in their customers account with the help of computers.

SELF ASSESSMENT – QUESTIONS

Questions

01. What is information technology?
02. Key components of IT _____, _____, _____.
03. What is SWIFT

Answers

01. Computer based information system
02. Computer hardware, operating system, software packages, networking systems
03. Society for world wide internet bank financial telecommunication.

IMPACT OF IT ON FUND TRANSFER AND SETTLEMENT MECHANISM

Handling customers' receipts and payments are important services provided by banks. However, the transfer or receipt of funds for banks customers involves intense data processing and record keeping. There were many innovations in this area which have brought revolutionary changes in the settlement mechanism by introduction of Electronic Fund Transfer (EFT) in the banking industry. The developments in this regard can be traced to two distinct phases.

First Phase of EFT 1969 to 1984: During this period, the banks introduced Automatic Teller Machines (ATM) which were linked to banks' central computers overleased line or telephone line. The ATMs identify the customer using magnetic coding on the cards supplied to the customer and the password in the form of Personal Identification Number (PIN) keyed in by the customer, check the balance in his account, dispense cash and update customers balance. There are other services rendered on ATM's apart from cash dispensing. The ATMs quickly became popular as customers could access their funds at their convenience and banks could recover their cost of opening branches to service their customers.

The introduction of credit and debit cards by banks began the era of plastic money where banks release the payment on behalf of their customers who would in turn pay the banks. The use of credit cards became widespread in USA and Europe. Although, initially the credit cards were not linked to computer systems, gradually the cards were provided with hardware elements like magnetic strips and memory chips for identification to the bank's computer systems whereas credit card check the validity of card and allows credit to its customer for settling the retail transactions, debit cards actually debit customers' account for value of transaction at the time of transaction. Another variation of cards is charged cards or smart cards which are magnetised or charged against payment and the payment is made through transfer of magnetic fields from one card to other card or machine.

During this period, the banks also developed private and cooperative interbank networks for secured financial messaging such as Chemlink of Chemical bank .The cooperative society of European and American banks namely the Society for Worldwide Interbank Financial Telecommunication (SWIFT) was formed in 1973 for developing a secured and reliable network for financial messages. The network was made operational in 1976. The banks in United States of America (USA) formed an automatic clearing house called Clearing House Interbank Payment System (CHIPS) in 1970. The Federal

Reserve Bank of New York established a electronic settlement system called Fedwire for funds and securities settlement for the banks maintaining account with Fed Reserve during this phase, the U.S. Federal Reserve Bank established a electronic settlement system called fedwire for funds and securities settlement for institutions maintaining account with Federal Reserve Bank.

EFT I11985 Onwards: During this current phase, the banks have introduced new services like Electronic Fund Transfer at Point Of Sale (EFT/POS), Electronic Fund Transfer through Automated Teller Machine across the border, Electronic Data Interchange between different locations using pre-decided data formats, etc. New initiatives like magnetic smart cards which can be used to settle transactions by transferring magnetic cash data from one card to other card just like cash payment are also introduced in this phase. The advent of internet banking nas introduced new retail payment instruments like e-cash, digi-cash, etc. These initiatives are still in their initial stages.

The second stage of SWIFT network was introduced in 1990 and many other private networks for trade settlement, securities transactions, funds transfer, etc. were also developed for banking industry. The CHAPS network (Clearing House Automated Payment System) in UK was developed onlines of CHIPS in USA. Bank's sponsored Automated Clearing Houses (ACH) have become common in U.S. and the European countries.

A phenomenal growth in foreign exchange transactions and investment operations which pose serious risks to the settlement systems all over the world. The central banks of the different countries have taken up networking projects for netting transactions for net settlement as well as having a Real Time Gross Settlement Systems (RTGS) wherein transactions would be settled as soon as they are effected. The development of RTGS payment systems and Delivery Versus Payment (DVP) systems using Electronic Payment Network are considered as most essential item of agenda before the central banks with a view to control settlement risk arising out of explosive growth in domestic as well as cross border transactions in money market, foreign exchange and securities markets.

Impact of using IT in ATMs, credit cards, smart cards, EFTPOS, global ATM service have reduced the need for physical cash for the banks customers thereby attempting to ushering an era of cashless, anytime society.The innovations in retail payments are continued by the banking industry and also by non bank intermediaries like IT companies.

WHOLESALE BANKING

The IT enabled quick distribution of information on any issue of interest to the bankers. This meant that the banks could gather information about the

short-term and long-term funds available with them at branches and various other offices. The high value transactions at the corporate level among the different financial institutions is known as wholesale banking which is characterised by low volume but high value of funds transacted, ever changing nature of market and involvement of only the corporate participants like other banks, securities houses, financial institutions in the transactions. There are variety of instruments traded in wholesale banking. These institutional transactions and their settlement are also referred to as financial markets.

Timely decision-making and speedy settlement of transactions of these transactions is the basic infrastructure needed for the development of financial markets IT, by its very nature, provides for all these requirements. The versatility of IT solutions used for these operations decide the competitive edge of the bank in these operations. Further, as these are always high value transactions, the profitability of banks is decided by success or failure of banks in conduction these operations. Some of the applications are discussed below:

a) Maintenance of statutory reserves: As a statutory requirement, banks are required to maintain certain part of their deposits in approved securities and certain part as cash with themselves and central banks. The banks need to take action well in time so that they do not keep excess funds idle in cash form or invest in low yielding investments to meet statutory obligations. The speedy and accurate information on deposits, advances and cash positions is different branches of banks is needed for taking such decisions for which Information Technology is used.

b) Money market operations: The improved cash management makes it possible for banks to invest or disinvest excess funds in short-term money market instruments like interbank deposits, treasury bills, overnight deposits, commercial papers, bills of exchange, etc., alternatively, banks can also borrow from other banks on a short-term basis to meet its liquidity requirements. Such operations need intense IT support for collection of data and analysis as well as for communication. As the market started growing, more instruments and sophisticated IT applications with better communication facilities are developed and continuously improved upon.

c) Investment operations: Besides investing in the government securities for statutory reserves directly, the banks can also invest their funds in other securities as a part of their investments. There is also a secondary market in government and other securities wherein banks can purchase and sale securities as per their fund position. These investments are basically long-term in nature and prices are subject to various parameters like interest rate movement, liquidity in the market, maturity period of the securities, risk

perceptions about the securities, etc. The investment officers in banks need quick, reliable information of prices, yields and impact of changes in interest rates on securities for speedy decision making. A lot of hybrid instruments in securities like 'Repos', 'Reverse Repos', 'Securities Lending' are developed which required intense IT infrastructure for analysis and simulation, trading, confirmation of trades and settlement through clearing house and depositories. This service is provided by specialised IT products marketed by vendors who provide online news, rate movements, past data and also analytical tools.

EXTERNAL TRANSACTIONS OF THE BANKS

The international trade in commodities needs a different type of banking service wherein the banks purchase foreign currencies from the exporters for national currency and sale foreign currency to importers against national currency. The transactions known as foreign exchange transactions are characterised by its unique settlement system of correspondent banking in which the settlement is done in the respective countries by exchanging financial messages| with correspondent banks in those countries. The exchange rate between two currencies is decided by numerous social, economic, political factors in these countries as well as other countries, perceptions of the market as well as actions of market players. Thus, the exchange rates are continuously changing. This creates arbitrage opportunities for trading in foreign currencies. The banks, therefore, need very versatile IT solutions giving upto second information on exchange rates, economic indicators, political events, past data on various factors an ability to analyse the trends so as to take very fast decisions. At the same time, banks need! applications which can allow instantaneous communication for trading and confirmation Specialised agencies like Reuters provide these IT solutions which involve satellite communication very reliable software applications.

Similarly, the differences in interest rates and scope for economic development in different countries have created global investment opportunities for the global investors. The; transactions are similar to local investments discussed earlier but complex due to cross settlement of funds, complex legal transfer procedures and safe custody services required securities settlement. IT solutions are needed for collecting information, analysing trend contracting deals and settlement. Again, specialised services like Knight Bidder, Telerate and Bloomberg provide these IT solutions which are very complex involving satellite communication and versatile software packages.

The huge in foregin exchange and cross border investment transactions have pase serious problem for settlement and risk in settlement. The volume and value-of transactions done all over the world for exceed the liquidity

available in the clearing systems in the world and geogrpahical and legal factors further add to the systemic risk for settlement. This problem requires development of IT solutions like netting service, Real Time settlement. Delivery versus payment versus payment, linked settlement etc.

IMPACT ON HUMAN RESOURCES, PRODUCTIVITY & SUPERVISION

The growing use of IT in banking has altered the job content of the employees at all levels in the bank. The routine jobs of transaction processing have been increasingly automated thereby the capability to process transactions has been enhanced. The time can be used more effectively for improved customer service, follow up and devising strategies for individual customer. At the same time, the employees now require to acquire new skills in handling IT applications and computers, change their work procedures and get ready for a new situation. The use of IT has added new category of employees for various applications of IT such as IT planning and management, database administration, system designing, application development, quality assurance and system testing, system audit, network administration, computer operations, etc. This would alter the employee profile in the banks. There is need to develop human resources to have new skills and work as Knowledge Workers.

The ease with which the transactions can be handled and funds can be transferred have necessitated new regulations and security measures which need to be interned by employees so as to safeguard their interests as well as interest of their banks. The banks are increasingly threatened by the risk of misuse of technology. The bank managements are required to adopt new techniques to manage their assets and control the various risks using new risk control techniques for banking security in the computerised environment. There is increasing need for audit functions to be organised through the computer and also auditing the computer applications themselves. This in itself has created new challenge for the banking community as well as regulating authorities.

ORGANISATIONAL EFFECTIVENESS AND NEW INNOVATIONS

As IT has enabled improvement in the efficiency of bank operations, it has transformed the functioning of the banks and made them more effective.

The networking of computers have relegated the geographical distances to the background and the concept of branch banking itself has undergone a change. The customers can have access to their funds anytime and anywhere across the world. As discussed earlier, banks can provide better services for fund transfer and collection service using online services, EFT solutions and clearing services. At the same time, IT has also enabled banks to incorporate many control features on their operations such as financial limits, watching

compliance to operational guidelines, exception handling and auditing, giving statement of accounts to the customers, etc. Thus, the role of IT has changed from assisting banks for transaction processing to become a strategic infrastructure around which services of the bank could be organised. The IT has enabled the banks to concentrate on their innovation process with transaction processing taken care of.

i) Better Customer-Services: The banks can now analyse the pattern of transactions of any individual customer and analyse individual's savings pattern or credit requirements. This customer information service has led to a shift in the customer service from macrobanking wherein banks promoted schemes for their customers to join to microbanking where banks designed products to suit individual customers needs. The banks could develop new services like investment counselling and portfolio management for their customer. The banks could also undertake new activities like handling stock market transactions of their customer, arranging risk covers for their customer in the form of forward transactions, swaps, futures and options, etc. New products were developed for the customers using the IT skills acquired by the banks.

ii) Improved Management Information: The ready availability of management information improved the decision-making at the top management leading to improved risk management of their assets as well as matching of the assets and liabilities of the banks (Asset or Liability Management). The use of analytical tools and number crunching ability of computers enables the management in building different' What if...?' scenarios, analysing different trends and patterns and take more studied decisions. The present trend is towards introduction of 'expert systems' to areas like credit sanction, planning and investment decisions. The use of 'Artificial Neural Network' for pattern recognition and learning through experience is also increasing among bankers for wide ranging activities like identifying the sickness of the borrower accounts, fraud detection, audit of anamolous transactions, portfolio analysis, etc.

iii) Improved Regulatory Compliance: The task of reporting to the regulatory authorities like central banks, deposits insurance corporations, government authorities, etc. has been made more simple and effective as a result of adoption of IT thereby improving compliance to reulations and resultant effectiveness of the organisation. Off site monitoring through network is being adopted by the regulating authorities in different parts of the world using IT solutions.

iv) Innovative Products: The banks have diversified their activities in other areas like insurance, mutual funds, factoring services, credit rating,

housing finance, etc. Use of IT has therefore made banks as more proactive by anticipating the problems and potentials and tuning their services to their customers requirements.

BENEFITS

The impact of IT on cost of operations and revenue generation can be discussed as under:

- The simplification of work procedures and automation of data processing enabled banks to increase their operations without additional cost towards transaction processing and manpower. This enabled banks to expand their business with available infrastructure thereby reducing the cost.
- The developments in telecommunication reduced the cost of communication and improved management of funds there by increasing the revenue.
- As the cost of operations is reduced and revenue generation ability of the banks has increased, the customers of the banks are benefitted as the banks could reduce the spread between funds raised from its depositors and funds lent to its borrowers.
- The introduction of IT, enabled value added services issuing letters of credit, financial guarantees to the customers, portfolio management, custodial services and risk control services to the customers increased the revenue of the banks through non-fund activities.
- Increased the revenue of the banks from sources other than lending.The improvement in profitability of banks help banks to share it with depositors in form of better rates on deposits and with borrowers as reduced rate of interest on advances. Also, with the additional revenue at its disposal, banks could invest more in information technology and develop new value added products to their customers.
- In the process, the cost of introducing IT products has become major source of capital expenditure (around forty percent in USA and Europe). The cost of maintaining the IT services has become major item of revenue expenditure (about 16 per cent of total cost). The personnel and hardware depreciation forms major part of the cost to the bank. In view of this, the banks are under pressure not only to stay in competition with other banks but develop additional innovative services to maintain profitability of banks.

SELF ASSESSMENT – QUESTIONS

Questions

04. _____enables two independent computers to get connected to each other.
05. transmission media are broadly classified as _____ or_____
06. Cable based transmission media in clude_____,_____,_____

Answer

04. Computer network
05. Cable based (or) wireless communication
06. Coaxial cable, UTP X STP cables and fibre optics

IMPACT OF IT ON INDIAN BANKS

However, the impact of IT on banking discussed above was mainly observed in developed countries. Various measures were taken to introduce information technology in Indian banks although the pace of development was not the same as that in developed countries. The Developments in Indian context are reviewed hereafter.

The technology adoption in Indian banks was a process which stemmed out of recommendations of three committees formed by the Reserve Bank of India. The first two committees in 1983 and 988 respectively were formed under the chairmanship of Dr. Rangarajan, the then Deputy Governor of the RBI. The third committee was formed in 1994 under the chairmanship of Shri Saraf, Executive Director of RBI. In the meantime, the issue of technology adoption in banks was also examined in detail by the High-powered committee set up by the Government of India in 1992 and 1997 on restructing of banking industry in India under the chairmanship of Dr. Narsimham. Besides these main committees, there were other committees set up to examine introduction of cross border payment network in India (1989) and examine legal aspects of Electronic Funds Transfer. The recommendation of Narsimham committee on restructuring of banking sector (1998) were further reviewed for implementation by RBI committee on Technology Issues (1999) under the chairmanship of Dr. Vasudevan, the then Executive Director of RBI.

The process of technology absorbtion by Indian banks had been slowing down gradually. Although, the scale of IT adoption is still not at par with the

international level, a beginning has now been made. The another positive feature had been the attitudinal change among the bank employees, management and public from reluctance to use computers considering IT as not only desirable but as essential for the banking. The entry of new private sector banks and foreign banks who have a technological edge over older banks have given as impetus who have a technological edge over older banks have given an impetus to the momentum due to the competitive forces.

The progress of technology adoption in Indian Banks is reviewed as under:

FIRST RANGARAJAN COMMITTEE

It was set up in 1983'to:

a) Identify functional areas for computerisation in banks.

b) Recommend appropriate equipments. Recommend proper infrastructure.

c) Draw phased programme of implementation.

d) Suggest methods to exchange data on computerised media.

e) Suggest standardised procedures and have common processing arrangements.

The committees recommendations were to be implemented between 1984-1989.

The committee recommended installation of standalone Advanced Ledger Posting Machines (ALPM) with limited memory and limited role in the urban branches and suggested microprocessor based computers with processing capabilities at the regional and zonal offices. It suggested installation of mainframe computers at the head office of the banks.

Among other things, the committee suggested computerisation of clearing house operations at all RBI centres and National Clearing Cells at four metropolitan centres using MICR cheques, mainframe computers and reader sorter machines. CMC was involved for providing software packages for certain areas in the zonal, regional and head offices of the banks. The negotiations were held with employees trade unions to introduce mechanisation in phased manner. The networking solutions like 'Banknet' were considered for implementation.

1983 onwards, banks started using ALPMs on a standalone mode. Most of these ALPMs were personal computers without hard-disks and stored data on floppies. Problems of data corruption or data loss, infrastructural limitations and lack of standardised software the desired level of mechanisation could not be achieved in this phase. In 1987, the banks started using personal computers which had hard-disk storage capacity so that accounting data for longer period

could be stored on the PCs. There was increased awareness among the bankers regarding cost benefit of using computers and security of data. Computer PlanninGg and Purchase Departments (CPPDs) were established in the banks.

During this period Magnetic Ink Character recognition (MICR) cheques were introduced at four metro centres to automate Clearing house operations at RBI. Separate National Clearing house operations at RBI were computerised and National Clearing Cells were established. The communication network within Banks called 'Banknet' was developed and introduced by CMC during this period.

The phase of introduction of IT had a limited impact on Indian Banking. However, during this phase, the need for automation was realized and accepted by all although such acceptance was limited.

SECOND RANGARAJAN COMMITTEE

The committee was constituted in 1988 to prepare perspective plan for computerisation in banks during 1990-94. The tasks before the committee were to suggest ways to shift from dedicated standalone systems to online real time systems, to improve customer service, housekeeping, decision-making and thereby improve productivity & profitability of the banks.

The committee identified 30 business centres with 51 per cent banking business and suggested total computerisation of around 2500 bank branches having over 750 voucher per day, installation of a mini computer at all zonal and regional offices and installation of mainframe computers at the head offices of the banks. Data communication, Electronic Fund transfer and execution of standing instructions were identified for computerisation.

The branch computerisation was to be done in two phases as branches with over 1500 vouchers and branches between 750-1500 vouchers per day and three models were suggested as under:

a) Use of Super micro, mini or super mini computers in branches with online terminals and link to 'Banknet' through Public Data Network.

b) Use of Local Area Network with central server and personal computers with a link to 'Banknet' Network,

c) Use of central computer in a city with branch terminals through dedicated lines as well as fall back lines.

As regards, regional, zonal and head offices, the committee recommended installations of mainframes in five years time with provision for connectivity to Banknet, SWIFT etc.

Banknet and SWIFT were identified for providing national level and international level connectivity. Similarly promotion of Cash dispensers and

Automated teller machines was recommended on a trial basis. The committee also suggested providing online terminals for corporate customers, promotion of all bank credit cards, customer identification cards, office automation using computers and bilingualisation of software. Training needs were identified and|g promotion of institutions catering to training needs in IT was recommended.

In 1989-90, banks experimented with the concept of Total Branch Computerisation (TBC) covering all aspects of bank's transactions at the branch level. The computers were viewed as a useful tool in the banking. Some banks started imparting training to its officers for acquiring computer-related skills. The need for full-fledged computerisation of all banking operations was recognised by all the banks and banks started taking steps towards computerisation of their branches, zonal offices, regional offices and central offices.

The SWIFT network was introduced in December, 1991 for all international transactions of the banks. However, the experiment with 'Banknet'was not very successful due to various reasons.

This phase like earlier phase had a limited success although total branch computerisation was, introduced by some banks. The employees of the banks as well as the management were more appreciative of the need for computerisation. During this phase, the financial restructuring and banking reforms were introduced in India and many new private sector banks as well as foreign banks made their entry in the Indian Banking sector. The new banks started with the proper infrastructure in IT and thereby had an advantage over existing Indian Banks in terms of productivity. During this period, the Indian Banking industry witnessed a major financial scam in securities transactions wherein there was a large scale diversion funds. This incident exposed the weakness of the payment and settlement systems and the urgency of upgrading banking technology was widely accepted.

SARAF COMMITTEE ON TECHNOLOGY ISSUES

The third committee on technology issues in banking was constituted in 1994 and its recommendations are under implementation. The task before the committee were to:

a) review remittance facilities to the bank customers
b) propose screen based trading for government securities
c) review procedures for reporting government transactions & currency chest transactions
d) review clearing house systems, SWIFT and BANKNET

e) suggest reporting system between banks and RBI.

The main recommendations of the committee were:

a) introduction of an electronic network for interbank payments (EFT)
b) enactment of legislation for EFT and Data protection
c) introduction of DVP system in RBI for securities transactions
d) use of NICNET for government and chest transactions
e) extension of MICR clearing and intercity collection of cheques
f) establishment of VSAT network for interbank payments
g) setting an institution for research and development in Banking technology and training.

The recommendation were recommended by RBI in different phases. The MICR clearing was extended to all major banking centres and criterion for adopting MICR clearing as soon as the cheque volume reaches a there should limit was set up. The Electronic Clearing Service for bulk corporate payments like dividend and interest payment as well as utility payments like telephone bills and electricity bills was introduced. RBI offered Electronic Funds Transfer through NCC at select metro centres and pending legislation, bilateral contracts were suggested as legal measure. Delivery Versus Payment in its simple form was introduced at RBI. An Institute for Development and Research satellite based Banking network for payments.

This phase covered introduction of new services. Although, many of the new services like ECS, EFT, were introduced, their utilisation by banks and their customers continued to be lukewarm. The NICNET based reporting system for Government and currency chest transactions could not achieve desired level of success.

Despite concerted efforts by RBI, the IT impact on Indian banks had not been very significant till 1995. Most of the efforts towards computerisation were directed efforts of the committee on technological issues rather than bank's own planning process. However, the restructuring of banking and entry of new banks with IT infrastructure to being with has accelerated process of technology adoption by all Indian Banks. Almost all the banks prepared their own action plan for inducting IT. The Indian software industry started developing this time and many Indian software vendors developed banking software packages. Some banks have also established their own networks using satellite channels for data collection and funds transfer. Another important development, related to development of Indian telecommunication industry which improved necessary infrastructure for networking to a large extent.

FURTHER DEVELOPMENTS

Shere Committee on Legal issues on Electronic Funds Transfer

The RBI had set up another committee under the chairmanship of Smt. Shere, Principal Legal Adviser, Reserve Bank of India, to examine the legal aspects of 'Electronic Funds Transfer' suggested by the Saraf Committee. The committee considered that the legislation may followed the banking practices and to begin with, the Electronic Fund Transfer may be done through bilateral agreements under Indian Contract Act.

The Committee also examined different Legal Acts proposed draft amendments to these Acts which could be taken up by the parliament. The Indian parliament has enacted IT Act in 2000 which have legalised digital and electronic records.

Second Narsimham Committee on Banking Sector Restructing

The Government of Indian had set up a high powered committee in 1991 under the chairmanship of Dr. Narsimham, Ex-Governor of RBlto recommend steps to be taken up for restructuring the Indian banking sector. After the implementation of these recommendations, a second committee was appointed in 1997 under the chairmanship of Dr. Narsimham again to suggest further course of action. The committee has identified introduction of Information Technology & Nationwide Payment System wing electronic Networks as two pillars of modern banking. The committee analysed the needs of an customers in rural and urban areas as well as needs for retail, as well as wholesale banking and set a vision for national payment ststem the recommendations of the committee pertaining to technology issues in banks are as follows:

1. The banks may take up 'Process reenineering' alongwith introduction of Information Technology in Banks.
2. The Banks may use Dataware house & data mining techniques, promote credit information bureaus for sharing credit information.
3. The banks in Indian may speed up introduction of inter branch networks (India net) which would link with the Inter bank network. Banks may prepare their own technology upgradation plans.
4. The IDRBT Hyderabad may be entrusted with the responsibility to introduce nation-wise payment network wing satellite and terrestrial telecommunication among Indian Banks.
5. Reserve Bank of India should introduce Real Time Gross Settlement System for instantaneous transfer of funds among bank.

6. The RBI and IDRBT may identify the roles and responsibilities of different participants. They may also examine and adopt different security standards, as well as for smart cards. RBI should encourage setting. Automated Clearing Houses (ACH) by banks.

The recommendations of high powered committee gave direction to the up-gradation of the information technology in the banking sector.

Vasudevan Committee on Technology Up-gradation in the Banking Sector (1999)

The committee was set up under the chairmanship of Dr. Vasudevan, Executive Director of RBI to suggest ways to implement above recommendations.

The committee examined and gave commendations on following aspects:

- Legislative Framework for electronic banking.
- Outsourcing of services & technology by banks
- Strategy for intrabank/intracity networking
- Computerisation of Government Transactions
- Data warehousing and MIS for banking sector.

The committee has suggested architecture for the Indian Financial Network (INFINET) based on satellite transmission as well as intercity terrestrial leased lines with Transmission Control Protocol/Internet Protocol (TCP/IP) protocol for communication. It has suggested that the network itself should be closed user group of banks for which Institute for Development and Research in Banking Technology would frame the rules. The *Network would have it hub at* Hyderabad where every member bank would have its Bank Level Server. Other important recommendations of the committee are:

- Security standards for cryptography for encryption of messages over the network and standards for card-based operations were identified so that multi-vendoe products can work harmoniously were identified.
- Guidelines for outsourcing the application development based on vendor's standing, past experience ability to provide support at different locations and ensuring integration of products developed by different vendors were formulated. The committee also suggested that the terms and conditions should be properly specified, source code and documentation's to be obtained, and involvement of all stake holders to be ensure development process.
- Other recommendations of the committee cover computerisation of Government transations, development of Data Warehousing, Data

Mining & Management Inform System, Re-engineering of processes, development of Human resources and shari experiences.

The recommendations of Vasudevan Committee relate to processes rather than products thus provide a framework for further development.

CVC directives on Computerisation in Banks

Concerned with growing incidence of vigilance cases, on 27th November 1998, the Central Vigilance Commissioner (CVC) issued directives tot he banks on following lines.

1. The Banks must compulsorily offer Electronic Cleamace Services to their custom
2. Banks must computerise at least 70% of their business before January 2001.
3. Data Encryption standards may be followed to ensure proper security.
4. All cases of willful default in banks should be reported to RBI and their information should be made available over wide Area Network.
5. The CVC directives have provided legal and administrative impetus for technology up-grad in banks.

Developments in Payment System

The RBI has taken steps to implement Network payment system in the country by taking following steps.

1. National Payment Council Comprising top Bank officials, RBI officials and IDRBT is condtituted to direct efforts in this regard.
2. Inter-disciplinary Payment Systems group is constituted within RBI to study developer and review the progress.
3. Structure Financial Messages have been developed for all possible banking application which are adopted from Internationally accepoted SWIFT message standards,
4. The Interbank applications for funds management, securities settlement, real gross settlement, etc., are taken up for development and deployment.

Future directions of developments in Indian Banks

- The Indian Parliament has enacted ' IT Act 2000' which have legalised maintenance computerised records and acceptance of digital signature using Public Key infracture (PKI). A central certification authority to oversee the use of digital signature has been appointed. Thus legal obstacle in Induction of IT in Indian banks is overcome.

- ❖ The Reserve Bank has taken up the introduction of Real Time Gross Settlement system for inter-bank payments which is expected to be introduced in two years. Negotiated dealing screen (NDS) and securities settlement system would be introduced by RBI in recent future. Many other services would be provided using INFINET network. This would call for developing new software systems and work procedures, training people and organizing the services around this network.
- ❖ The commercial banks and led by statebank of india have taken lead to introduce securities instruments. This corporation for government securities and other debt instruments. This corporation would used also take up interbank cleaning for money market and foreing exchange transactions. This would call for information systems which can be integrated with these systems.

A computer network enables two independent computers to get connected to each other, submit jobs, move data files and share resources. The computer network allows sharing of hardware and software resources, distribute workload and exchange ideas, improves availability and reliability of the system and provides an excellent medium of communication. The computer networks can cover a limited area or connect computers at far away locations. The computers can communicate through a central server or directly get connected to each other as in peer to peer network or can have both types of connections. The computers networks are composed of host computers and communication subnet. Communication subnet comprises switching devices and communication channels. The network communication can be either point-to-point as in case of two computers or broadcast communication for all the computers in a network. Point-to-point communication is called connection-oriented service whereas broadcast communication is called connectionless service.

The network communication could be either analogue communication suitable for audio and video signals or digital communication suitable to computer to computer communication. Digital communication comprises streams of electrical pulses known as bits, bytes and packets and is more effective than analogue communication. Data communication from computer can be either parallel or serial. In a parallel communication, data is transferred in stream of eight bits or a byte whereas serial communication transmits one bit at a time. The serial communication can be asynchronous transmitting each byte separated by start and stop bit whereas synchronous communication transmits group of characters separated by a control character. As analogue

signals are more suitable for transmission due to lesser attenuation and ability of multiplexing many signals together, the digital communication are sent by modulating the analogue signal. Amplitude, frequency and phase modulation as per input signal are three methods used for modulating carrier analogue signals to carry digital signals. The process of demodulation separates digital signal modulated on analogue signals. This process of modulation and demodulation is done by the modems. The data transmission can be done over normal telephone lines, leased lines using modems but if the lines are designed for digital communication modems are not necessary.

The data communication can be done using copper, glass or air as the medium. Different transmission media are broadly classified as cable-based or wireless communication. The cable-based transmission media include coaxial cable, UTP & STP cables and Fibre optics. The coaxial cable or UTP cables use copper as medium and transmit electrical pulses whereas fibre optic cable uses glass as medium and transmits signal as light pulses. The wireless transmission includes radio frequency transmission, terrestrial microwave or satellite microwave transmission or infrared transmission. The choice of the transmission media depend on the purpose, cost, bandwidth requirements, node capacity of the medium, attenuation, electrico-1 magnetic interference suffered in the medium and the security needs.

The network interface card provides necessary service of establishing physical link between the network and the application software by providing level of abstraction. The network interface card receives data through the motherboard, converts it into data frames of data having addresses of transmitting and receiving cards, data unit, checksum of the data and transmits over the network .The network cards are connected as an external device and require its own interrupt, upper memory area and port. In case of computers using PCI bus this allocation is done by the computer but for other bus it is required to be done by the user. The selection of network card depends on the networking technology, transmission medium used and the type of bus used in the computer.

STRATEGIC ISSUES INVOLVED IN ADOPTION OF INFORMATION TECHNOLOGY

As already discussed, the Information Technology has a deep impact on all the economic and social activities in the society and has been widely accepted as an important variable in its strategic planning for attaining the organisational goals. Both the information and information technology, have a role to play in the attainment of organisational goals as can be illustrated *below:*

a) Information Technology provides us abilities to process and transmits data very efficiently. This feature enables us to automate the data dependent tasks involving structured decisions and the related physical processes. For example, in an ATM operation, the teller machines can be programmed to dispense the cash if the card holder is found to be a genuine customer of the bank having adequate balance in his account and also update the balances of the customer. This improves the productivity of the bank in relation to customer service and relieves the time of bank employees for more qualitative work.

b) The information on the other hand allows the organisations to improve the performance by better control and coordinated decision-making. The information also provides capability to provide or sell value added services. For example, in case of the bank in question above, bank's ability to organise data from various sources and derive information on the present and future financial position of the companies enables the bank to provide financial consultancy to its customer regarding the his or her portfolio investment. This can be marketed as a new and Value Added Service to original service of maintaining the account of customer and making payment as the customer wants.

The synthesis of these two capabilities therefore opens new opportunities and an array of new means and ends. To illustrate, the corporate strategy of gaining competitive advantage in the market can be supported by technological applications developed by the organisation. At the same time, technological applications can be developed so as to gain strategic advantage. Thus the strategic plans and information technology gets aligned to each other with one reinforcing the other.

ISSUES IN ADOPTING IT IN STRATEGIC PLANNING

Very often, business strategy is determined first and this strategy defines the use of technology in achieving the business objectives. The role of technology itself on strategic planning often tends to get ignored and the issue of managing the technology to gain competitive advantage or attainment relating of corporate goals is not taken into consideration. Some of the important issues relating to adoption technology are as under:

a) There is a relationship between the technology and socio-economic conditions in which the strategy is formulated and this relationship needs to be identified.

b) The characteristics of the technology and the innovative activity need to be identified before selecting the technology and deciding the implementation strategy.

c) Ways of incorporating technological issues in strategic planning need to identified before deciding organisational strategy.

d) The effects of adoption of technology on capabilities of organisation and how to translate this improvement in capabilities into competitive advantage need to be assessed at the time of strategic planning.

Thus analysis of technological changes is necessary for formulating strategic goals and this analysis should be made use to identify:

a) Ways in which changes in technology can affect strategic decisions

b) The innovation process which can transform abstract capabilities into tradeable goods and services using technology

c) Attitudinal shift necessary in the organisational thinking process so that the technology is| adopted as an instrument of development process by all the members of the organisation.

STRATEGIC APPLICATION OF IT IN ORGANISATION

The first step in strategic planning is to define the nature of business clearly in the current context. The role of research and development is determined by the level of competition in the industry in which the organisation competes. The organisation may adopt a defensive strategy or offensive strategy depending on its relative position at the time of formulating the strategy.

a) Defensive Strategy: The organisation may for instance focus on maintaining the marketability of its existing products and services; improve its organisation process) reduce cost and increase operating efficiency. This strategy might be adopted when the organisation is facing difficult situation and struggling to maintain its market position.

b) Proactive Strategy: If the organisation has already safeguarded its position in the current level of competition and is comfortable with its existing position, it may adopt a proactive strategy to market new products, to gain competitive advantage or even diversify its activities.

The IT can be applied strategically in four different ways to as under to:

i. improve productivity and performance

ii. facilitate new ways of managing and organizing

iii. gain competitive advantage

iv. develop new business

The role of IT would therefore depend on organisations strategic decisions and these decisions can be taken after the analysis of technological changes as discussed above.

While deciding strategic role for IT, it is necessary to distinguish between the roles of Information and Information Technology as these two are separate resources with their own capabilities. The capabilities of information are more abstract and also strategically more important in nature.

BUSINESS STRATEGY AND INFORMATION STRATEGY PARADIGM

As the information is an important resource supported by information technology, the management of information systems becomes an important management function and consists of three important components as:

a) Information Technology (IT) which provides capability of organising the information efficiently.

b) Information System (IS) which decides the essential attributes of the information sought to be organised using the information technology.

c) Information Management (IM) which decides the process of organising the data and information, controls the access to the information of the organisation and decides the usage of the information for business strategy.

The Information Strategy Planning involves all these three aspects and plans for usage of the information in best possible manner. IT being the strategic resource of the organisation, there is a very close association between IT and the business strategy of the organisation as discussed under:

1. The information strategy may be based on the business strategy alongwith Information system strategy The information strategy may be based on the business strategy or the available IT infrastructure may position the organisation to diversify or integrate into another sector. For example, the bank with strong IT infrastructure may position itself into insurance sector, merchant banking or in custodial services. Business strategy cannot be complete without Information system strategy.
2. Information Strategy Planning (ISP) should be an integral and important part of the organisations business strategy plan so that the organisation may exploit their IT to meet the competition in their market place and gain competitive advantage.
3. The planning for information system is a strategic exercise which evaluates present information system, identifies its weakness and strengths, identifies the threats to existing systems and looks forward to the opportunities from the IT. The resource allocation to IT and information system can be decided only after such an exercise.

4. The process of Information Strategy Planning can be initiated by the practitioners of IT but it must involve the top management since they are involved in business strategy plans and are also responsible for ongoing actions. The commitment as well as steering of action plans for IT development by the top management is key to the success of information strategy plans of the organisation.

SELF ASSESSMENT – QUESTIONS

Questions

07. What is TPS?
08. MIS means _____
09. What is EFT pos?

Answers

07. Transaction processing system
08. Management information system
09. Electronic funds transfer at point of sale.

Important questions

Section – A

01. What is information technology?
02. What is management information system?
03. What is transaction processing system?
04. What is information strategy planning?
05. What is expert systems?

Section - B

06. Briefly explain about the need of IT in banking.
07. Explain about the benefits of IT in banking.
08. Write short notes about the key components of IT.

Section - c

09. Explain about IT impact on banking
10. Bring out strategic issues involved in adoption of IT.

NOTES

UNIT – II

COMPUTER TECHNOLOGY IN BANKS

Financial services such as banking, insurance, merchant banking, share market operations, _ funds transfer, custodial services, etc., have become intensely technology dependent. In banks, the Information Technology has moved from being peripheral for processing transactions to the core of banking functions. This makes it imperative to all participants to absorb technology.

Further, the institutions with superior IT infrastructure have an advantage over those which do noth ave this infrastructure the risk of losing to competition.

The introduction of IT have also made the banking vulnerable to attacks by unscrupulous elements thereby requiring improved risk control and vigilance mechanism. The technology risk is therefore an additional risk factor required to be managed by bank management.

The introduction of network banking, automated clearing houses, electronic payment systems like Real time Gross settlement, Netting as well as electronic trade settlement services like delivery Versus Payment, payment versus payment have introduced new dimension of procedural and legal changes in the financial system. The bank management would have to incorporate these changes in their working.

FINANCIAL SERVICES

The financial services sector such as Banking, Insurance, leasing companies, mortgage companies, investment consultancy, stock exchanges, share registry and custodial services like depositories process large volume of data. These services have got a big boost with the advent of Information Technology.

- The banking and insurance companies use the IT to keep track of their customers transactions and appraise the credit worthiness of their customers, their financial needs, and for organising their business.
- Stock markets use IT for online trading with the help of computer-based terminals connected to trading serves, and arriving at the settlement.
- Depositories and custodial services maintain computerised records of shares and securities held by them on behalf of their customers so as to enable speedy settlement.
- The organisations like Reuters, Telerate, Knight rider and Bloom Berg have effectively utilised IT for providing the online data on current development in the financial sectors thereby providing basic infrastructure for investments.

- The impact of IT on financial services has been most significant in payment services in the wholesale and retail segment. The developments aided by IT in retail customer payments includes introduction of Automated Teller Machines (ATM). Magnetic ink character Recognition (MICR) cheques Credit cards, Debit cards, Electronic Funds Transfer at Point of Sale (EFTPOS), Smart cards, digital cash e-money and other modes environment. These developments have helped emrgence of Cashless, Anytime society' wherein transactions can take place for all the twenty four hours of the day. The developments in Wholesale segment have enable instant and online transfer of funds through Real Time Gross Settlement (RTGS), Delivery Versus Payment (DVP) and Payment Versus Payment (PVP) mechanism. These developments have minimised the risks in payment system.
- The development of Information infrastructure couple with ability to instant transacting and speedly and secure settlement aided by developments in payment system have led to emergence of wide financial markets which have global coverage. The emergence of global financial markets has led to integration of global financial services and globalisation of national economies.)

WHAT IS A COMPUTER?

Computer is the most powerful tool man has ever created. Computers have made a great impact on our every day life. Their presence is felt at almost every working place viz. homes, schools, colleges, offices, industries, hospitals, banks, retail stores, railways, research and design organizations and so on. Computers, large and small, are used nowadays by all kinds of people for a variety of tasks in a modem and industrialized society

A computer is basically a programmable computing machine.! Earlier computers were used for complex computations and used by only scientists and engineers. The trend was to design large and powerful computers to handle large data and solve complex problems.

They were very costly and hence only large organizations could afford them. The technological breakthrough in design and fabrication of semiconductor devices had made now possible to manufacture powerful microcomputers which are within the reach of small organizations and even individuals. These computers being very fast can be used not only for computation but also to store and retrieve information, to control certain processes and machines, to measure and display certain physical and electrical quantities and so forth) Developments in software allow massive application of computers

for non-computational jobs like text preparation, manipulation, storage and retrieval; transmission of texts, graphics and pictures from one place to another and artificial intelligence and expert systems, for example, robots, and so forth.

DIGITAL AND ANALOG COMPUTERS

Computers which are in use today are digital computers. They manipulate numbers. They operate on binary digits 0 and 1. They understand information composed of only Os and Is. In the case of alphabetic information, the alphabets are coded in binary digits. A binary digit is called *bit.* A group of 8 bits is called a *byte.* They do not operate on analog quantities directly}' If any analog quantity is to be processed, they must be converted into digital quantity before processing. The output of a computer is also digital. If analog output is needed, the digital output has to be converted into analog quantity. If output is to be displayed in the form of text, the digital output is converted to alphabets. The components which convert alphanumeric characters to binary format and binary output to alphanumeric characters are the essential parts of a digital computer. But the electronic components which convert analog quantity to digital quantity or digital quantity to analog quantity are connected to a digital computer as a peripheral where needed. Processing of analog quantity is usually encountered in industrial control and instrumentation, not in general purpose computation, text manipulation or information storage, retrieval or transmission.

The computer which can process analog quantities is called an *analog computer.* Today, analog computers are rarely used. Earlier, analog computers were used to simulate certain systems. They were used to solve differential equations.

HISTORY OF EARLY COMPUTERS

Electronic computers using valves appeared in 1940s. The successful general purpose mechanical computers were developed in 1930s. Before 1930 mechanical calculators were built for automatic addition, subtraction, multiplication and division. A calculator is not a programmable device. Calculations are performed using step by step technique. The user does not prepare program for his calculation. A computer is a programmable machine. A program is to be prepared to solve a problem.

The Mechanical Era

The first mechanical calculator was developed in 1623 by Wilhelm Schickhard, a professor at the University of Tubingen. His machine did not become populaqA popular mechanical calculator was developed in 1642 by the great French philosopher and scientist Blaisc Pascal. His machine was capable of performing addition and subtraction automatically.) For this the machine

employed counter wheels. There were two sets of six dials or counter wheels to represent decimal numbers. The calculator contained a mechanism for automatic transfer of carry while performing the sum of two numbers. The numbers were represented by the positions of the counter wheels. Around 1671 Pascal's machine was extended to perform multiplication and division automatically by German philosopher and scientist Gottfried Leibniz) This machine consisted of two parts: one part to perform addition and subtraction and the other part to perform multiplication and division. The part which performed addition and subtraction was similar to the calculating box of Pascal. It further included two additional sets of wheels to represent multiplier and multiplicand. Chains and pulleys were used to implement multiplication.

In 1823, Charles Babbage tried to build a mechanical computing machine capable of performing automatic multistep calculations. He named his machine a difference engine; This was designed to compute tables of functions such as logarithms and trigonometric functions. A polynomial was used to represent a function. The method of finite differences was used to evaluate a function. He could not complete the machine. Swede George Scheutz successfully built a difference engine which could handle third-degree polynomials and 15-digit numbers.

In 1830s Charles Babbage conceived of a much more powerful mechanical computer. He called this machine an analytical engine. This machine was designed to perform any mathematical calculation automatically. It contained all the essential components of a modem digital computer) namely:

i. A processor capable of performing addition, subtraction, multiplication and division. He called it a 'mill'.

ii. A memory unit. It was constructed from decimal counting wheels. Its capacity was 1000 numbers, each number consisting of 50 digits.

iii. Several I/O devices such as a card punch, a punch-card reader and a printer.

The analytical machine was a programmable machine. It had a mechanism for enabling a program to change the sequence of its operations automatically. In other words there were conditional branches of instructions in the program. The condition was based on the sign of a number. One sequence of operations was to be performed if the sign were positive, and another one, if negative. Babbage's analytical machine was also not completed.

In the late nineteenth century punched cards were commercially used. Herman Hollerith was the inventor of punched-card tabulating machine. The major application of his machine came about in the 1890 United States Censusi In 1896 he formed the Tabulating Machine Company to manufacture his

machines. In 1911 his company was merged with several others to form the Computing-Tabulating Recording Company. This very company was renamed as the International Business Machines Corporation (IBM) in 1924.

Successful general purpose mechanical computers were built in 1930s. Konrad Zuse developed a mechanical computer, the Zl, in 1938 in Germany. The Zl used binary number system instead of decimal system. Konard was unaware of Babbage's work. He built several small mechanical computers. The Z3 was completed in 1941. It is believed to be the first operational general purpose computer. The Z3 employed relays (electromechanical binary switches) to construct arithmetic unit. The machine used floating-point number representation. Howard H. Aiken, a professor of Physics at Harvard University, designed a general purpose mechanical digital computer. This machine was called an Automatic Sequence Controlled Calculator and later as Harvard Mark I. It was constructed in cooperation with IBM, a leading manufacturer of office equipment at that time. Aiken was aware of Babbage's work. He used decimal counters wheels for its main memory. Its memory capacity was seventy two 23-digit decimal numbers. Punched paper tape was used to program and control the machine. Mark I started working in 1944. Later, Mark II was built by Aiken and his colleagues. Mark II employed electromechanical relays for its operation. Many computers using electromechanical relays were built in the 1940s. But they were quickly superseded by faster and more reliable electronic computers.

The Electronic Era

The first electronic computer using valves was developed by John V. Atanas off in the late 1930s at Iowa State University. It contained an add-subtract unit. It was relatively a small computer and used about 300 valves.- Its memory unit consisted of capacitors mounted on a rotating drum. It used binary numbers for its operation. Each capacitor was capable of storing one binary digit. It used a number of input/output (I/O) devices including a card punch and a card reader. It was completed in 1942. It was a special purpose computer to solve simultaneous equations. Several other electronic computers using valves were successfully constructed in the early 1940s. Some important computers were those developed by use in Germany and a series of computers called Colossus developed in England.

The first popular general purpose electronic digital computer was the ENIAC (Electronic Numerical Integrator and Calculator). It was developed at the University of Pennsylvania under the guidance of John W. Mauchly and J. Prosper Eckert. John Von Neumann was the consultant of the ENIAC project. It was a very large machine weighing about 30 tons and containing about 18000

vacuum tubes. It took 200 microseconds (ms) for addition and 3 milliseconds to perform a 10-digit multiplication. It used decimal numbers for its operation rather than binary numbers. Its working memory was composed of 20 electronic accumulators. Each accumulator was capable of storing a signed 10-digit decimal number, A decimal digit was stored in a ring counter consisting of 10 vacuum-tube flip-flops connected in a closed loop. Like Analytical Engine and Mark I, in ENIAC also programs and data were stored in separate memories. Introducing a new program or modifying a program was an extremely tedious job with separate memories for program and data.

The ENIAC designers, most notably John von Neumann, gave an idea to use a high-speed memory to store both program as well as data during program execution. This idea is known as *stored program concept* and was first published by Neumann for a new computer ED VAC (Electronic Discrete Variable Automatic Computer) in 1945) This machine started operation in 1951. It used binary rather than decimal numbers for its operation. It used serial binary-logic circuits. It used a larger main memory (mercury-delay line) 1 K words and a slow secondary memory (magnetic wire memory) 20 K words. (Where K stands for Kilo which is equal to 1024 to be exact). Access to the main memory was bit by bit, i.e. serial.

Neumann and his colleagues designed and built a new computer called IAS (Institute of Advanced Studies) at the Institute for Advanced Studies in Princeton during 1946-1952. This machine had the features of a modem computer. It used random access main memory consisting of cathode-ray-tube. An entire word could be accessed in one operation. It used parallel binary circuits. The CPU contained several high-speed (vacuum tube) registers to store operands and results. This computer served as the prototype for most subsequent general purpose computers. The basic logical structure proposed by Neumann is still used in a standard computer. The term Neumann Computer became synonymous with standard computer architecture. A standard architecture includes a CPU, memory and input/output devices. In future the architecture may change; instead of a centralized processing, distributed processing may be used with corresponding other changes in the design and architecture.

The transistor was invented in 1948 at AT & T Bell Laboratories. In the 1950s the engineers started using transistors in place of vacuum tubes to construct computers. One of the earliest computers using transistors was TX-0. It was an experimental computer built at the Massachusetts Institute of Technology's Lincoln Laboratories. It started operation in 1953. Commercial computers using transistors were constructed in the late 1950s and early 1960s

by many companies. For example, IBM introduced a large computer, the 7090, for scientific applications. It was a transistorized version of the IBM 709. a vacuum-tube computer.) The transistorized computers used transistors as the components of CPU. These computers used ferrite core main memory and magnetic disk, drum and tapes as secondary memory. Ferrite core memories consist of tiny rings (cores) of magnetic material called ferrite. Each ferrite core stores a single bit of information. Transistorized computers were faster and compact, and consumed much less power compared to vacuum tube computers.

Integrated Circuits (ICS) were first designed and fabricated in 1958-1959 by Jack S. Kilby at Texas Instruments, and by Robert S. Noyce at Fairchild independently. The first commercial 1C was introduced in 1961 by Fairchild. ICs began to replace transistor circuits since 1965. The examples of computers using ICs an IBM 370 and PDP-8. By 1970 all new computers used ICs, SSI and MSI as CPU components and LSI for main memory. SSI. MSI. LSI and VLSI are the classification of ICs based on components density. SSI contains components, usually transistors, 1 to 100. MSI 100 to 1000. LSI 1000 to 10.000 and VLSI more than 10.000.

The first LSI chips were introduced in 1970 in the form of computer memory units. With the advent of LSI and VLSI chips it became possible to fabricate the whole CPU unit on a single chip called microprocessor. The first microprocessor, the 4004 was introduced in 1971 by Intel Corporation. The first single-chip micro-computer the 8048 was introduced in 1976 by Intel. Computers built in the 1970s and onwards used microprocessors and other LSI and VLSI components.

Computer Generations

First Generation (1946-1954). The digital computers using electronic valves (vacuum tubes) are known as first-generation computers. Some examples of the first-generation computers are: IBM 700 series-IBM 701. IBM 704, IBM 709, EDVAC and UNIVAC. The first-generation computers usually used vacuum tubes as CPU componentst The high cost of vacuum tubes prevented their use for main memory. So less costly but slower devices such as acoustic delay lines were used for memory. They stored information in the form of propagating sound waves. Electrostatic (CRT) memories have also been used in the first generation computers. A first generation computer. Whirlwind I, constructed at MIT was the first computer to use ferrite core memory. The first generation computers used assembly language for programming. They used fixed-point arithmetic.

Second Generation (1955-1964). The second-generation computers used transistors for CPU components and ferrite cores for main memory, and

magnetic disks, drums and tapes for secondary memory. They used high-level languages such as FORTRAN (1956). ALGOL (1960) and COBOL (1960) for programming) Floating-point arithmetic hardware was widely used. I/O processor was included to control input/output operations. It relieved CPU from many time-consuming routine tasks. Examples of second generation computers are: IBM 1620 (I960). IBM 7090 (1960). IBM 70941 (1962). 7094II (1964); Control Data Corporation's CDC 1604; and Digital Data Corporation's PDP 1 (1957), PDP 5 (1963) and PDP 8 (1965). PDP (Programmed Data Processor) series is a series of minicomputers. PDP 8 was a 12-bit minicomputer. Its earlier units used transistors; 1C version was introduced in 1967.

Third Generation (1965-1974), The third-generation computers used ICs (SSI and MSI) for CPU components in the beginning third generation computers used magnetic core memory, but later on semiconductor memories (RAMs and ROMs) were used. Semiconductor memories were LSI chips. Magnetic disks. drums and tapes were used as secondary memories. Cache memory was also incorporated in the computers of third generation. Microprogramming, parallel processing (pipelining, multiprocessor system, etc.). multiprocessing, multiprogramming, multiuser system (time-share system), etc. were introduced. The concept of virtual memory was also introduced, The example of third generation computers are: IBM/370 series (1970). CDC 7600 (1969). PDP 11 (16-bit minicomputer. 1970).CDC's CYBER-175 and STAR-100. etc

Fourth Generation (1975-up till now. The fourth-generation computers use VLSI chips for both CPU and memory. A CPU consists of one or more microprocessors, yhe latest microprocessors contain more than one million transistors. Semiconductor memory of 4 M bit on a single chip is available. Cache memory is being provided on the CPU chip. Besides on-chip cache memory, external cache is also provided in (he computer. Massive use of pipelining and multiprocessors is being made. BBN Lab. Inc.'s Butterfly computer developed in the late 1970s consists of up to 256 CPUs (Motorola 68.000 microprocessors). Intel iPSC (Personal Supercomputer) introduced in 1985 can contain up to 128 Intel 80286 microprocessors. Supercomputers of more than 1000 MFLOPS are being developed. ETA 10 has a processing speed of 10 GIGA FLOPS. Computers with artificial intelligence are also being developed. They are used as expert systems.

Many improvements have been made in speed, memory size and packing density of ICs. Many components such as CPU, and several I/O devices are being packed into a single chipjVery sophisticated peripheral chips are being manufactured. A single peripheral chip contains clock generator,

interrupt controller, DMA controller, bus controller, memory, refresh controller, numeric processor control logic, etc., e.g., Intel 82230/231,82370, 82310/82311, etc.

Examples of fourth-generation computers are: CRAY Y-MPC (1992), CRAY 2 (1985), CRAY Y-MP (1988), IBM 3090/600 (1988), IBM ES/9000 (latest series), VAX 8842 (1988), IBM AS/400/B60 '(1988), IBM PS/2/50 (1987), IBM PS/2 model 80, WIPRO LANDMARK 860, S-68030 V, HCL Magnum with 68030 CPU, Magnum 040 series (68040 CPU), HP 9000 series 800; HP 9000 Model 870S/400. HP 3000 Model 870S/300, etc.

A number of companies manufacture personal computers and minicomputers in India. They are WIPRO, HCL, PCL, Modi Olivetti, ESSEN, etc. PCs and PC/XT *ate* manufactured using Intel 8088 CPU, PC/AT wilh 80286 CPU and supermicros with 80386 and 80486 CPU. Minicomputers use 68030 and 68040 CPUs. WIPRO LANDMARK 860 is a supermini developed around Intel's 64-bit i860 processor. HP 9000 series is supermini. It uses VLSI RISC processor of Hewlett Packard. A few companies produce mainframe computers.

Fifth Generation The fifth-generation computers are under development stage. Japan and USA nave under taken projects to design and develop such computers. These computers will use USLI (ultra-large-scale integration) chips. ULSI chips contain millions of components into a single 1C. Such computers will use intelligent programming, knowledge-based problem solving techniques, high performance multiprocessor system and improved human-machine interfaces.

The input and output information for these computers will be in the form of speech and graphic images. The computers will understand natural languages like English, Japanese, etc. The programmers will not have to learn programming languages. They will be able to speak commands or key information in their mother tongues. Visions system will also be incorporated. A computer will be able to see its surroundings. The fifth-generation computers will use intelligent software. The intelligent software will have artificial intelligence. In intelligent programming the user will tell the computer what to do. He will not tell the computer how to do. The computer will do the task of programming. Thus the user will not have the burden of programming.

In the last 40 years there have been many innovations, inventions and developments in the field of computer technology but still today most of the computers use Neumann's structure of a digital computer. The first four generations of computers used this basic structure and design in which a processor executes simple instructions in a sequence. In the fifth-generation of

computers a different design and architecture may be used. In such a design, processing units may not be centralized but distributed in the computer system. All data may not be stored in the main memory. The data may flow through the processing units activating each of them as needed. There will be extensive use of parallel processing. Special coprocessors will be developed to make logical inferences and manage massive amounts of stored knowledge. These computers will be knowledge-based computers. PROLOG is expected to play an important role in making logical inferences. Users will work in natural languages like English. Japanese, etc. The language of operating system will be PROLOG.

SELF ASSESSMENT – QUESTIONS

Questions

01. Computer is an _____device.
02. What is digital computer?
03. UNIVAC I is an example for _____generation computer

Answers

01. Electronic
02. Is a computer which accepts data in the form of digits.
03. First

CLASSIFICATIONS OF COMPUTERS

Modern computers are classified, according to their computing power in the following categories:

i. Microcomputers
ii. Minicomputers
iii. Mainframe computers
iv. Supercomputers

Microcomputers

A microcomputer is a low-cost, small, digital computer. It contains a microprocessor as its CPU. a memory unit. an input device and an output device. The word length of a microcomputer lies in the range of 8-32 bits. Microcomputers have a wide range of applications. A few examples are: general purpose calculations, industrial control, instrumentation, home appliances, commercial equipment control, watches, fuel injection control of a car, office automation, and so on. Personal computers are microcomputers for general purpose computations.

Personal Computer (PC)

From cost and performance point of view personal computers are classified as PC. PC/XT, PC/AT and super AT (or super micro). When we use the term PC in general literature to discuss certain features of personal computers, it means all categories of PCs, that is. PC. PC/XT. PC/AT and super micro. All categories of personal computers contain a CPU. RAM. ROM. CRT display, keyboard and secondary memory (hard/floppy disk). PC is the simplest and cheapest type of personal computer] It uses Intel 8088 as CPU. 640 KB *RAM.S* KB ROM and floppy disk as secondary memory. It does not contain hard disks. There are two 360 KB floppy disk drives. PC/XT (personal computer extended technology) contains hard disks as well as floppy disk drive (360 KB/I.2 MB). It is costlier than PC because of the hard disks component. It contains Intel 8088 CPU, 640 KB RAM and 8 KB ROM. PC and PC/XT are single-user systems. Their ROM can be extended up to 64 KB. They use MS-DOS operating system. They use 8087 numeric coprocessor. PC/AT (personal computer advance technology) contains Intel 80286 us CPU, 640 KB RAM (expandable to 4 MB). 64 KB ROM (expandable to 128 KB), hard disk drive and floppy disk drive (360 KB/I.2 MB). Its CPU is powerful than the CPU of PC/XT. Four terminals can be connected to it to make it multiuser. In multiuser environment it uses XENIX as operating system. It uses 80287 numeric coprocessor. Processing speed of PC, PC/XT and PC/AT lies in the range 1-5 MIPS. and that of home computers and microcomputers for industrial control is less than 1 MIPS. Their hard disk capacity lies in the range 20-80 MB.

Super AT (or super micros) uses a 32-bit CPU, Intel 80386 or 80486. The processing speed of 80386 CPU lies in the range 3-5 MIPS and that of 80486 CPU is 12 MIPS at 25 MHz clock. The RAM capacity of super micros lies in the range 2-8 MB. In case of 80386 CPU it can be extended up to 32 MB and in case of 80486 up to 64 MB. The hard disk capacity of super micros lies in the range 200 - 780 MB. With multidrive system it may be even more. UNIX is used as operating system. Up to 8-12 terminals and 16-64 terminals can be connected to 80386 and 80486 CPU respectively.

Personal System/2 (PS/2)

PS/2 is the new generation of personal computers, where 2 stands for second generation. Its earlier models, PS/2 model 50 and 60, used 80286 CPU and the later model, PS/2 model 80 used 80386 CPU. PS/2 is more powerful than PC/AT. PS/2 models 50, 60 and 80 have built-in video graphic array (VGA) circuitry. They use a keyboard with 101/102 keys. PC/AT and PS/2 have sophisticated keyboard control circuitry that can perform teveral functions. Such functions cannot be performed by the original IBM PC and

PC/XT. PS/2 uses 3.5 inch floppies whereas PCs use 5.25 inch floppies. PS/2 uses OS/2 or UNIX operating system.

PCs and PS/2 are microcomputers for general purpose computations. Users can work on PCs and PS/2 in high-level languages such as BASIC. FORTRAN, COBOL, PASCAL, etc. Popular application packages such as word processing, spreadsheet, database management, graphics, accounting packages, etc. also run on PCs and PS/2.

Home computers, which are also microcomputers, are used for entertainment, basic education and home management. A television set is used as video terminal to make it inexpensive. Audio cassette recorder is used as secondary memory system. BASIC is the most commonly used language for home computers. One can make income tax calculations, investment analysis, music composition, painting work etc. using home computers.

Minicomputers

Minicomputers are faster and more powerful than microcomputers. Their word length is 32 bits) Most minicomputers use Motorola 68030 or 68040 CPU. Some minicomputers are uniprocessor systems whereas some are multiprocessor systems. The processing speed lies in the range 10-30 MIPS,) Memory (RAM) capacity lies in the range 8 MB-96 MB. In some systems it can be extended up to 128-256 MB. The hard disk capacity lies in the range 380-3 GB. A minicomputer can support up to 64 or even hundred terminals.! Minicomputers are extensively used for payroll preparation, accounting and scientific computation. High-performance workstations with graphics input/output capability use minicomputers.) Minicomputers are used for multiuser and interactive; applications in colleges, universities, research organizations, government organizations, industries and so on) They are also used for sophisticated real-time (Industrial) controls and interactive engineering design work. Minicomputers can support a greater variety of fast peripheral devices. Examples of minicomputers are: IBM AS/400/B60 (first installed in 1988), VAX 8842 (first installed in 1988; VAX stands for Virtual Address Extension. VAX computers are manufactured by Digital Data Corporation); WIPRO S-68030V and S-6833V built around 68030 CPU, WIPRO LANDMARK-860 (a super mini) built around Intel i860 CPU (a 64-bit RISC processor); HP 9000 series 800 (super mini) built around Hewlett Packard's VLSI RISC processor, MIPS for different models: 11-52; and HCL magnum built around 68030 CPU, and 68040 CPU; etc.

Mainframe Computers

The mainframe computers are very powerful large general purpose computers. They are faster and more powerful than minicomputers. Their word

length may be 48, 60 or 64 bits, memory capacity, 64-256 MB, hard disk capacity, 1000 MB-10 GB or more and processing speed, 30-100 MIPS. They are used where large amount of data are to be processed or very complex calculations are to be made, and these tasks are beyond the computing capacity of minicomputers. They are used in research organizations, large industries, large business and government organizations; banks and airline reservations where large database is required.'Examples of mainframe computers are: IBM 4300 series (small to medium size models), IBM 308X series (large models), the latest model IBM 3090 series (IBM 3090/600 was first installed in 1988), IBM Enterprise system-/9000 series, HP 9000 model 870S/400, HP 9000 Model 870S/300, etc.

Supercomputers

Supercomputers are much faster and more powerful than mainframe computers. Their processing speed lies in the range of 400 MIPS-10,000 MIPS, word length 64-96 bit, memory capacity 256 M3 and more, hard disk capacity 1000 MB and more, and machine cycle time 4-6. Supercomputers are specially designed to maximize the number of FLOPS. Their FLOPS rating is usually more than 1 gigaflops per second. A supercomputer contains a number of CPUs which operate in parallel to make it faster. They are used for massive data processing and solving very sophisticated problems. They are used for weather forecasting, weapons research and development, rocketing, in aerodynamics, seismology, atomic, nuclear and plasma physics.,In some applications in aerodynamics and nuclear physics, as many as $10'^{3}$ arithmetic operations are needed for a single problem. This may take about two days of computing time on a supercomputer. Hence, there is a constant demand to increase the performance of a supercomputer. Today's supercomputers are not fast enough to simulate the airflow around an entire aircraft. Therefore, designers and builders of new airplanes simulate the airflow around separate parts of a plane. Thereafter they combine the results to obtain an effective aerodynamic design. Thus the technology and performance of the supercomputer must continue to evolve. Examples of supercomputers are: CRAY X-MP/14, X-MP/24 and X-MP/48; CRAY Y-MP, CRAY 2, CRAY 3, CRAY Y-MPC. ETA 10 (developed by Control Data Corporation), SX-2 (developed by Nippon Electric Corporation, Japan), SX-3R (25.6 GIGAFLOPS, NEC make), HITAC S-300 (32 GIGAFLOPS, Hitachi make), etc. HITAC S-300 is the latest and fastest supercomputer. Earlier supercomputer of Cray Research was CRAY 1. Cray was a designer in Control Data Corporation. He designed third generation computers CDC 6600 and CDC 7600. Later on he formed his own company, Cray Research to develop CRAY 1 and CRAY 2. In 1989 he left to form yet

another company to develop CRAY 3 which is designed with 16 processors to be 10 times faster than CRAY 2.

The cycle time of a supercomputer may be as low as 4 ns. In a single machine cycle, two 64-bit data can be added; cost range is 10 to 15 million dollars. Supercomputers have limited use and limited market because of their very high price. They are being used at some research centers, and government agencies doing sophisticated scientific and engineering tasks.

Computer is the most powerful tool man has ever created. It made great impact oil every activity of mankind and plays an important role in daily functioning of all industrialized societies. Earlier computers were used for scientific and engineering computations. But now about 75% of work done by computer is of non-computational nature. Nowadays they are used for office work, games, for preparing manuscripts of books, automatic control in factory, ticket issue and reservation in railways and other places, control of military equipment; to store. display, send and receive information; to draw drawings, graphs and pictures; to control missiles and to control airplanes; to diagnose diseases and prescribe medicines in hospitals, to perform clinical tests, to maintain and sort the records of clients; lo teach students; to perform accounting and financial work, tabulation of results: 10 prepare horoscopes, to select life partner; to supervise and watch certain areas; help police in crime investigation; to control robots; and so on. In this chapter some important applications of computers are discussed.

USES OF COMPUTERS

Important work performed in offices are: preparation of letters, reports, memorandum. copy of advertisement, publicity, contracts, forms, notes, etc. Today these tasks are efficiently performed by computers. Nowadays microcomputers are available at reasonable cost. Even small offices, organizations and institutions can afford to have a computer. A personal computer costs in the range of Rs. 25000 - Rs. 50.000. A computer helps user in preparation, storing, retrieving and displaying of text. As already explained in Chapter 8 software for this purpose called word processing package is available. It helps users write, edit. manipulate, store, retrieve, display, and print the text.

The term electronic office is used when all work of the office is done employing computers. In an electronic office computers are used for the following tasks:

i. to prepare, store and retrieve files.

ii. to handle correspondence and office communication.

iii. to facilitate administrative work and preparation of related papers.

iv. to assist decision making.

The term office automation is used when computers arc extensively used for office work.

A personal computer is a general purpose machine. It can perform a number of tasks including the task of word processing. Dedicated machines called *word processors,* designed to perform the task of only word processing are also available. Word processors are less expensive than PCs.

The word processor has many advantages over typewriters. In word processor errors can be corrected very easily. Addition of text can be made to the document. When additions are made the contents after the addition are automatically pushed down (or shifted) as much as necessary. Similarly, any word, sentence, paragraph or page can be deleted from the document. As the word processor has storing capacity, the document can be stored for future need or reference. If and when desired changes can be made in the document. All these things are done using the editing capability of the word processing programs which helps users insert, delete and modify the text. It also provides the capability to move a word, sentence or paragraph from one place to another.

Word processing programs have many other powerful commands and facilities such as searching, mail merging, spelling checking etc. Suppose someone makes mistakes in spelling or he wants to change some word with some other word; for such purposes the search and replace command is used. This command searches a particular word throughout the document and replaces i(with another word supplied by the user. A word processor program includes spelling checker which checks the spelling of all the words of the document. A dictionary is provided with the word processor. The words of the document are compared with the words available in the dictionary. If a word of the document is not found in the dictionary, it is identified. The user can add some unusual or technical words to the dictionary.

A syntax checker is also included. It checks syntax error, poor uses of words and other related items. Using mail merge command some information (data) can be included into the document (which is being processed by the word processor) from other files or database. There is also a facility to get synonyms or opposite words corresponding to a particular word if user so desires. Then he can select the proper word to use at certain place where he is unable to use the suitable word himself. Some word processing programs provide graphics facility also. In advertising materials, financial reports and brochures graphs can be included, Bar graph and pie charts can be included in financial reports.

There is also a facility to provide special mathematical symbols, notations, underline, bold letters, suffix, italics etc. in the document. Word-processing packages have powerful formatting commands. Once the text has been entered, it can be formatted as desired before printing the text. Line spacing, left margin, right margin, right justification etc. can easily be specified before printing the text.

In offices accounting, billing, preparation of pay rolls, data analysis etc, also done using computers. These are discussed under separate headings.

USE OF COMPUTERS IN BOOKS PUBLICATION

Nowadays conventional letter composition in press for book publishing is becoming obsolete. The manuscripts of books arc now prepared using computers. These computers contain word processing programs. Text of the manuscript is entered into a computer. Entered text is displayed on the CRT screen. Text is stored on a floppy disk. Usually, laser printers are connected to the computer which is used for text processing. Laser printers produce high quality print. Prints of the text are taken out. First proof reading is done in the press. The stored text is retrieved and displayed on the screen. The programmer makes correction as pointed out by the proof reader. Again prints of the corrected text are taken out. Finally, theses prints are sent to the author of the book for final proof reading. Errors pointed out by the author are corrected again. Then final prints are taken out. Space is left for pasting illustrations, sketches, diagrams etc. Drawing made in black ink are pasted on the pages of the text.

For mass printing, a negative of the document is produced and it is use to prepare plates for offset printing.

Nowadays thesis, project reports etc. are also produced using word processing package. In case of thesis, project reports, etc. 4-6 copies are taken out using laser printers. Alternatively, only one copy of the text is printed out using laser printer and rest of the copies are produced by photocopying.

SELF ASSESSMENT – QUESTIONS

Questions

04. ENIAC means _____

05. What is an analog computer?

06. What is a hybrid computer?

Answers

04. Electronic Numeric Integrator And Calculator

05. is a computer which operates on data by measuring

06. A single machine is equipped with both analog and digital capacity.

DESKTOP PUBLISHING SYSTEM

A desktop publishing package is more powerful than word processor package. It includes computer and a number of peripherals with powerful software that can produce page layouts complete with pictures and text primed in a variety of attractive ways. Such pages are used in manuals, bulletins, newsletters etc. They are more attractive and efficient compared to the simple clear print outputs of word processors. It contains an art library containing over one thousand pictures which can be used by the programmer in his documents. The system contains an output device which can produce text and pictures. Digitizers or scanners arc used to convert art, photo and text images into suitable signals to be fed into processors. The screen used is a high resolution screen. Though the package may run on PC powerful computers are generally used. Phototypesetter is used which gives better output than dot-matrix or laser printers. For inferior quality work dot-matrix printer or letter quality printer can be used with desktop publishing package. But these devices do not produce pictures having quality as good as those produced by photosellcr. The desk top publishing package can accept the text which has already been prepared by word processing package and stored in a 1'ilc. Examples of desktop publishing packages (DTPs) are : Ventura and Page Maker. Ventura is a very powerful, sophisticated and widely used DTP package.

The desktop publishing package includes a program called page layout (or page make up or page composition) program which permits operators to format pages of the text and merge text and pictures on display screen. The operator designs the pages taking suitable pictures from the picture library. He combines pictures and texts and views on the screen. He tries a number of alternatives, then he selects the final design of the page layout. The page layout editor allows him to arrange the text around the picture as he likes. He can add

pictures, can move the position of the picture, can change the style and size of headlines, design of borders etc.

When the design is completed, text is entered, the output of the desktop publishing package, i.e. text and images are sent to graphics printer (an output device used with desktop publishing unit) for multiple copies. Alternatively, pho-totypesetling equipment can be used for output, or a negative can be prepared. The negative is sent to printing firms for mass production.

APPLICATION OF COMPUTERS FOR DATA ANALYSIS

Computers are widely used for data analysis. There is a special software called spreadsheet program for data analysis. Data are entered into rows and columns. Using spreadsheet program one can tabulate results, calculate number of students in first class, second class, failed student, percentage of students in different classes, list of failure students, average marks etc.

One can prepare product sales, profit, investment computation for an organization using spreadsheet programs. Yearwise numbers of unit sold, price per unit. production cost. selling cost etc. are entered into the spreadsheet. Revenue arc calculated from the units sold and per unit price. Total expenditure is the sum of production cost and the selling cost. Profit is equal to production cost minus total expenditure.

Similarly, any kind of computation for data entered in the tabulated form can be made using computers with spreadsheet program.

Computers are widely used for statistical data analysis. Statistical packages are available for such purposes. They have functions to calculate average, maximum. minimum etc. They can accept data from other files and sort. merge and manipulate data as needed.

Spreadsheet templates are available for various kinds of data analysis. The user has only to enter data and get the desired results. Lotus 1-2-3 is a popular spreadsheet package used for data analysis.

The spreadsheet programs are also used for accounts, sale analysis, inventory control, financial aspect of business, preparation of budgets etc. These item; discussed under separate heading.

ACCOUNTING, INVESTMENT, INVENTORY CONTROL ETC.

A spreadsheet program is a general tool for the analysis of accounting, investment. inventory control, preparation of budget, students grade sheet etc. But special purpose programs are also available for financial calculation, accounting etc,

Accounting: Specialized programs are available to handle accountant's ledger. The task of maintaining ledger becomes easy when computers arc used

for this purpose with special accounting packages. Other accounting routines are order entry, billing, account receivable, account payable, inventory control, sales analysis, tax calculation, pay roll preparation, auditing, budget analysis etc. Accounting packages are available for one or more jobs stated above. Integrated packages are also available to handle general ledger, order processing, inventory control, pay roll calculation, accounts receivable, accounts payable etc. Small organizations use integrated packages. Large firms prefer separate specialized packages for each type of accounting work.

Investment Analysis: Computers are used for investment analysis. Many companies issue shares, debentures etc. A large number of persons nowadays make investment in shares. Some people take decision on the advice of brokers or financial managers. But others like to analyze themselves using computers. Software packages for such analysis are available. The user has to simply emir data and get the results of analysis. To handle this type of work software packages are available for fundamental analysis, technical analysis, portfolio management and personal financial management.

Fundamental Analysis Packages: Such as package analyzes the present financial position, prospect etc. to a company which issues securities. It analyzes its increase in sales in previous years, its present rate of securities etc. A person can collect information regarding different companies from newspapers, magazines, companies annual reports and databases available for such purposes. Then he makes screening to select a company on certain basis what he thinks right in his interest. He makes analysis on computers and then decides to purchase securities of certain companies. For screening purposes stock-screening packages are also available.

Technical Analysis Packages: Such a package helps users decide the best time to purchase and sell securities. It is based on changes in prices of shares, trend of price rise, trading volumes of the company etc. Information is collected from database, newspapers, magazines and annual reports of companies. It helps users in purchasing or selling securities.

Portfolio Management Packages: Such a package makes analysis of the present status of securities owned by a person. One has to supply the number of shares he is having, the purchase rate, current price etc. The program will calculate gain or loss, total investment in purchasing the shares, total current value, also these values companywise. total gain or loss. percentage gain or loss etc.

Personal Financial Management: Nowadays people use computers for keeping record and making analysis of their investment, income expenditures, and savings. A personal financial management package is available for this

type of work. It helps in preparing budget, calculating income, interest, insurance, printing cheques to make payment of bills, income tax calculation etc. It also calculates savings. The person can decide how much of the saving can be invested in securities etc.

APPLICATION OF COMPUTERS IN GRAPHICS

Computers are being used to draw drawings, graphics and pictures. One need not depend on draftsman or artist for these purposes. For this work graphic packages are available. Preparation of drawings is a time consuming task if it is done by draftsman. But computers can draw sophisticated drawings in multi colour in minutes. It can produce three-dimensional pictorial views. Graphics packages are often integrated with spreadsheet, investment analysis and statistical analysis. Graphics such as bar graphs, pie charts and line graphs are plotted from spreadsheet data and other tabulated form of stored data. Graphics packages are also used to recognize picture, process images, draw pictures etc.

Drawings or pictures can also be modified. They can be reduced, enlarged or rotated while displaying on the screen. When specifications and dimensions are given the computer will draw three-dimensional views or two-dimensional drawings. Moving pictures can be presented and analyzed. Drawings from different angles can be presented to designers. For example, a designer will like to see the different views of buildings, aircraft etc. All such facilities are provided by graphics packages.

Graphics packages in different categories are available, for example, design, paint, analysis and presentation packages.

Paint Packages: A paint package is used to create drawings or pictures. They are used by artists. The package also provides art library of stored images. The artist can select picture from the library. Then he can select colours of his choice and can do painting work. The package allows to rotate or *flip* a shape, add titles or captions in a style as he likes. He is allowed to make changes in scales. There is a zoom command which is used to increase or decrease the scale of a viewed object. The paint package permits to zoom in on part of the emerging drawing to refine image details. When the picture is completed it is printed and stored.

Analysis Packages: An analysis package presents masses of data in graphical or picture form which gives a better concept of the relationship, changes and trends that are hidden in their data. Bar charts, pie charts and line charts are widely used by analysts. The package allows users to vary colours, add and delete lines and headings. It also allows to change scales, and edit the look so the graphs. The results can be printed and stored for future use.

USE OF COMPUTERS IN COMMUNICATIONS

Computers are extensively used in sending and receiving information. The information transfer may take place either between two points or throughout a computer network that connects a number of computers or workstations; Data communication packages are available which are used to send and receive information. For communication purposes one must have a computer, a data communication package and a modem. Usually telephones lines are used over which data are transmitted from one place to another. The telephone lines have been built for voice transmission. To transmit human voice continuously variable analog wave patterns are used. Thus a telephone line is designed to transmit analog signals. On the other hand, a computer processes digital signals consisting of pulse or no pulse, i.e. presence or absence of an electrical voltage. Digital signals can not be transmitted over existing telephone lines which have been designed to transmit analog signals. Hence, modems are needed to convert or modulate digital signals to analog signals and vice versa when existing telephone lines are to be used. A modem connects a computer to the telephone lines. The modem receives data from a computer or a terminal which are to be transmitted over telephone lines. The modem converts (modulates) the digital signals into analog signals which can be transmitted over the telephone lines. The modem at that other end receives the data from telephone lines and converts (or demodulates) the received analog signals into digital signals. These digital signals are processed by a computer at the receiving end and they are reproduced as the original information. Data can be transmitted in both directions. A modem performs both tasks: modulation and demodulation. When data is being transmitted from an end, the modem placed at that end performs modulation. When data is received at an end the modem placed at this end performs demodulation.

From physical design consideration the modems are of two types: external modem (or stand-alone or freestanding modem) and internal modem. An external modem has its own cabinet. An internal modem is installed inside a PC. It is cheaper than external modem. It does not require additional desk space. An external modem is recommended only in situations where computers are likely to be changed.

Both types of modems are equipped with microprocessors, memory chips and special communication chips. Such modems are intelligent modems. They can be programmed to automatically perform dialing, answering and disconnecting tasks.

Communication lines are being designed and built in USA. Japan and most of European countries to transmit digital signals directly. Such systems do

not need modems, because they do not use analog signals. Until such networks are fully developed, existing telephone lines will continue currently to be in use for data transmission.

Computer communications are being .used to send and receive electronic mail, engage in online conferencing (computer conferencing, teleconferencing or videoconferencing); to view and post news on computer bull cline boards; for electronic shopping, banking and brokerage and to get information services etc. This type of information utilities fall in the following three categories:

i. Communication services
ii. Transaction services
iii. Information services

The communication services include electronic mail, online conferencing, to view and post news on computer bull tine boards etc. The transaction services include electronic shopping, banking and brokerage services. The information services include online information given by some organizations which maintain database for such purposes. A customer can access the database to get the desired information. Information may be of general nature or deal with some specialized topic or business.

Electronic Mail/Message System (EMMS)

When messages are delivered and received employing computers it is called electronic mail/message. In EMMS it is not necessary to locate the person who had to receive the message. The persons who are connected through this system have an individual mailbox to store messages to be received. The messages are sent on the first try. The messages may be either spoken or keyed text. They may be sent at any time, day or night. The receiver need not be interrupted or disturbed at odd time. He will link up with the system periodically at his convenience to review the stored messages. The message can be sent to an individual or a number of persons. The keyed messages are usually entered and received on PCs, teleprinters or visual display terminals.

Documents and pictures can also be transmitted. A facsimile machine (or fax machine) is used to send or receive pictures or documents. At the sending end the fax machine scans the document and at the receiving end a fax machine reproduces the scanned image. The receiving machine produces duplicate or facsimile of the original.

Bulletin Board Systems (BBS)

The appropriate software program permits bulletin board computer to answer telephone calls from user's computers, accept and store messages from outside users and allow access to the information stored in its files. Users can actively exchange ideas and participate in ongoing discussions or passively observe the electronic conversation of others. This type of service is offered to a group of users who have similar interests. For example, bulletin may be for a group of employees, customers, clients, patients, readers, students and so on. Life insurance company may provide BBS to give general information and answers to the questions of policy holders or who want to have new policies. Health organizations may have BBS for doctors. Industries can provide BBS for their employees and so on.

Computer Conferencing (Teleconferencing or Videoconferencing)

The videoconferencing allows persons silting at different places to participate in a conference. It is also known as online conferencing. The participants are at their PCs or terminals. Facsimile machines are used to facilitate the transmission of texts and pictures. This allows people to meet at a common time and communicate over wide distances.

Computer Information Services

Many organizations and individuals develop and maintain databases for specific subjects. They allow subscribers to use their databases. They provide online services. They provide subscribers a Communication package which allows to access the database. The subscriber has to give his identification number and password, and then he can access the stored information.

There are two types of services to provide information on demand. They are *teletext* and *videotex!*. A teletext system is a one way system. It continuously transfer information in one direction only. In this system usually information is received on a TV set. A videotext system is a two-way system. It is an interactive system. It provides graphics-rich service. It stores very large amount of graphic and alphanumeric information at the centre where central computer facility has been made available. It can receive customer's demand for providing stored information over telephone lines and other channels. It retrieves the information as demanded by the customer and forwards it to him electronically. The customer must keep an equipment to receive electronic information. Thus people can get home-service for information on demand.

The databases may be basically of two types: one type includes specialised, well defined systems to serve the needs of a particular section of people. The other type may contain multipurpose information utilities. The specialised services may be for doctors, engineers, lawyers and so on. General

purpose information services may be for general people. Some examples of general purpose information services are given below.

CompuServe: It is a general purpose information service, based in Columbus, Ohio. with more than 200,000 subscribers. It provides two types of services: consumer information service and executive information service. Under consumer information service customers get the facilities of electronic mail, home shopping via electronic mail, travel arrangements through TWA's reservation system, and national bulletin board service. In home shopping the customer makes the selection of goods from catalogs or newspaper advertisements. He does not enjoy the pleasure of window shopping. Some systems allow viewers to see items on the television screen. The viewer can rotate items displayed on the screen or view them in closeup.

Under executive information service, besides all above mentioned services, other services are: access to financial, demographic and editorial information, stock quotes, market and industry indexes etc.

The Source. It is a general purpose information service. It is based in McLean, Virginia. It provides news, weather and sports information, business and investment data (including online stock trading) and electronic shopping.

Home Banking

A person sitting at home can perform all bank transactions. For this type of work a PC or special input device attached to TV set can be employed. A communication package is used for the purpose. Information is transmitted over telephone lines? One can see his balance, make payment of bills, apply for loans, and deposit money. He can make payment for purchasing securities and can perform other kinds of bank transactions.

Online Investment Brokerage System

One can use computers for online investment brokerage which will connect user to investment brokerage houses. He can see the present rates of securities and can place order to purchase or sell securities.

Office-Work Sitting at Home

Using computers one can do the office-work silting at home. He will connect himself to the office and will take instructions from his supervisor what tasks are to be performed. He will enter the text, prepare documents etc. into the computer. The documents will be sent to the office. It will be stored in his file. The officer-in-charge can see the work done by his junior or other staff on the screen and guide them for effecting some modifications, improvement or assign other new tasks.

Telex and Teletex

World-wide standardised text communication is currently being offered by the telex service. At present millions of telex lines are in existence. Telex communication lakes place between two teleprinters. In telex system an operator has to dial (or redial if number is engaged) to transfer the message, it a slow system, Today telex is facing challenge from teletex or electronic mail. In *lelelex* the communication takes place between two word processors. In this system letters and documents can be transmitted via telecommunication lines from one word-processor to another. The text can be transmitted and received in the form with which we are most familiar. It is a more advanced public system for sending copy of a text providing a much wider character set that includes punctuation and lower and uppercase characters. Transmission rate is much higher. This system offers direct communication between (wo wordprocessors. It has potential to outperform the telex service in the near future. Us superiority lies in ils rich character set and flexibility with regard to document layout, its error recovery features. more powerful memory based terminal system and higher speed.

Satellite Communications

To transmit large volume of data at high speed, over 100,000 CPS. broad channels are employed. Coaxial cables, microwave circuits and communication satellites are commonly used for broadband channels. To transmit data through space microwave channels are used. In microwave system very high frequency radio signals are employed. When microwave systems are used through ground routes repeater stations are installed at every 40 Km. The data signals are received, amplified and then transmitted onward at each repeater station. Alternatively, if a communication satellite is available, data can be routed through it. A satellite is the quickest and cheapest medium for transmission of voice, data. text and pictures over long distances. The data are sent to the satellite from a transmitting station on the earth. The satellite acts as a reflector. It accepts signals from one point on the earth and returns the same signals to some other point on the earth. A satellite's speed matches the earth's rotation, it may look stationary from the earth. Several satellites are now in orbit to handle transmission of data in a certain zone or all over the world.

APPLICATION OF COMPUTERS IN EDUCATION

In educational institutions computers arc used as teaching aid. information resource and computing and research tool. When computer is used as a teaching aid it is referred to as *computer-assisted instruction* (CAI). Software for CA1 *can* be prepared by class teachers or software packages can be purchased). The subject material is displayed on CRT screen. The computer

also asks questions to test the students. When a student gives correct answer, the computer gives some comments to indicate that answer is correct. If the answer is not correct, the computer gives some error signal. The CAI programs can be prepared in a variety of modes, such as tutorial, discovery, problem solving, modelling, and drill and practice mode. In *tutorial mode* the computer presents new ideas followed by test questions. In *discovery mode* the computer presents information and asks students to draw conclusions. In *problem solving mode* computer allows students to apply their concept in solving a problem. //; *modelling mode* a process or a system is presented mathematically to make its analysis. Students arc allowed to change variables lo see their effects. In *drill and practice mode* it is assumed that the skill in question is known but repetition is essential to have command over the subject. The interactive feature of the computer makes computer-aided leaching attractive. Computers can repeat the presentation of the material as many times as desired. This helps students make certain concepts clear if they arc not clear in earlier attempts. Other attractive features of computers are graphics—particularly colour graphics ability. Pictures can move. rotate, computer can speak; all these features attract students. Graphics help students to sec three-dimensional figures and view from different angles. Figures can be enlarged or reduced.

Computers are widely used for computation, design, and research. The word processing package is used for preparing text. typing thesis, office and administrative work, preparation of lest questions etc. Its vast storing capacity is to store large volume of information. Data processing capability of computers arc used by students, teachers and research scholars to analyses manipulate and process data. Information stored in databases serve as a learning resource for students. Database may be purchased or developed by teachers and students. Remote databases can be accessed through computer network. Question banks may be prepared and stored in computer's memory. Test questions may also he stored so that students can manage their examination to test their knowledge. Teachers can use computers to maintain students grade, to analyses student performance. grade students, and to give home assignments etc.

General purpose languages such as BASIC and PASCAL which were used earlier by several programmers to prepare CAI software, are not well suited for CAI. An extended version of PASCAL, called UCSD has been developed or CAI software. It makes easy to process words, clauses, lines, curves and also slu-dcnt answers. LOGO is another language which is very much suitable for CAI programs. Its graphics ability enhances its utility for CAI programs. It allows lo draw colour, and animate pictures on the screen, which is interesting and attracting feature of graphics. LOGO is very easy to

learn. It has been popularized educational language. Children can it very easily. They can use it to achieve intellectual growth and develop problem solving skills. It is also used to data. compose music and manipulate text. It can also perform programming. It runs on PCs and is used in schools and colleges.

PILOT is another language used in CAI. It stands for programming Inquiry Learning or Teaching. It is a dialog-oriented language. Its syntax is simple, handles words and text easily. It emphasis drills, lexis and dialogs.

APPLICATION OF COMPUTERS IN MEDICAL FIELD

Computers are widely used in hospitals to help doctors in diagnosis, gelling information on patients, diseases, treatments. drugs etc. They are also used in administration and in keeping patient records. Doctors can get information from distant data banks and expert systems.; They can discuss with colleagues using teleconferencing.

Many medical databases are being developed. They contain information on diseases and treatment. Doctors are taking help of expert systems in the diagnosis and treatment of a patient. An expert system is a program based on the expert knowledge of specialists. It is a diagnostic tool for doctors. The doctors have to supply the detailed information such as symptoms, medical history, test results etc. This information is processed by the computer and a diagnosis is made by the expert system. At present the expert systems are helping doctors; they do not substitute doctors. They are currently useful primarily in reminding doctors of diagnosis and treatment that should be considered. The databases in the expert systems must be constantly checked and updated. Some more details are given later on in this chapter.

Many devices take images and diagnose diseases. Such devices use computers to process huge amount of data collected by the scanners associated with such devices. Examples are: Computerized Axial Tomography (CAT), Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI) etc. These devices take pictures of brain and help in diagnosis of various kinds of diseases. These machines are at present very expensive.

Computers are also used in pathological tests. Programs have been developed to monitor various pathological processes, record data and analyze results. From a single sample of blood computer can test hemoglobin, hematocrit, glucose, BUN, creatinine, total CO;, chloride, sodium, potassium, calcium, phosphorous, uric acid, albumin, protien, globulin, A/C ratio, cholestrol, triglycerides, bilirubin, phosphate, white and red blood cell count etc. Computer controlled monitoring of tests increases speed, and give accurate and reliable results.

Microprocessors are being used to control artificial limbs. Microprocessor-controlled artificial *arms* and legs have been developed for disabled persons. For paralyzed persons, robot arms actuated by voice signals can handle eating utensils, turn pages of books and move certain objects. A person confined to bed can direct a robot by voice commands, and can which the movement of the robot on a television or CRT screen. Microprocessors will bring revolution in health care for disabled in near future. Computers are also used in athletic training. Computers watch the movement, analyze/positions at various moment and point out errors, weaknesses etc. if any. Coaches utilize computer to tabulate, process and analyze game statistics. Computers are widely used today in both judging and scoring athletic events.

ARTIFICIAL INTELLIGENCE

A machine with reasoning, learning and logic capability is said to possess artificial intelligence. For example, expert systems possess artificial intelligence. An expert system is a software which utilizes a knowledge base collected Ire human specialists in a certain area. and helps users refer to this expertise in making their own decisions.

An artificial intelligence system has a knowledge base and programming technique to probe and process the facts in the knowledge base. The development of a knowledge base is very difficult and lime consuming job. To develop knowledge base the designers and research workers consult experts of a particular field. They collect facts that are based on the knowledge and experience of experts in that field. Such a collection forms a knowledge base. An expert uses a knowledge base for its artificial intelligence. Besides expert's know an expert system also uses the decision rules of human specialists to reach conclusion and to give recommendations. Natural language may be used to the user's facts and queries. The recommendation made by an expert system is based on the collection of information in the knowledge base. Hence, the knowledge base must be updated regularly. An expert system select one of many opinions depending on input data and information. The machine uses a set of decision rules on logical basis to choose an opinion. The machine is designed to perform such logical functions. It asks users to supply informations on a problem. Computer then processes the information and reaches conclusion making use of the knowledge base.

Due to various reasons many organizations want to develop expert systems. If an expert retires, dies or resigns the organization looses his expertise. So this is a very good reason to preserve expertise of experienced specialists. Another reason is that other person are benefitted by the specialist's expertise. Some examples of expert systems are as follows.

Several expert systems in various specialized fields have been developed and are in use. Important specialized fields in which expert systems are in use are: medicine, engineering, chemistry, biology, defence, oil industry, mining, geology, training, computer science and mathematics.

A number of medical diagnostic expert systems have been developed to diagnose diseases and recommend treatment. An expert system called HELP has been developed *to* diagnose heart diseases. Another expert package is PUFF which has been designed to diagnose lungs diseases. The expert system CADUCEUS is a generalized package. It can process and evaluate over 4000 symptoms and other information to diagnose over 600 diseases. The expert systems in the medical field at present do not replace doctors. They are currently helping in reminding doctors of diagnosis which should be considered.

An expert system called DELTA has been developed to detect malfunctioning of diesel electric locomotives. It helps maintenance staff correct malfunctioning. DENTRAL is an expert system developed by Stanford University to estimate the molecular structure of unknown compounds analyzing mass spectrographic, nuclear magnetic resonance and other related data.

APPLICATION OF COMPUTERS IN BANKS

Banks use computers for general purpose computations, to provide online service to customers who want to perform bank transactions from home terminals and lo answer customers at hank terminals regarding their balance etc. At bank counters computer allows customers to make withdrawals and deposits. The customer supplies his password and makes a few key strokes to give other details. To handle cash banks use cash dispensing machines. Such a machine is a microprocessor-based machine. This machine provides cash when identification number is typed in. Money can also he put into an account in the same way. The large volumes of cheques received everyday in hanks nowadays arc processed computers. To handle this task magnetic-ink character reader is employed will) computers.

With the use of a computer electronic transfer of funds from one account to another has become possible. A customer from his home. office or store can insert his identification number and type the transaction details on the terminal's keyboard. Immediately the amount he specifies will move out of his account and enter another's account.

APPLICATION OF COMPUTERS IN DESIGN AND RESEARCH WORK

Scientific and engineering design and research work involve complex and massive computations. In many cases simulation is also required. Design of

bridges, towers, buildings, generators, motors, electrical transmission network, statistical analysis of molecular structure of complex proteins etc. need complex computations. In some cases massive data are to be processed particularly in statistical analysis. Computers are suitable for both complex computations as weli as processing of massive amount of data. Research work in science and engineering field also requires complex computation. Such complex computation is not possible by hand or calculators. Nowadays computers arc must for this type of work.

REAL-TIME OR ONLINE APPLICATIONS

When a computer is controlling certain machine, equipment, process or certain activity, it measures and receives data (status or other information) regarding the equipment, process or activity which is to be controlled. If the measured quanlity deviates from its predetermined value, the computer sends control signal for its immediate correction. This type of computer control is known as *real-time* or *online control.* In real-time control the computer receives data, processes the received data immediately and gives output to control, direct or change (he process or ongoing activity. In such a situation there is time constraint. Suppose a computer is controlling the launching of a satellite. It measures its distance and angle. If it deviates from the prescribed direction, the computer sends control signal for correction. The processing of data, computation, sending of control signals all are to be performed within a prescribed limit of lime, otherwise the satellite will go far off and the project will fail. Take another example of computerized protective relays. Nowadays computers are used to protect power plants, electrical transmission lines etc. If a short-circuit occurs on the power network, it has to be detected and the faulty part must be isolated within a fraction of a second or otherwise the system will be damaged. So the computer is to be fast enough to perform its task of protection within some milliseconds. There may be certain control, where the time limit is of the order of a few seconds, for example control of temperature of a furnace. The computer may measure temperature and control it at every 15 seconds. So the entire temperature measurement and control process can be done in some seconds; there will be no harm. But computers are very fast they do compulation and control, tasks in some milliseconds. Most of the industrial controls are real-lime control.

SELF ASSESSMENT – QUESTIONS

Questions

07. Types of digital computers are_____, _____, _____
08. V generation computer uses _____
09. Examples for computer uses _____,_____,_____

Answers

07. Mainframe, mini, micro, personal
08. Artifical intelligence
09. Banking, industrial applications, airline reservations etc.

Important questions

Section – A

01. What is a computer?
02. What is binary code?
03. Enumerate the difference between analog and digital computers.
04. Give some examples for I generation computers
05. What is artificial intelligence?
06. What is personal computer?
07. How computer helps in banking operation?

Section - B

08. Write short notes about application of computer technology in banking.
09. Briefly explain about early computers.
10. Briefly explain about history of computers.

Section - C

11. Classify the different types of computers
12. What do you understand by the term computer generation explain
13. Explain about computer application.

NOTES

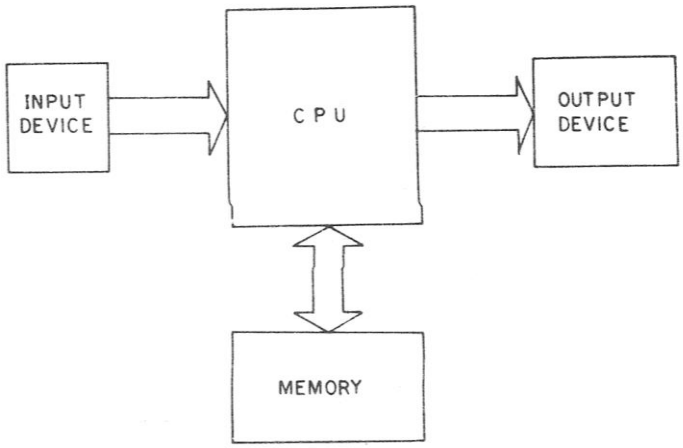
UNIT – III

HARDWARE, SOFTWARE AND FIRMWARE

The physical components of a computer are called hardware. A physical components may be electronic, electrical, magnetic, mechanical or optical. Examples of hardware are microprocessors and other ICs, hard disks, floppy disks, optical disks, cathode ray tube (CRT). Keyboard, printer, plotter, etc.

MAJOR COMPONENTS OF A DIGITAL COMPUTER (or) ANATOMY OF COMPUTER

The major components of a digital computer are: CPU (central processing unit), memory, input device and output device. The input and output devices are also known as peripherals. Fig. shows a schematic diagram of a digital computer.



Schematic Diagram of a Digital Computers

CPU

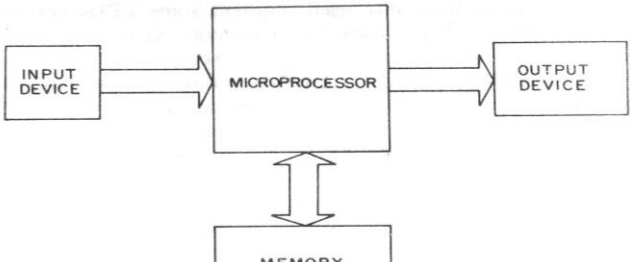
The CPU is the brain of a computer. Its primary function i.s to execute programs. Beside executing programs, the CPU also controls the operation of all other components such as memory, input and output devices. Under its control, programs and data are stored in the memory and displayed on the CRT screen or printed on the printer.

The CPU of a small computer is a microprocessor. Fig. shows the schematic diagram of a microcomputer. The CPU of a large computer contains a number of microprocessors and other ICs on one or more circuit boards. Each microprocessor in a large CPU performs a specific task.

Fig. shows the schematic diagram of a CPU or microprocessor. The major sections of a CPU are:

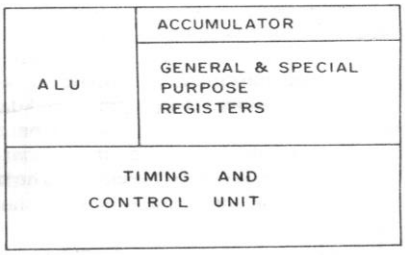
(i) Arithmetic and Logic Unit (ALU)

The function of an ALU is to perform arithmetic and logic operations such as addition, subtraction, multiplication, and division; AND. OR, NOT complement and EXCLUSIVE OR operations It also performs increment, decrement, left shift and clear operations.



Schematic Diagram of a CPU of Microprocessor

Fig. 1.2 Schematic diagram of a microcomputer



The timing and control unit generates timing and control signals necessary for V the execution of instructions. It provides status, control and timing signals necessary for the operation of other parts of the CPU, memory and I/O devices. It controls the entire operation of a computer. It is actually the control section of the CPU, which acts as the brain of a computer.

(iii) Accumulator, General and Special Purpose Registers

The accumulator is a register which holds one of the operands prior to the execution of an instruction and receives result of the most arithmetic and logical operations. It is the most frequently used registers Some CPUs contain a single accumulator, others contain several accumulators. General purpose registers store data and intermediate results during the execution of a program. They are accessible to programmers through instructions if they are working in an assembly language. Special purpose registers are not accessible to users. They are used by the computer for different purposes during program execution. Examples of special purpose registers are: program counter, stack pointer, index registers, instruction register, etc.

Memory

The function of the memory is to store information. It stores program, data, results or any other kind of information. Two or three levels of memories such as main memory, secondary memory and cache memory are provided in a digital computer. The *main memory* (or primary memory) is a fast memory. It stores programs along with data, which are to be executed. It also stores necessary programs of system software, which are required to execute the user's program. The main memory is directly addressed by the CPU. Semiconductor memories, RAMs are used as main memory) It possesses random access property, and has smaller access time, 80-100 ns (nanosecond). *Secondary (or auxiliary) memory* stores operating system, data files, compilers, assemblers, application programs, etc. The CPU does not read information (residing in the secondary memory) directly from the secondary memory. The programs and data (residing in secondary memory), if needed by CPU, are first transferred from tlie secondary memory to the primary memory. Then the CPU reads them from the primary memory. The results are also stored in the secondary memory. The secondary memory is a mass storage memory. It is slow but cheap. It is a permanent memory while the main memory (RAM) is volatile memory. The capacity of the main memory is comparatively much smaller than that of the secondary because of its high cost,' Hard disks are used as secondary memory. Their access time is about 20 ms (millisecond).

The *cache memory is* placed in between the CPU and the main memory. It is much faster than the main memory; access time 15 -25 ns. It stores instructions and data which are to be immediately executed. It is much costlier than the main memory. Hence, from cost consideration its capacity is kept much less than that of the main memory.

Destructive and Nondestructive Readout In some memories the process of reading the memory destroys the stored information. This property is called *destructive readout (DRO}.* Example of a memory having DRO characteristic is a dynamic RAM. In some memories the process of reading information does not destroy the stored information. This characteristic of the memory is called *nondestructive read-out (NDRO).* Examples of memories having NDRO features are static RAM. hard disks, floppy disks, magnetic tapes, etc.

Real (or Physical) and Virtual Memory

The real or physical memory is the actual main memory available in a computer system. It is directly addressed by the CPU.

The technique which allows a program to use main memory more than a computer really has is called *virtual memory technique.* For example, the 80386

microprocessor can have the maximum physical memory capacity 4 gigabytes (GB) but its virtual memory capacity is much larger. 64 terabytes (TB)

Direct Access Storage Devices (DASD), On-Line and Off-Line Memory Devices

While processing data it is often required to access any record at any lime. It may be desired to access a single record, update it and put it back in its original place. This type of data processing is called direct processing or random processing. It needs locating, retrieving and updating any record stored in a file without reading the preceding or succeeding records in the file. These requirements can be fulfilled with direct access storage devices (DASD equipment). DASD includes hard disks, floppy disks and several forms of optical devices.

Memory devices which always remain connected to a computer system are called on-line devices. Hard disks are on-line secondary memory. The devices that can be connected to the system when needed are known as off-line memory. Magnetic tape is an example of off-line memory.

Memory Management

In a multiuser, multitasking or multiprogramming system, memory must be specifically managed to handle multiple programs. The physical size of the main memory is usually not large enough to accommodate the operating system and all of the application programs which are needed to execute the programs of various users. In a multiuser system users should not interfere with one another, and also they should not interfere with the operating system. This is achieved by providing suitable memory management scheme. Memory management can be provided totally by the operating system or with the help of hardware called MMU (memory management unit).

In a uniprogramming system, the main memory is partitioned into two portions, namely, one portion for the operating system and the other portion for the program currently being executed. In a multiprogramming system the user's portion of the memory must be further subdivided to accommodate multiple tasks. The task of subdivision is done dynamically by the memory management scheme. Modern MMUs provide virtual memory to handle large program or a large number of programs. This is achieved by using swapping technique.

There are two types of memories from technology point of view: semiconductor memory and magnetic memory. Semiconductor memory is static, faster, lighter, smaller in size and consume less power. It is used as main memory of a computer. Magnetic memory is slower but cheaper than semiconductor memory. It is used as secondary and back up memory of a

computer for mass storage of information, RAMs, ROMs, EPROMs, etc. are semiconductor memories, and hard disks, floppy disks and magnetic tapes are magnetic memories.

Semiconductor Memory

Semiconductor memories are of two types: RAM (random access memory) and ᵛ ROM (read only memory). RAM is a read/write memory. Information can be written into and read from a RAM. It is a volatile memory. It stores information so long as plover supply is on. When power supply goes off or interrupted the stored information in the RAM is lost. ROM is a permanent type memory. Its contents are not lost when power supply goes off. The user cannot write into a ROM. Its contents are decided by the manufacturer and written at the time of manufacture RAMs of various capacities are available, for example, 1K, 4K, 16K, 64K. I'M, 4M and so on. Intel 21019 is a dynamic RAM of 1 MB x 9-bit capacity. DRAMs of 4 MB x 9 bit capacity are also available. ROMs store permanent programs and other types of information which are needed by the computer to execute user's programs.

Programmable ROMs are also available. They are called PROMs. Further, different types of PROMs such as erasable PROM called EPROM, electrically erasable PROM called E^2 PROM are available. User can write permanent information in PROMs. Such information is required while executing user's programs.

Magnetic Memory

Magnetic memories are nonvolatile memory. They store information permanently. They are slower than semiconductor memory. The commonly used magnetic memories are of three types: hard disks, floppy disks and tapes. These devices are bulk storage devices. They are used to store information at a lower cost compared to semiconductor devices. These are not static devices. They are rotated while reading or writing information.

Floppy Disks. Floppy disks are commonly used as secondary and back up memories. They are also called diskettes. These disks are very thin and flexible, and hence, called floppy. They are small, inexpensive and convenient. They are removable disks. A floppy disk is inserted in the computer when needed. The most popular sizes of floppy disks are: 5.25 and 3.5 inches square; 5.25 inch disks are also called minifloppy and 3.5 inch disks microfloppy. The protective cover of a 3.5 inch disk is hard while that of a 5.25 inch disk is thin and soft. 5.25 inch floppy is rotated at 300 rpm and 3.5 inch floppy at 360 rpm. A floppy disk is a surface device. The surface is divided into a number of concentric circles called *tracks.* Information is recorded on the tracks. Each track is divided into a number of *sectors.* The capacity of 5.5 inch double-sided

double-density disks is 360 KB, and high-density disk 1.2 MB. The capacity of a 3.5 inch disk is 720 KB (comparatively lower density), and 1.44 MB (high density). Floppy disks of 2 MB and 4 MB are expected soon. Floppy disk controllers are used to interface floppy disks to a processor. The controllers are in 1C form. for example. Intel 8272A and 82077.

Hard Disks. Hard disks are made of aluminium or other metals or metal alloys instead of plastic (thir lexible Mylar sheet). They are coated on both sides with magnetic material usually iron oxide. Unlike floppy disks, hard disks are not removable from the computer. To increase the storing capacity several disks (platters) are packed together and mounted on a common drive to form a *disk pack.* The disks units packed in a sealed container are called Winchester disk drives. As the sealed containers are dust-free, they allow very high speed, usually 3600 rpm. A hard disk is more stable as it is rigid and contained in the dust-free environment. Its track and bit densities are much higher as compared to floppy disks. A hard disk can have 200 to over 10,000 tracks per surface and a bit density over 10,000 bits per inch of a track. The data transfer rate is 10 MB/sec. The average access time is from 25-50 ms. The reliability of data is 1 in 10" which is better than that of floppy disk, that is, 1 in lO'-lO^{10}. Hard disks come in different sizes 3.5, 5.25, 8 and 14 inch. Larger sizes are used in large computers, and smaller sizes are used in mini and microcomputers. Hard disks used in PCs are of 10 MB to 80 MB capacity. Hard disks used in powerful PC/AT may be 200-780 MB. In a minicomputer it may be 380 MB-3GB with 5.25 inch disks. For large computers it may he even more. 1-10 GB.

Hard disk controllers are used to interface hard disks to a processor. An example of hard disk controllers is 82064.

Magnetic Tape. Magnetic tape is a mass storage device. It is used as back up storage. The advantage of magnetic tape is its low cost and larger storage capacity. Its main disadvantage is that it stores information sequentially. It is a serial access type memory. The magnetic tape is made up of plastic material (Mylar) coated (only on one side of the tape) with magnetic material. The standard tape is 1/2 inch wide and has 9 tracks. It is coated with iron-oxide magnetic material.

The newer 1/2 inch tape contains 18 tracks and are coated with chromium dioxide coating. The tapes of the newer system are packed in 4 x 5 inch cartridges. While the data density of a 9-track tape is 16,500 characters per inch, that of a 18-tracks (ape is 38,000 characters per inch of the tape. The tape comes in the form of large reel, small cartridge or cassette.

Input Devices

Information is entered into a computer through input devices. An input device converts input information into suitable binary form acceptable to a computer. The commonly used input device is a keyboard. Several input devices which do not require typing of input information have been developed, for, example, mouse, joystick, light pen, graphic tablet, touch screen and trackballs; Each of these allows users to select one of the items or images displayed on the screen. Therefore, these devices are called *pointing devices.* In industrial control electrical signals representing physical or electrical quantities such as temperature, pressure, force, current, voltage, frequency, etc. are entered a computer for their measurement and control. The sensors, transducers and data acquisition system act as input devices. Nowadays voice input systems have also been developed. A microphone is used as an input device. In many applications, computers with vision are required, for example, robots, computer-based security system, etc. The input systems for this type of computers use optical system, semiconductor devices sensitive to light, devices based on ultrasonic waves, etc. Such input devices produce digital signals corresponding to images, pictures etc.

Output Devices

The output devices receive results and other information from the computer and provide them to users. The computer sends information to an output device in the binary form. An output device converts it into a suitable form convenient to users such as printed form, display on a screen, voice output,) etc. In some applications the computer's output may also be converted by an output unit in the form which can be used as an input to other devices, equipment, machines, etc. This is particularly true in industrial applications. The commonly used output devices are CRT screen and printers. Other output devices are LEDs (light emitting diodes), LCDs (liquid crystal displays), plasma displays, plotters, microfilm, microfiche, speaker or telephone system, etc.

The display screen is also called monitor or VDT (video display terminal). Two types of display units are available: monochrome and colour monitor. Monochrome monitor displays texts in a single colour: blue, white, yellow or amber. A colour monitor displays text or graphics in multicolour. It may be desired in art/graphics applications. For graphics display, screens of higher resolutions are required. To provide higher resolution, screens contain more number of pixels to display text or images.

Control Processing Unit

The central processing unit (CPU) is the brain of a computer. Its primary function execute programs. The program which is to be executed is stored in the main memory. A program is a sequence of instructions to perform a specified task. The program to be executed must be fetched from the memory. The CPU fetches one function of the program from the memory at a time, decodes it and then executes it. After decoding the instruction the CPU comes to know what operate performed. It also comes to know whether the data to be processed is in the memory or in a register of the CPU. If the data is in the register, it executes instruction immediately. If the data is in the memory, the CPU reads the data memory. Then it executes the instruction. After executing one instructed the next instruction for its execution. This process is continued he instructions of the program are fetched and executed. The result is the memory or sent to an output device according to the instruction the program.

Besides executing programs, the CPU also controls input devices, output and other components of the computer. It controls input and output devices receive and send data. Under its control programs and data are stored memory and displayed on the CRT screen.

CPU of a small computer is a microprocessor. The CPU of a large computer contains a number of microprocessors and other ICs on one or more circuit ' microprocessor in a large central processing unit performs a within the CPU.

SELF ASSESSMENT – QUESTIONS

Question

01. What is a hardware _____
02. Main components of a computer are _____, _____, _____
03. ALU means_____

Answer

01. The physical components of a computer
02. CPU, input devices, output- devices, memory units
03. Arithmetic and logic unit.

CPU ORGANIZATION

There are the main sections of a CPU:

i. Arithmetic and logic unit (ALU)
ii. Control unit
iii. Accumulator and general and special purpose registers

Arithmetic and Logic Unit (ALU)

The function of an arithmetic and logic unit is to perform arithmetic and logic operations. Usually an ALU performs the following arithmetic and logic operations'.

i. Addition
ii. Subtraction
iii. Multiplication
iv. Division
v. Logical AND
vi. Logical OR
vii. Logical EXCLUSIVE-OR
viii. Complement (logical NOT)
ix. Increment (i.e. addition of 1)
x. Decrement (i.e. subtraction of 1)
xi. Left or right shift (the content of the accumulator can be shifted left or right by one bit)
xii. Clear (the content of the accumulator or carry flag can be made zero).

Other mathematical operations such as exponentiation, logarithm and trigonometric functions and floating-point operations are not performed by ALU. These operations are performed by either software technique or an auxiliary special purpose arithmetic processor (or coprocessor) which is another 1C chip. In addition to these operations a coprocessor also performs basic addition, subtraction, multiplication and division. Some microprocessors don't have instructions for multiplication and division. Therefore, such microprocessors use subroutines for multiplication, division, exponentiation, logarithm trigonometric functions etc. If coprocessor is used with such microprocessor, multiplication, division and other mathematical operations arc performed by the coprocessor. The use of subroutines makes execution slower. Coprocessors speed up program execution and reduce programming complexity.

Control Unit

The control unit of a CPU controls the entire operation of the computer. very section of the CPU really acts as the brain of the computer. It also controls all other devices such as memory, input and output devices connected to the CPU. It fetches instruction from the memory, decodes the instruction, interprets the instruction to know what tasks are to be performed and sends suitable control signals to other components to perform further necessary steps to execute the instruction. It maintains order and directs the operation of the entire system. It gives order to ALU what operations are to be performed. It generates timing and control signals, and provides them for all operations. It controls the data flow between CPU and peripherals (including memory). It provides status, control and timing signals that the memory and I/O devices require.

Under the control of the control unit the instructions are fetched from the memory one after another for execution until all the instructions are executed. For fetching and executing an instruction the following steps are performed under its control:

i. the address of the memory location where instruction lies, is placed on the address bus.
ii. instruction is read from the input data bus.
iii. the instruction is sent to the decoding circuitry for decoding.
iv. addresses and data required for the execution of the instruction are read from the memory.
v. these data/addresses are sent to the other sections for processing.
vi. the results are sent to the memory or kept in some register.
vii. necessary steps are taken to fetch next instruction. For this the content of the program counter is incremented.

Registers

A CPU contains a number of registers to store data temporarily during the execution of a program. The number of registers differs from processor to processor. Some processors contain more registers, some less. Registers are classified as follows:

Accumulator. The accumulator is a register which holds one of the operands prior to the execution of an instruction, and receives the result of most of the arithmetic and logical operations. So an accumulator is the most frequently used register. Some CPUs have a single accumulator; some have several accumulators.

General Purpose Registers. These registers store data and intermediate results during the execution of a program. They are accessible to users through instructions if the users are working in assembly language.

Special Purpose Registers. A CPU contains a number of special purpose registers for different purposes. These are:

i. Program Counter (PC)
ii. Stack Pointer (SP)
iii. Status Register
iv. Instruction Register (IR)
v. Index Register
vi. Memory Address Register (MAR)
vii. Memory Buffer Register (MBR) or Data Register (DR)

All CPUs do not contain all of these special registers. A powerful CPU contains most of them. A brief description of these registers is given below:

Program Counter (PC). The Program counter keeps track of the address of the instruction which is to be executed next. So it holds the address of the memory location which contains the next instruction to be fetched from the memory. Its content is automatically incremented after an instruction has been fetched assuming that instructions are normally executed sequentially. In case of a jump instruction its contents are modified, and program jumps to the memory location which contains the desired instruction to be executed next.

Stack Pointer (SP). The stack is a sequence of memory locations defined by the user. It is used to save the contents of a register if it is required during the execution of a program. The stack pointer indicates upto what memory locations the stack is already filled up. In other words it indicates from which memory location onward the stack is vacant for further storage. The stack will be discussed in detail later on.

Status Register. The status register is also called *condition code or flag register.* It holds 1-bit flags to indicate certain conditions that arise during arithmetic and logical operations. The important indications shown by computer are:

Carry - it indicates whether there is overflow or not

Zero - it indicates whether the result is zero or nonzero

Sign - it indicates whether the result is plus or minus

Parity - it indicates whether the result contains odd number of Is or even; number of Is.

Auxiliary carry or Half Carry is also indicated.

Instruction Register. It holds an instruction until it is decoded. Some computers have two instruction registers, and so they can fetch and save the next instruction while the execution of the previous instruction is going on.

Index Register. Index registers are used for addressing. One or more registers are designated as index registers. The address of an operand is the sum of the contents of the index register and a constant. Instructions involving index register contain constant. This constant is added to the contents of index register to form the effective address, i.e. the address of the operand. Usually special instructions are provided to increment or decrement an index register so as to access the entries of a table in a successive manner. Alternatively, some computers have the facility of auto-indexing by which the index register is automatically incremented or decremented.

Memory Address Register (MAR). It holds the address of the instruction or data to be fetched from the memory. The CPU transfers the address to the next instruction from the program counter (PC) to the memory address register. From MAR it is sent to the memory through the address bus. The address lines of the memory are connected to the outputs of MAR. Sometimes it is called simply address register (AR).

Memory Buffer Register (MBR) or Data Register (DR). It holds the instruction code or data received from or sent to the memory. It is connected to data bus. The data which are written into the memory are held in this register until the write operation is completed. It is also called data register (DR). Thus the flow of data from the CPU to the memory or from the memory to CPU is always through MBR. It is within the CPU.

Memory

Memory is an essential component of a digital computer. It is a storing device. It stores programs, data, results etc. At present the following two kinds of memory are commonly used in modem computers:

i. Semiconductor memory

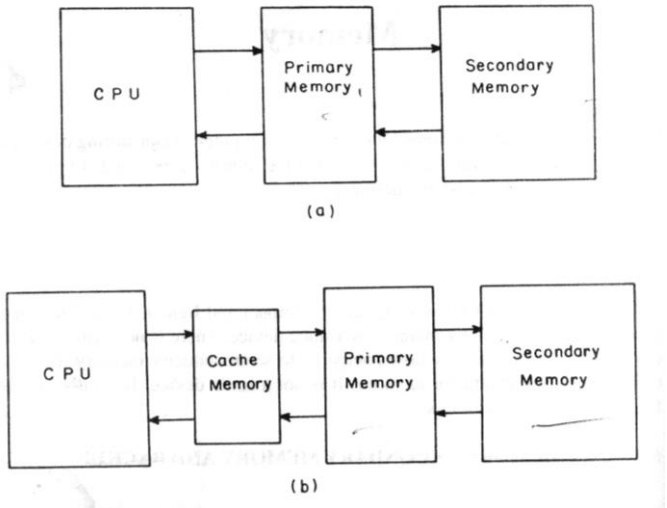
ii. Magnetic memory

The semiconductor memory is faster, compact and lighter. It consumes less power. The semiconductor memory is a static device. There is no rotating part in it. The magnetic memory is slow compared to semiconductor memory. But it is cheaper than semiconductor memory. It is not a static device. It is either in the form of a rotating disk or tape.

MAIN MEMORY, SECONDARY MEMORY AND BACKUP, MEMORY

All computers except very small systems contain both semiconductor as well as magnetic memory. The semiconductor memory is employed as the *main memory (or primary memory) of* the computer. It stores programs and data which are currently needed by the CPU. The magnetic memory is used as *secondary (or auxiliary} memory.* The information which is not being currently processed resides in the secondary memory. The information which is needed by the CPU for current processing is transferred from the secondary memory to the main memory. The size of the main memory is comparatively much smaller than that of the secondary memory because of its high cost. The CPU communicates directly with the main memory. As the CPU employs semiconductor technology and has very high speed, its matching memory must be very fast. Only semiconductor devices can provide the matching speed. Thus the main memory also must employ semiconductor technology. RAM and ROM ICs are used as the main memory of the computer. RAMs are volatile, i.e. their contents are erased which power goes off.

The secondary memory is employed for bulk storage (mass storage) of programs, data and other informations. It has much larger capacity than main memory. It stores system software, assemblers, compilers, useful packages. large data files etc. The secondary memory should not be of volatile nature. It must store information permanently. The magnetic memory has this property. It retains the information once stored in it. The magnetic memories such as hard disks and floppy disks arc the most common secondary memories used in computers.



Memory hierarchies (a) without cache memory (b) with cache memory

The two most common memory hierarchies are shown in Fig.(a) shows a computer system which has only main and secondary memories but no cache memory. Fig. (b) shows a system which includes a cache memory.

Backup memory is used to store the copy of the important programs such as operating system, compilers etc. Floppy disks and magnetic tapes can be employed as backup storage. These programs are generally available in the secondary memory but their copies are also kept in the backup memory so that they can be reloaded into the secondary memory in case the programs stored in the secondary memory are lost accidentally or due to any other reason.

CACHE MEMORY

The word cache is pronounced as cash. The cache memory is placed in between the CPU and main memory. It is much faster than main memory. Its access time is much less compared to that of the main memory. The access time of a cache memory is 15-25 nanoseconds (ns) whereas that of the main memory is 80 ns. The cache memory is not accessible to users. It stores instructions and data which are to be immediately executed. It is used to reduce the average access time for address, instructions or data which are normally stored in the main memory. Thus the cache memory increases the operating speed of the system. But it is much costlier than main memory. From economical consideration the capacity of the cache memory is much less compared to the main memory. Sometimes cache is employed to store only instructions but not data such as the instruction cache in MC68020. It has 256-byte instruction cache which allows it to prefetch instructions from the main memory and store them in the cache during the period when the system bus would otherwise be idle. The 68030 has both 256 byte instruction cache and 256 bit data cache.

32-bit microprocessors operate at very high speed. The required matching memory should also be very fast. But very high-speed memory is very costly. If fast microprocessors operate with conventional main memory, they have to operate with several wait states wasting performance. A compromise is made and a very high-speed cache memory is placed in between the CPU and the main memory, to operate at the speed of the CPU. Now most of the 32-bit microprocessor have cache memory on the chip. In addition to the cache on the chip the modem computers also provide external cache on the board.

The technique to access cache memory is different from that of accessing the main memory. When the CPU accesses main memory, it outputs the data contained at the specified address. On the other hand the cache memory first compares the incoming address to the address stored in the cache. If the address matches, it is said that a 'hit' has occurred. Then corresponding

data are read. If the address does not match it is said that a 'miss' has occurred. In case of the occurrence of a miss, the data have to be read from the main memory. The data read from the main memory are also provided to the cache memory so that when this specific address is accessed next time, a hit may occur.

Ideally, the main memory should use the same technology as that for CPU registers. This will give the same speed of operation for both CPU as well as the main memory. But it will be too expensive. To solve this problem a cache memory is employed. The size of cache should be small to give a reasonable overall cost of the memory. But its capacity should be sufficient to have reasonable access time. The cache size may be between 1K and 128K, depending upon the speed features of the processor and the main memory.

High Performance 32-Bit Cache Controller, Intel 82385

The 82385 is a high performance 32-bit cache controller. It was developed for Intel 80386 microprocessors. It stores a copy of frequently accessed codes and data from the main memory in a zero wait state local cache memory. It is optimized as 386DX companion. It enables the 386DX to operate at its full potential by reducing the average number of CPU wait states to nearly zero. The hit rates are upto 99%. It can operate at 16 MHz, 20 MHz, 25 MHz and 33 MHz. It has dual bus structure which permits other masters to access the system resources while the 386DX operates locally out of its cache. It integrates a cache directory and all cache management logic necessary to support an external 32 KB cache.

SELF ASSESSMENT – QUESTIONS

Questions

04.Examples for input devices _____, _____, _____,_____,

05. Printers is an _____ device

06. Important parts of CPU are_____,_____,_____,

Answers

04. key board, mouse, joystick, light-pen

05. Output- device

06. Primary storage unit ALU, control unit

REAL (OR PHYSICAL) AND VIRTUAL MEMORY

The real or physical memory is the actual main memory provided in the system. It is directly addressed by the CPU. The address of a location of the physical memory is called physical address.

The technique which allows a program to use main memory more than what a computer really has is known as *virtual memory technique.* It gives the programmers an illusion that they have main memory available more than what is physically provided in the computer. The entire program and its data arc not placed in the main memory. Only the instructions and data which are to be currently executed are brought from the secondary memory into the main memory. The remaining part of the program resides in the secondary memory. When the part of the program which is in the main memory has been executed, it is sent back to the secondary memory. Thereafter another part is brought into the primary memory for its execution. Thus we see that a program requiring much larger capacity than that of the main memory can be executed by using virtual memory technique. The virtual memory space is much larger than the physical memory (main memory) space. For example the 80386 can directly address 4 GB of physical memory. The capacity of virtual memory will be equal to the capacity of the secondary memory available to users.

The addresses which are used in a program are called *logical addresses.* These addresses indicate the positions of instructions and data in the program. The logical addresses are translated into physical addresses by memory management unit, MMU. The MMU is placed in between the processor and main memory. The CPU generates logical address while executing the program. The' MMU receives a logical address from the processor and determines whether the logical address is present in the physical memory (i.e. main memory). If it is present in the main memory, the MMU determines the corresponding physical address. If the logical address is not present in the physical memory, the MMU interrupts CPU. The CPU executes a service routine to bring the required information from the secondary memory to the physical memory. Thereafter the MMU determines the corresponding physical address. The details of MMU will be discussed later on in this chapter. The logical address is also called *vim address* in a system which has provision for virtual memory.

SEMICONDUCTOR MEMORY

Semiconductor memories are of two types: RAM (random access memory ROM (read only memory). The various kinds of RAMs and *ROMs* are as described below.

RAM

The read and write memory (R/W memory) of a computer is called RAM. The users can write information into RAM and read information from it. It is accessible to users. The user enters his program and data into RAM. It possesses random access property. In a random access memory any memory location can be accessed in a random manner without going through any other memory location. The access time is same for each memory location. RAM is a volatile memory. The information written into it is retained in it as long as the power supply is on. As soon as the power supply goes off (or interrupted) its stored information is lost. The programmer has to reload his program and data into the RAM when the power supply is resumed.

RAM is not the correct name of R/W memory because both RAM and ROM possess random access property. But R/W memory has been called RAM since long and in practice it has become an established name. Thus R/W memory is commonly called RAM.

There are two important types of RAMs: static RAM and dynamic RAM. Static RAMs retain stored information only as long as the power supply is on. But a dynamic RAM loses its stored information in a very short time (a few milliseconds) even though the power supply is on. In a dynamic RAM a binary slate is stored on the gate to source stray capacitor of a transistor of the MOS memory circuit. The presence of charge on the stray capacitor represents 1, and the absence of charge on the stray capacitor represents 0. The charge on these capacitors leak away as a result of normal leakage in a few milliseconds. Therefore, dynamic RAMs have to be refreshed periodically, generally every 2 milliseconds. The dynamic RAMs are cheaper and have high packing density and moderate speed. They consume less power. They are used where large capacity of memory is needed. Static RAMs are costlier and consume more power. They do not need refreshing circuitry. They have higher speed than dynamic RAMs. Static RAM and dynamic RAM are also written as SRAM and DRAM respectively.

The refreshing and control circuitry for a dynamic RAM may be either on the chip itself or on a separate 1C called dynamic RAM controller. If the dynamic RAM and its refresh and control circuitry are on the same 1C, it is called iRAM (integrated RAM). In other words the iRAM integrates a dynamic RAM and its control and refreshing circuitry into a single 1C. iRAM is also known as quasi static RAM or pseudo-static RAM.

Static and dynamic RAMs use MOS technology. Semiconductor memories AMs and ROMs) are implemented with NMOS. Semiconductor memories using CMOS technology arc produced nowadays. They consume

very low power. They are at present costly. Static RAMs hold information in a flip-flop circuit consisting of two cross-coupled inverters. In a RAM the memo must be associated with read and write facility. Six transistors are need memory cell in a static RAM. Dynamic RAMs require less number of transistors per memory cell because information is stored on stray capacitors. Only on transistor is needed to form a memory cell of the dynamic RAM. This results in high packing density of the dynamic RAM compared to static RAM.

The capacity of memory chips are given in the form m *x n* bits. For exn the capacity of Hitachi static RAM. HM 6287 is 64 K x 1 hits. The capacity of NEC static RAM, UPD43256 is 32 K x 8 bits. A memory chip may be bit-nibble or byte-oriented. The capacity written in the form 64 K x 1 bits means that bit can be read from or written into the memory at a time. Such memories oriented. If the capacity is written as 32 K x 8, it means that 8 bits can be from or written into the memory at a time. This type of memories are byte oriented. The examples of dynamic RAMs are: Toshiba dynamic RAMTC 51100 of 1 M x 1 bits; TC 514256 of 256 K x 4 bits etc. Intel 21019 is a 1 MM DRAM. 4 MB x 9 bit DRAMs are also available. The ninth bit is for checking. Examples of static RAMs arc: Hitachi HM 6116,2 K x 8; HN K x 8; HM 6287,64 K x 1; NEC μ*PD43256.*32 K x 8: etc.

ROM

ROM slants for "Read Only Memory". It is nonvolatile memory. i.e. the information stored in it is not lost even if the power supply goes off. It is used for permanent storage of information. It also possesses random access property. ROMs are much cheaper compared to RAMs when produced in large volumes to defray the cost of making the mask. The stored information can only be read from ROMs at the time of operation. Information can not be written into a ROM by the users/programmers. In other words ROMs are not accessible to users. The contents of ROMs are decided by the manufacturers. The contents are permanently stored in a ROM at the time of manufacture). From programming mode point of view the ROMs are placed in broad categories: masked-progromn programmed. ROMs in which contents are written at the time of IC manufacture are called mask-programmed ROMs. PROM, EPROM, E^2ROM or any other kind of PROM are user-programmable ROMs. If we simply write or say ROM it means masked programmed ROM because user programmable ROMs are called PROM. EPROM, EEPROM etc.

ROMs store information which is not subject to change. They store fixed programs. In microprocessor-based system which arc used for industrial controls. ROMs store monitor, assembler, debugging package, function tables such as sine. cosine, logarithm, square root, exponential and code conversion

tables etc. An example of a ROM is Toshiba Mask ROM. TCS 534000.512 K x 8 bits.

PROM

PROM is a programmable ROM. Its contents arc decided by the user. The user can store permanent programs, data or any other kind of information in a PROM. A special equipment called PROM programmer is available for the programming of PROMs. With the help of PROM programmer the user stores his programs in a PROM. PROMs are once programmable, i.e. the user can write his information in a PROM only once. PROMs are more cost effective if small number of chips are to be produced to store certain fixed programs^ An example of PROM is 74S287.

EPROM

An EPROM is an erasable PROM. The stored data in EPROMs can be erased by exposing it to high intensity short wave ultraviolet light for about 20 minutes. An UV source of 2537 A wavelength can *be* used for the purpose. The technique of erasing contents is not easy and convenient because the EPROM 1C has to be removed From the computer for the exposure to the ultraviolet light. When an EPROM is exposed to ultraviolet light. The entire data are erased. The user cannot erase contents of certain selected memory locations. EPROMs are cheap, reliable and hence they are widely used.

EPROMs are used to store programs which arc permanent out need updating. The permanent programs which are a the research and development stage also need lo be stored in EPROM because they are modified several limes. Where updating or changes in the programs at the development stages are required, EPROMs are far more economical than PROMs because they can he reused.

EPROMs employ MOS technology. They store 1 or 0 as the charge or no charge on the insulated floating-gate of the transistor. The UV light causes the stored charge to leak off. Thus the data arc erased and it allows the user to repro-gram the EPROM. For programming it requires high voltage. 30 V or higher. But its operating voltage, i.e. the voltage for read operation is only 5 V.

Examples of EPROMS are: Intel's 87C2.57, 256K (32K x 8) CHMOS EPROM: Intel's 27C010, 1M (128K x 8) Byte-wide High-speed CMOS EPROMs: Toshiba, TC571000. 128 K x 8 EPROM. Intel currently produces EPROMs in the range of 16K to 4M bit. Intel 27C040 is a 4M (512 K x 8) CHMOS EPROM and 27C240 is a 4M(256 K x 16) CHMOS EPROM.

EEPROM (or E^2PROM)

EEPROM is an electrically erasable PROM. It is also known as EAPROM (Electrically Alterable PROM). The chip can be erased and reprogrammed on the board easily on a byte by byte basis. Either a single byte or the entire chip can be erased in one operation. It requires much shorter lime. a few milliseconds for erasing as compared to 10-20 minutes for EPROM. There is a limit on the number of limes the EEPROMs can be reprogrammed, usually 10.000 times. It need not be removed from the computer's board for erasing. Compared to RAMs, E^2ROMs take much longer time for both writing and erasing a byte. But the access time for reading RAMs, ROMs, PROMs and EEPROMs are comparable, a few hundred nanoseconds.

Intel 2816A is a 16K (2K x 8) EEPROM. The access time for its various versions lies in the range of 200 ns-450 us. Any byte can be erased in 9 milliseconds without affecting the data in any other byte. Alternatively, the entire memory can be erased in 9 milliseconds. It takes 9-15 ms for writing a byte. The Intel's 2817A is also an 16K (2K x 8) E^2 PROM. It possesses automatic byte-erase facility before write operation. It takes 20 milliseconds for a combined erase/write operation.

E^2ROM requires 21 volt pulses for writing or erasing and 5 V for read operation. Some EEPROM chips require external high voltage pulse for erase/write operation, for example Intel 2816. But some do not require because high voltage pulses for erasing and writing are generated by on-chip circuitry, for example, Intel 2816A.

Non-Volatile Flash Memory

Non-Volatile flash memories are also electrically erasable and reprogrammable nonvolatile memories. They possess the feature of quick-pulse programming, a typical time is 100 US for byte-program and 4 seconds for chip-program. The chip is flash erasable and programmable. The whole device is erased in one operation. A typical electrical flash erase time for the chip is 1 second. The access time for read operation is 150--170 ns. It can be used in place of EPROM. It is suitable for firmfare (i.e. codes) storage whereas conventional EEPROMs arc suitable for parameter storage. When codes are to be updated the entire codes are rewritten to avoid errors. For the updating of firmware codes flash memories are quick and economical as compared to EPROMs. In case of parameter updating, they need to be rewritten individually byte by byte while system is on-line, in normal operation. Hence, EEPROMs are best suited for such applications.

Flash memories also have the limit on the number of times they can be reprogrammed usually 10,000 erase/write operations. But the failure rate is less compared to EPROMs.

Examples of flash-memories are:

i. Intel 28F512, 512K (64K x 8) bit CMOS Flash Memory
ii. Intel 28F020, 2048 K (256K x 8) bit CMOS Flash Memory
iii. Intel 28F001, IM byte (512 K x 8) CMOS Flash Memory

Nonvolatile RAM

A high speed static RAM and EEPROM are packed into a single 1C to form a nonvolatile RAM. It operates as a normal RAM. In case of power failure the entire contents of the RAM are transferred automatically in parallel in the EEPROM. Xicor Inc. has developed a nonvolatile RAM X2201 of 1K bit capacity. It contains a 1KB RAM and 1KB EEPROM. The entire contents of the RAM are transferred to the EEPROM in 4 milliseconds. Intel 2004 is also a nonvolatile RAM of 512 x 8 bits capacity. II takes 10 ms to transfer the data from RAM to EEPROM. The data from EEPROM are transferred back into RAM when power is resumed. A STORE signal is used to save the contents of the RAM. A signal known as RECALL is used to get the contents back into the RAM from EEPROM. In 2004 both functions are controlled by a single signal. NE which can easily be activated with traditional circuitry in memory mapped space, through an I/O port or from the output of a power-fail detector. The minimum endurance is 10.000 non-volatile store cycles.

The advantage on NVRAM is that a battery backup is not needed to save the working data in the event of power failure. A typical example is the buffer storage for a communication system. The NVRAM can be employed for buffer storage for data being transmitted or received over a communication line. In the event of power failure, a single microprocessor instruction causes NVRAM to save all the buffered data.

PERIPHERAL CONTROLLERS

INPUT AND OUPUT PORT

Input and output devices can not be interfaced to a microprocessor directly because they are not provided with necessary logic circuitry needed for direct interfacing to the processor buses. They are usually interfaced to the processor buses through electronic circuitry called I/O ports. An I/O port is supposed to contain device selection logic, bus drivers, data buffers, status register, control lines etc. Standard I/O ports in 1C forms arc available. An input device is connected to the processor through an input port. The port is the place for loading or unloading data. The input device unloads data into an input

port. Then the microprocessor reads the data from the input port. Similarly, an output device is connected to the processor through an output port. The microprocessor unloads data into an output port. Then the output device receives data from the output port.

An I/O port may be programmable or nonprogrammable. A nonprogrammable port is permanently connected to the processor to behave cither as input port or output port. If a port is connected as an input port. it will always act as an input port. Similarly, if a port has been connected as an output port. it will always act as an output port. The operating mode to act as input port or an output port can not be altered by the user. A programmable port is also permanently connected to the processor. But it can be made to act either as input port or output port by software technique. The same port can be programmed as an input port for one problem and as an output port for another problem. Of course when it has been programmed to act as input port. an input device will he connected to it. When it has been programmed to act as an output port, an output device is connected to it.

Intel 8212

It is a nonprogrammable 8-bit I/O port. It can be used either as input port or output port. Once an 8212 1C is connected as input port, it will always work as input port. When it is connected as an output port, it will always work as an output port. Suppose we require one input port and two output ports in a particular system. In this case three 8212 ICs will be used. One unit will be connected as an input port and two units as output ports.

Programmable Peripheral Interface

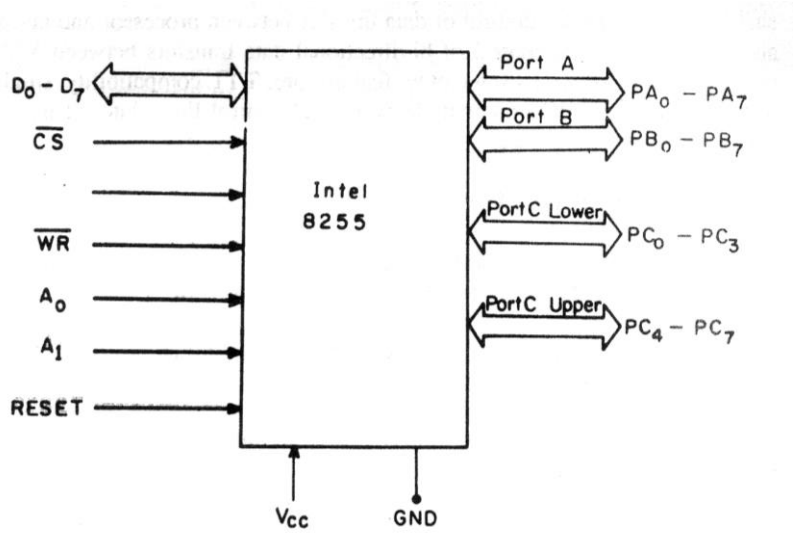
A programmable peripheral interface is a multiport device. Its ports can be programmed in a variety of ways as required by the user. It is very useful device for interfacing input/output devices. Some manufacturers use the term 'Peripheral Interface Adapter' or 'Versatile Interface Adapter'.

Intel 8255A, 82C55A

The 8255A is a programmable peripheral interface (PPI). Fig. 7.11 shows its schematic diagram. It contains three 8-bit programmable ports. Port A, Port B and Port C. The Port C can further he divided into two 4-bit ports: Port C_{upper} and Port C_{lower}.

The 8255A operates in three modes: Mode 0. Mode 1 and Mode 2. In mode 0 all the three ports operate as simple I/O ports. In Mode 1 the Port A and Port B operate in strobed input/output mode. Pins of the Port C are used for their control (for handshaking signals, interrupt etc.). The combination of Mode

1 and Mode 0 is also possible. For example, the Port A can operate **in** Mode 1 and



Intel 8255

Port B in Mode 0. In Mode 2 only Port A operates. When the Port A operates in Mode 2, the Port B may operate in Mode 1 or Mode 0. Mode 2 is a strobed bidirectional mode of operation.

When the 8255A is programmed in Mode 1 or Mode 2, the Port C sends or accepts hand shaking signals. The contents of Port C permit programmer to test and verify the status of each peripheral device and change the program flow accordingly. Pins of Port C are also used to interrupt the CPU. See details in the Applications of 8255A given in Intel's Handbook.

The 82C55A is the CHMOS version of 8255A

The programmer makes a control word that defines which port will act a an input or output and what is its mode of operation. The 8255A provides parallel ports.

SCL 6522. It is a versatile interface adapter (VIA) manufactured by Semiconductor Complex Ltd. (India). It contains two 8-bit bidirectional I/O ports, two 16-bit programmable timer/ counters, serial data port. and a serial-to-parallel / parallel-to serial shift register. The control of peripheral devices is handled primarily through two 8-bit bidirectional ports. Each line can be programmed as cither input or output. Several peripheral I/O lines can be controlled directly from the interval timers for generating square waves of the desired frequency or for counting externally generated pulses. To facilitate the control of the many powerful features of this 1C, an interrupt flag register, an interrupt enable register and a pair of function control registers arc also

provided. Its expanded handshake capability allows control of data transfer between processor and peripherals. It also allows the control of bi-directional data transfers between VIAs in multiprocessor system. Its some other features are: TTL compatibility, single +5 V power supply, CMOS compatible peripheral control lines, latched input and output peripheral devices etc.

Parallel and Serial Ports

Computers have a few built in interfaces called ports. Peripheral device are interfaced to the computer through these ports. Data flow in and out through these ports. Ports are of two types: parallel and serial. A parallel port allows the transfer of all the bits of a word simultaneously. In parallel interface there are multiple lines to connect the peripheral to the port. A parallel interface is used to transfer data at faster rate for high-speed peripherals such as disk and tape. A parallel interface is also known as Centronics interface as it was first popularized for interfacing printers manufactured by Cantinas. Within the computer data is transferred in parallel so that the computer works at high speed.

A serial port allows serial data transfer. In serial data transfer one bit of data is transferred at a time. In serial interface only one line or a pair of lines is used to transmit data. It is used for slow-speed peripherals such as terminals. Printed employ either serial interface or parallel interface.

Programmable Interrupt Controllers (PIC)

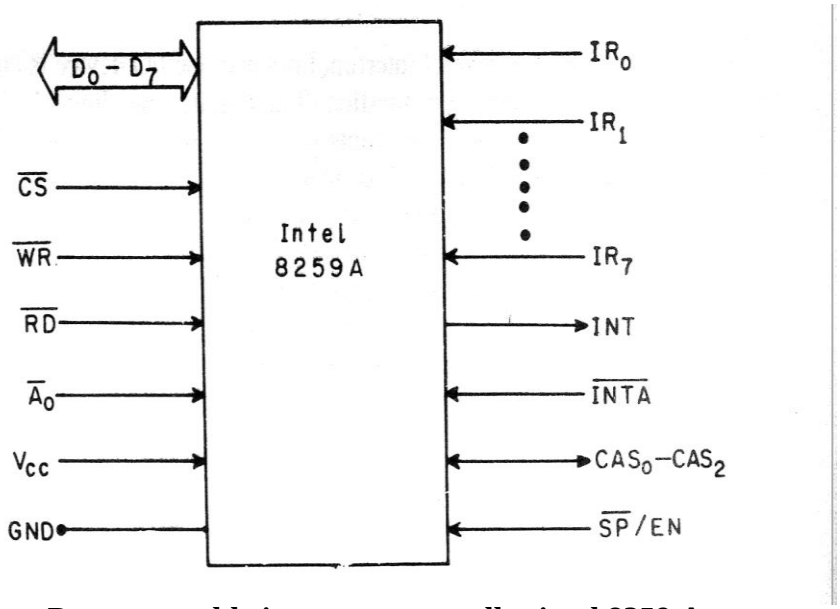
When several I/O devices are to be connected to the same interrupt line of the processor, they can be connected through an interrupt controller. An interrupt controller operates as an overall manager in an interrupt driven system. It accepts interrupt signals from I/O devices and determines which of the interrupting devices is of the highest priority. Each I/O device has a special program or subroutine to serve its requirement. This is known as ISS (interrupt service subroutine). Having decided the priority the controller interrupts the processor through its INT line. The microprocessor sends acknowledgement through INTA line. Then the controller sends necessary information to the processor so that the processor executes the ISS for the interrupting device. The information contains the starting address of the ISS.

Intel 8259A

The Intel 8259A is a programmable interrupt controller. It can handle upto 8 vectored priority interrupts for the CPU. It uses NMOS technology and requires a single +5 V supply. It is packed in a 28-pin DIP or 28-lead PLCC package. Fig. 7.16 shows the schematic diagram of Intel 8259A. Fig. 7.17 shows the interfacing of 8259A chips to a microprocessor. If there is only one 8259A chip, its INT will be directly connected to INR.

Its important signals are as follows:

IRg-IR,	Interrupt requests. An I/O device sends interrupt signals through one of these lines. The interrupting device makes IRn high and keeps it high until it is acknowledged. These are asynchronous inputs.
Di,-D7	Bidirectional Data bus. Control, status and interrupt vector information is transmitted through these lines.
CS	Chip Select.



Programmable interrupt controller intel 8259 A

WR	Write. When WR is low the 8259 accepts command word from the CPU.
RD	Read. When RD is low the 8259 sends various status signals on the data bus for the CPU.
INT.	Interrupt. The 8259 interrupts CPU through this line.
INTA.	Interrupt acknowledge. The CPU sends acknowledgement through this line to 8259. This enables 8259 to send necessary information to CPU.
CAS_0-CAS_2	Cascade lines.
A_0	Address line. This pin acts in conjunction with CS, WR and RD.
SP/EN.	Slave program/enable buffer.

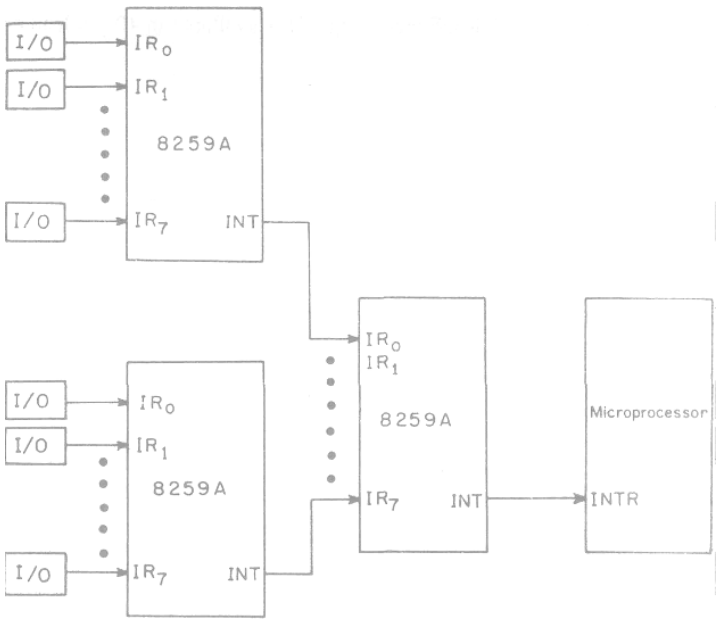


Fig. Interfacing of 8259A lo microprocessor

Programmable DMA Controllers

The basic principle of DMA data transfer has already been discussed in the beginning of the section 7.10. The necessity of DMA controller has also been explained. The DMA data transfer scheme is used where bulk data transfer is required directly from an I/O device to memory and vice versa. In this section, some DMA controllers are described.

Intel S237A, 8237A-4,8237A-5

'The 8237A is a high performance programmable DMA controller. It has 4 independent DMA channels. It has the feature of independent auto initialization of all channels. Each channel can be individually programmed to auto initialization to its original conditions following an end of process (EOP). Each channel has a full 64K address and word count capability. Memory-to-memory data transfer capability is provided. Data upto 1.6 MB/sec can be transferred at 5 MHz by 8237A-5. It can be expanded lo any number of channels by cascading additional controller chips. It has the ability of address increment and decrement. It has also the feature of software DMA requests. It is compatible to 8086, 8088, and 8085 processors. It uses NMOS technology. It is available in 40-pin lead cerdip and plastic packages.

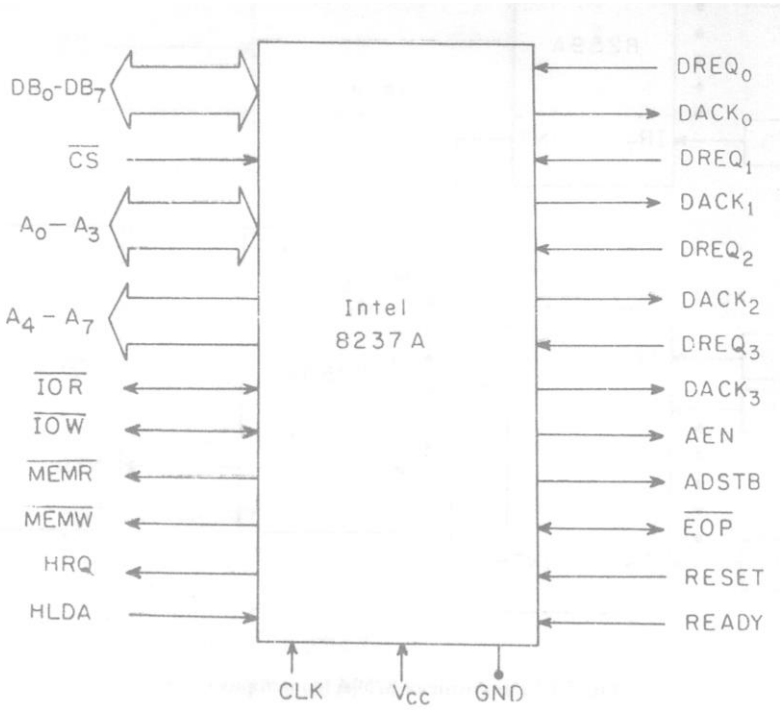


Fig. Programmable DMA controller 8237A

Fig. shows the schematic diagram of 8237A. Its important signals are as follows:

$DREQ_0$-$DREQ_3$	DMA request. An I/O device uses one of these lines to send its DMA request. DREQ should be maintained high until corresponding DACK goes active.
$DACK_0$-$DACK_3$	DMA acknowledge. When DMA is granted the I/O device is informed by 8237A through this line.
DB_0-DB_7	Bidirectional 3-state data bus lines. During DMA cycles they carry 8 MSBs of memory address which are to be latched in an external latch. The address bits are transferred in the beginning of the DMA cycle. The bus is then released to carry data during the rest of the DMA cycle.
A_0-A_3.	These are 4 bidirectional LSBs of the address lines. In id cycle these are inputs and are used by the CPU to address tl register to be loaded or read. In active cycle they are outputs and carry the lower 4 bits of the output address.
A_4-A_7.	These are 4 MSBs address lines. They give 3-state outputs. These are enabled only during DMA cycle.

HRQ. Hold request. The 8237A sends hold request to the CPU through this line.

HLDA. Hold acknowledge. The CPU sends acknowledgement to the 8237A through this line. It indicates that the CPU has relinquished the control of the system buses.

MEMR. Memory read. It is low when data arc transferred from memory to the I/O device.

MEMW. Memory write. It is low when data are transferred form the I/O device to the memory.

IOR I/O read. It is low when data arc transferred from the I/O device to the memory.

IOW. I/O write. It is low when data arc transferred from memory to the I/O device.

AEN. Address enable. It performs several tasks. It enables 8-bit latch, containing upper 8 address bits onto the system address bus. It disables other system bus drivers during DMA transfer.

ADSTB. Address strobe. It is active high. It is used to latch the upper 8 address bits into an external latch.

EOF. End of process. When the transfer of programmed number of bytes is completed the 8237A makes EOP low. It unasserts its hold request to the processor and makes AEN low to release buses back to the processor.

READY. Ready. It is an input used to extend the memory read and write pulses from 8237A to accommdale slow memories or I/O devices.

The 8237A has a number of internal registers. It stores the memory address. byte count etc. in internal registers. When the CPU grants DMA data transfer to some I/O device, it loads the device number, memory address, byte count, direction of data transfer and other necessary information into the registers of 8237A. For data transfer from the memory to the I/O device MEMR and IOW arc made low. For the data transfer from the 1/0 device 10 the memory MEMW and 10R are made low. The 8237A sends 8 MSBs of the memory address over DB-bus. These 8 MSBs of the address arc laiched into an external latch. The 8 LSBs of the address are sent on Ao-A7 lines. As the 8237A docs not have 20 address lines, so it sets up the bus address lines using some dedicated latches. When the processor 8086 supplies memory addresses, those are 20-bit addresses. The address bits A_{16}-A_{17} remain latched in external

latches. These bits are available and they are utilized by 8237A during DMA data transfer. EOP goes low when all programmed bytes of data are transferred. In fixed priority DREQg has the highest priority and DREC^ has the lowest priority.

Some terms used in DMA data transfer are as follows:

Idle Cycle. When there is no request from any channel, the 8237A enters the idle cycle. In this cycle the controller samples the DREQ lines-every clock cycle to detect if any channel is requesting a DMA cycle. The controller also samples CS to check whether the microprocessor is attempting to write or read internal registers of the controller.

Active Cycle. When the controller gets DMA request, it outputs an HRQ to the microprocessor and enters the active cycle. DMA data transfer takes place in the active cycle.

The operating modes of 8237A arc as follows:

Single Transfer Mode. In this mode the device is programmed to perform one transfer only. The word count is decremented and the address incremented or decremented after each transfer.

Block Transfer Mode. In this mode the 8237A is activated by DREQ to continue data transfer during the service until a TC (terminal count) caused by word count or an external end of process (EOP) is encountered. DERQ need only be held active until DACK becomes active. An autoinitialization occurs at the end of the service if the controller is programmed for it.

Demand Transfer Mode. In this mode the device is programmed to continue data transfer until a TC or external EOP is encountered or until DREQ goes inactive. Thus the data transfer may continue until the I/O device exhausts its data capacity.

Cascade Mode. In this mode more than one 8237A are cascaded as shown in Fig. This permits the DMA requests of the additional 8237A units to propagate through the priority network circuitry of the preceding unit.

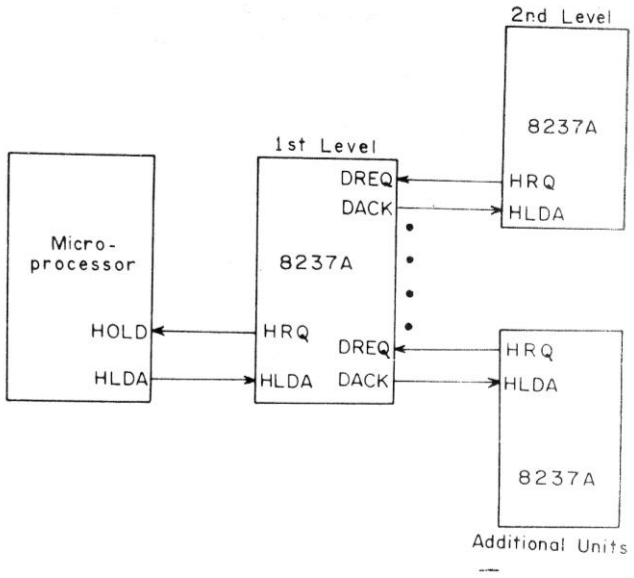
Intel 82C37A-5

It is CHMOS version of 8237A-5. It is pin to pin compatible with NMOS 8237A-5.

Intel 8257/8257-5

It is a 4-channel DMA controller. The 8257-5 is compatible with 8085 processors. Each channel generates a sequential memory address which permits the I/O device to transfer data to or from the memory. Each channel contains two 16-bit registers: DMA address register and byte count register. These registers are initialized before a channel is enabled. Initially, the DMA address

register is loaded with the address of the first memory location to be accessed. During DMA



Cascade connection of 8237A units

operation it stores the next memory location to be accessed in the next DMA cycle. Fourteen LSBs of the byte count register store the number of bytes to be transferred; 2^{14} = 16384 bytes of data can be directly transferred to or from the memory.

Its operations are similar to those explained in case of 8237A. Pins are also similar. This chip contains DACKii-DACI<3 pins and a terminal count pin. TC. TC becomes high when all programmed bytes arc transferred. The main features of 8257 are: priority DMA request logic, auto load mode. channel inhibit logic, etc.

Intel 82380

It is a high performance 32-bit DMA controller with integrated system support peripherals. It contains an 8-channel. 32-bit DMA controller, a 20-levc! programmable interrupt controller which is a superset of the 82C59A. four 16-bit programmable interval timers which are functionally equivalent to the 82C54 timers. a DRAM refresh controller, a programmable wait state generator, and system reset logic. It is developed to be used with 32-bit processor 80386. It uses CHMOS III technology and is packed in 132-pin PGA package.

The 82380 contains an 8-channel, 32-bit high performance DMA controller. It can transfer data at the rate of 50 MB/second at 25 MHz. The channels are independently programmable. It can transfer any combination of bytes, words and double words. The addresses of both source and destination can be independently incremented, decremented or held constant, and cover the entire 32-bit physical address space of the 80386. The DMA controller contains 24 general status and command registers. Any of the channels can be programmed into any of the possible modes through these registers. It contains 3 programmable registers for each channel which determine the location and amount of data to be transferred.

Byte count register (24-bits) - It holds the number of bytes to be transferred.

Requester register (32-bits) - It holds the address of memory or peripheral which is requesting DMA service.

Target register (32-bits) - It holds the address of memory or peripheral which is to be accessed.

DMA service can be requested either through hardware or software. DMA data transfer can be performed from memory to I/O, memory to memory, I/O to memory and I/O to I/O.

Intel 82307

It is a DMA/Micro channel arbitration controller. It is a VLSI device. It contains an 8-channel. 8/16-bit DMA controller. The DMA controller has 24-bit address a capability. It operates in two cycles transfer mode as defined in the microchannel architecture. The other major function of this chip is microchannel arbitration. It provides full microchannel bus arbitration capability according to the 18-level priority scheme. Besides DMA controller the 82307 also contains integrated central arbitration control point, numeric coprocessor interface, address decoder logic for interrupt controller and POS address space. It has the feature of microchannel refresh address generation/cycling. It uses low power CF technology and is packed in a 132-pin PQFP package.

Intel 82258

The Intel 82258 is an advanced high-performance 16-bit DMA coprocessor.

MICROCONTROLLERS (SINGLE-CHIP MICROCOMPUTERS)

A single-chip microcomputer contains all the essential elements of a microcomputer on a single chip. It contains CPU. RAM. ROM or EPROM, I/O ports a timer/counter. In case of single-chip microcomputers the programs are

fixed. They need not be changed because they are used for dedicated applications. The are stored in ROM or EPROM. Hence. ROM or EPROM of a single-chip microcomputer is called *program memory.* The data are stored in the RAM and hence, it is called *data memory.* In addition to these elements some single-chip microcomputers also contain serial port, A/D converter etc. Single-chip microcomputers are usually used for dedicated applications such as industrial control, instrumentation and (he control of peripherals in a computer. As they are generally used for control purposes they are also called mi*crocontrollers.* Intel has developed a number of single-chip microcomputers as described below.

If a microprocessor-based system is used for industrial control it contains a number of ICs. The circuit becomes complex. A microcontroller being on a single chip is very compact unit for such applications.

Intel 8048 Series of Microcontrollers

The 8048 series consists of a number of 8-bit microcomputers. They were introduced in 1976. The family members are 8048, 8748, 8035, 8049, 8041, 8021 and 8022. The 8048 contains an 8-bit CPU, 1024 bytes ROM, 64 bytes RAM, three 8-bit I/O ports, a timer/counter and one interrupt line. The 8748 contains 1024 bytes EPROM and all other elements same as those of 8048. The 8035 has no on-chip program memory (i.e. ROM or EPROM). Its other elements are same as those of 8048. The 8049 has 2048 bytes ROM. Its oilier elements are same as those of 8048. The 8048 is a simple, single-chip microcomputer that may be used as a stand alone device or a part of a multiprocessor system. The 8048 microcontrollers are also called MCS-48 family of microcontrollers. This series is the first generation of microcontrollers.

The 8041 and 8021 are slave microcomputers of the 8048 series of microcomputers. They can not work independently. They require the presence of a master microprocessor on one side and external logic on the other side. The 8041 is in fact, a universal interface device. It can serve a wide variety of interface logic functions. Thus whenever a complex interface controller part is required. the 8041 provides an alternative. The 8041 contains an 8-bit CPU. 1024 bytes ROM. three 8-bit I/O ports, timer/counter and 64 bytes RAM. It has no interrupt line. The 8741 contains 1024 bytes EPROM and other elements are same as those of 8041. The 8021 contains 1024 bytes ROM, 64 bytes RAM. timer/counter, two 8-bit I/O ports and one 4-bit I/O port. It has no interrupt line. The 8022 contains 2048 bytes ROM. 64 bytes RAM, three 8-bit I/O ports, one interrupt line, timer/counier and A/D converter.

All members of 8048 series are 40-pin devices except 8021 which is a 28-pin device. The 8048. 8748. 8049 and 8035 are expandable. The Intel 8243 is an I/O expander for 8048 series of microcontrollers. The 8041.8741.8021 and 8022 are not expandable.

Intel 8051 Series of Microcontrollers

In 1980. Intel introduced a more powerful 8051 series of 8-bit single-chip microcomputers. The family members of the series are 8051 AH, 8031 AH, 8751 AH. 80C51. 80C31, 8052 and 8032. Table 7.2 shows the details of 8051 family. The 8051 microcontrollers are the second generation of microcontrollers. The 8051 microcontrollers are also called MCS-51 family of microcontrollers.

Microcontrollers	On-Chip Program Memory	On-Chip Data Memory	Technology	Pins
8051 AH	4K bytes ROM	128 bytes	HMOSII	40
8031 AH	None	128 bytes	HMOSII	40
8751 H	4K bytes EPROM	128 bytes	HMOSI	40
80C51	4K bytes ROM	128 bytes	CHMOS	-
80C31	None	128 bytes	CHMOS	-
8052	8K bytes ROM	256 bytes	HMOSII	40
8032	None	256 bytes	HMOS II	40

The MCS-51 microcontrollers are versatile microcontrollers which are used for a wide range of applications from a simple industrial control to the control of a sophisticated equipment. The new members of MCS-51, the 8052 and 8032 have more on-chip memory and an additional 16-bit timer/counter. The new timer/counter can be used as a timer, a counter or to generate baud rates for the serial port.

The main features of MCS-51 family are:

i. 8-bit CPU

ii. 64K bytes address space for program memory. The lower 4K bytes (8K bytes for 8052) are on-chip. The remaining memory may be for off-chip external program memory.

iii. 128 bytes (256 bytes for the 8052 and 8032) on-chip data memory. 64K bytes memory space for external (off-chip) data memory. The external data memory is in addition to internal on-chip data memory.

iv. Two 16-bit timer/counters (three on 8052 and 8032).

v. On-chip oscillator and clock circuitry

vi. Full duplex serial port.

vii. Boolean processor.

viii. The 8051 has 5 interrupts: 2 from external devices, 2 from timer/counters and 1 from the serial port. The 8052 and 8032 have 6 interrupts.

ix. 32 I/O lines.

The important registers of 8051 are accumulator, B register, PSW register, 8-bit stack pointer, 16-bit data pointer, 16-bit counting registers for timer/counters. program counter, RAM address register, program address register, instruction register, control registers, serial data buffer (two separate registers: a transmit buffer and a receive buffer register), etc. The B register is used during multiply and divide operations. For other functions it can be treated as another scratch pad register. The function of the data pointer is to hold a 16-bit address.

The 8051 has 111 instructions: 49 single byte, 42 two-byte and 17 three-byte. It has instructions for multiplication and division. It operates with 12 MHz clock and requires a single +5 V supply. It takes 1 p sec for addition and 4 n sec for multiplication and division.

Intel 8096 Series of Microcontrollers

Intel introduced 8096 series of microcontrollers in 1983. The 8096 microcontrollers are 16-bit single-chip microcomputers. The family members of the series are 8096. 8396, 8097. 8397 etc. The details arc shown in Table 7,3.

Table 7.3MCS-96 Family

Options		**68 Pin**	**48 Pin**
Without A/D convener i.e. digital I/O	Without ROM	8096	8094
	With ROM	8396	8394
With A/D converter i.e analog and digital I/O	Without ROM	8097	8095
	With ROM	8397	9395

The important features of MCS-96 are:

i. 6-bit CPU.

ii. 8K bytes ROM, i.e. program memory.

iii. 232 bytes RAM, i.e. data memory.

iv. Hardware multiplication/division.

v. Five 8-bit I/O ports.

vi. 10-bit A/D converter. It takes 42 n sec for conversion. It can convert upto 8 (in 68-pin chips) and upto 4 (in 48-pin chips) analog inputs to digital values.

vii. Full duplex serial port.

viii. Watchdog timer. It provides ability to recover from software malfunction or hardware upset. The watchdog timer resets the system if the software is malfunctioning and docs not progress properly. It also resets the system if the hardware does not work properly

The input/output (I/O) devices and secondary storage units of a computer are called *peripherals.* The term peripheral is used in a wider sense, it also includes interfacing devices such as I/O port, programmable peripheral interface, programmable interrupt controller, DMA controller, communication interface, counter/interval timer, CRT controller, memory Controller, floppy disk controller, hard disk controller, keyboard interface etc.

PERIPHERALS

INPUT DEVICES

Data and instructions are entered into a computer through input devices. An input device converts input data and instructions into suitable binary form which can be accepted by the computer. The commonly used input device is a keyboard. A number of input devices have also been developed which do not require typing for inputting information. Examples are: mouse, light pen, graphic tablet, joy slick, track ball, touch screen etc. Each of these devices permits the user to select something on CRT screen by pointing to it. Therefore, these devices are called pointing devices. Voice input systems have also been developed. A microphone is used as an input device.

Keyboards

Programs and data are entered into a computer through a keyboard which is attached to a microcomputer or the terminal of a mini or large computer. A keyboard is similar to the keyboard of a typewriter. It contains alphabets, digits, special characters and some control keys. When a key is pressed an electronic signal is produced which is detected by an electronic circuit called *keyboard encoder. A* keyboard encoder may be special 1C or a single-chip microcomputer used as encoder. The function of an encoder is to detect which key has been pressed and send a binary code (corresponding to the pressed key) to the computer. The binary code may be an ASCII, EBCDIC or HEX code.

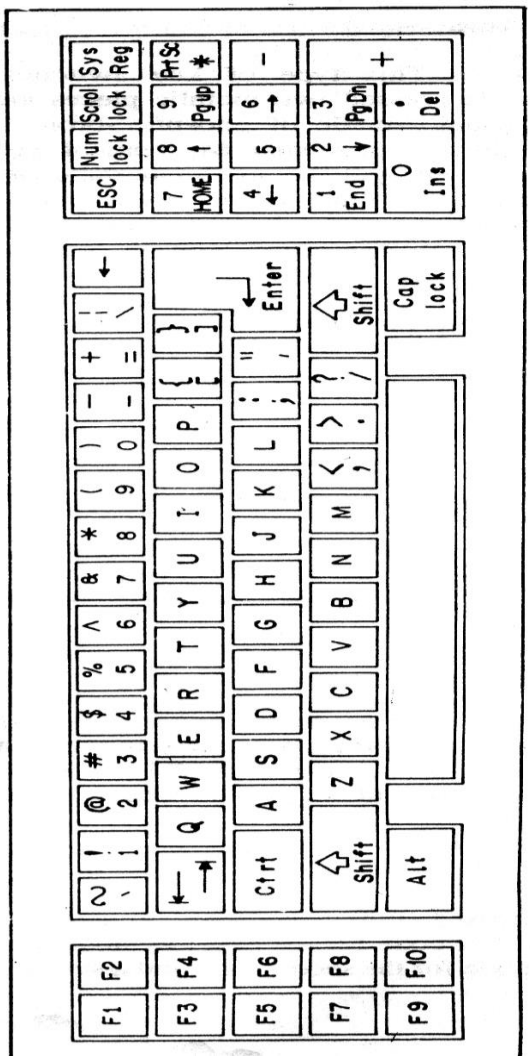
In some computer systems the keyboard encoder sends simply a *scan code.* indicate which key has been pressed. There is a computer program called

keyboard translation program to assign the meaning of the scan code. The program will give the desired binary code corresponding to the pressed key. This approach is known as *soft keys.* This approach makes possible to change the meaning associated with various keys on the keyboard.

A single chip microcomputer used as encoder contains a lookup table in a ROM. The binary code is obtained from the lookup table. By changing the lookup table in the ROM the output code can be changed. For example, the keyboard system which previously was outputting ASCII, can be made to output EBCDIC or any other codes by changing lookup table in the ROM.

The codes from the encoder may be transmitted to the computer usually in serial mode. In serial transmission number of connecting wires is reduced and data is sent one bit at a time. Computers use standard keyboards having QWERTY type layout of characters, which is commonly used in mechanical typewriters. For faster typing keys are rearranged to give a different layout known as Dvorak keyboard. It is available at extra cost as an optional.

Fig shows an arrangement of a QWERTY type keyboard. It contains 84 keys. Some upgraded keyboards have 101/102 keys. The keyboard contains alphabets, digits, special symbols, some function keys and control keys. When Enter (or Return) key is pressed the cursor comes in the beginning of the next line. Home key allows the user to move cursor instantly to the beginning of the stored text. End key brings cursor at the end of a line of the text. Alt (alternate) key gives alternate function of other keys. For example, holding down Alt key, press p, it will type PRINT on the screen. Similarly, press I, it will type INPUT; pressing D will type DELETE etc. Ctrl is a control key. It is used to give commands to PC. Holding it down one of the letter or number key is pressed. Exactly what Ctrl does depends on the software you are using at that time. Esc (escape) key is an undo key. Suppose you have typed certain line (statement of the text), if you want to escape that, press Esc. That line will be erased. You will learn more when you handle the keyboard. There are keys to move the cursor up, down, left and right. The PgUp or PgDn permit the user to move one page of the stored information at a time upward or downward respectively. Del (delete) key allows to erase characters. Ins (insert) key allows to insert characters. When Prt Sc (print 8 screen) is pressed the text on the CRT screen is printed. The function keys are Fl. F2 .....F10. They are used in various ways when programs are run. For example in word processing the F7 key is used to underline the text. the F8 is to print bold typeface. In BASIC F2 is used to run a program. F4 to save a program etc.



Keyboard

Construction of the Keys

Mechanical Keyswitches. This type of key switches are mechanical type switches. When a key is pressed two metalic pieces arc pushed together. The switch elements are usually made of phosphot-bronze alloy. When a key is pressed an electronic signal is produced. Mechanical type keys suffer from contact bounce. A pressed key may make and break the contact several times before it makes a perfect contact. They may become dirty or oxidized. This makes their contact imperfect and they are no longer reliable. The life of high quality mechanical keys is about 1 million keystrokes.

Capacitive Keyswitches. A. capacitive type keyswitch uses plates: one movable and two fixed. When a key is pressed, the movable plate comes closer to the fixed plates. This causes a change in the capacitance between the two

fixed plates. An electronic circuitry detects this change and produces a signal. It is better and more reliable than mechanical switches, but it requires special circuitry to detect change in capacitance. Its life is more than mechanical type keyswitches, 20 million keystrokes.

Hall Effect Keyswitches. In this type of keyswitches a current is passed through a semiconductor crystal between two opposite faces. This current acts as a reference. A magnet is moved to provide magnetic field. When a key is pressed, a small magnet moves. This produces a small voltage across the other two opposite faces of the crystal. Such keyboards are expensive but more reliable. Their life is 100 million or more keystrokes.

Two-Key Lockout

When more than one keys are pressed simultaneously a problem arises that the processor should not perform wrong operation. In the technique of two-key lockout a single key pressing is recognized. Additional key closure is ignored until the previous key is released. Only after the release of the previous key, next one is recognized.

Two-Key Rollover

When wo keys are pressed simultaneously or at nearly the same time, each one is recognized. The ASCII code for the first key and a strobe signal for it is sent out. Then the ASCII code for the second one and a strobe signal for it is sent out.

N-Key Rollover

When N-keys are pressed at a time each key is treated independently. The information of all the key closures is stored in some internal buffer. The operations performed in a sequence.

Light Pen

A light pen is pointing device. It is used to select a displayed menu option on the CRT It is a photosensitive penlike device. It is capable of sensing a position on the CRT screen when its tip touches the screen. When its tip is moved over the screen surface, its photocell sensing element detects the light coming from the screen and corresponding signals are sent to the processor. The menu is a set *of programmed choices offered* to the user. The user indicates his choice by' touching light pen against a desired *description of the menu. The signals sent by the light pen to the processor identifies the menu option.*

A light pen can also be used for graphics work. A user can draw directly on the CRT screen with the light pen if the computer system is provided with CAD package. The user can select various colours and line thicknesses, can add or erase lines and can enlarge or reduce the size of the drawings.

Mouse *(Pack)*

A mouse is also a pointing device. It is held in one hand and moved across a flat surface. Its movement and the direction of the movement is detected by two rotating wheels on the underside of the mouse. The wheels have their axes at right angles. Each wheel is connected to a shaft encoder which emits electrical pulses for every incremental movement of the wheel. The pulses transmitted by the mouse determine the distance moved.

When a user moves the mouse across a flat surface, the cursor on the CRT screen also moves in the direction of the mouse's movement. By moving the mouse the user can point to menu on the screen. By pressing the button on the mouse, the user communicates his choice to the computer.

The mouse is also used to draw sketches, diagrams etc. on the CRT screen. It is also moved on graphic tablet for drawing work. The mouse is also used to edit text. For editing a text on the screen the cursor is quickly moved to the desired point of the screen by moving the mouse. Fig. shows a mouse. A mouse has one or more buttons on the surface for the control purpose.

Joystick

A joystick is also a pointing device. It is used to move the cursor position on a CRT screen. Its function is similar to that of a mouse. A joystick is a stick which has spherical ball at its lower end as well as at its upper end as shown in Fig. The lower spherical ball moves in a socket. The joystick can be moved right or

Push button Switches

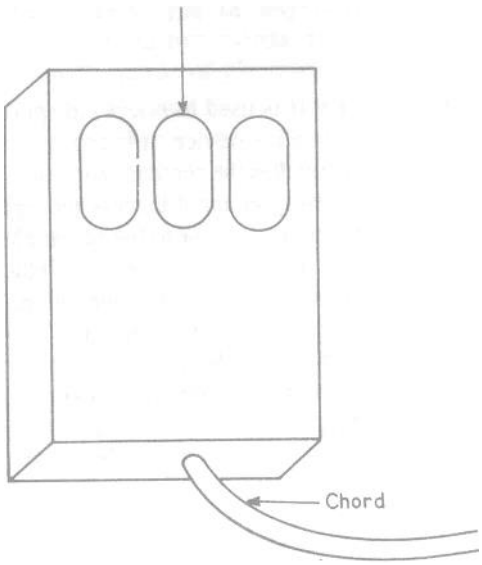


Fig. Mouse

left. forward or backward. The electronic circuitry inside the joystick detects and measures the displacement of the joystick from its central position; the information is sent to the processor.

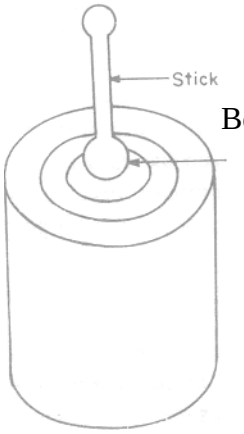


Fig. Joystick

Trackballs

Trackball is also a pointing device and contains a ball which can rotate in any direction. The user spins the ball in different directions to move the cursor on the CRT screen. The associated electronic circuitry detects the direction and speed of the spin. The information is sent to the processor.

Scanners

Scanners are a kind of input devices. They are capable of entering information directly into the computer. The main advantage of direct entry of information is that users do not have to key the information. This provides faster and more accurate data entry. Important types of scanners are optical scanners and magnetic-ink character readers.

Optical Scanners

The optical scanners are capable of reading information recorded on paper, 'employing light source and light sensors. The information to be scanned is typewritten information, information coded as ink or pencil marks or information coded as bars. The following are the commonly used optical scanners:

Optical Character Readers (OCR). An optical character reader detects alphanumeric characters printed or typewritten on paper. It may be a handheld scanner or a page scanner to detect light reflected from a line or from a page of the text. The change in the reflected light is convened to binary data which is sent to the processor. The text which is to be scanned is illuminated by a low-frequency light source. The light is absorbed by the dark areas while the light is

reflected from the lighted areas. The reflected light is received by photocells or CCDs (charged coupled devices) which provide binary data corresponding to dark and lighted areas. An OCR can scan several thousands printed or typewritten characters per second. Optical character readers are used in large-volume applications such as computer-oriented bills prepared by public utilities.

Optical Mark Reader (OMR) Special marks such as square or bubble are prepared on examination answer sheets or questionnaires. The users Fill in these squares or bubbles with soft pencil or ink to indicate their choice. These marks are detected by an optical mark reader and the corresponding signals are sent to the processor. If a mark is present, it reduces the amount of reflected light. If a mark is not present, the amount of reflected light is not reduced . This change in the amount of reflected light is used to detect the presence of a mark. This method is used where one out of a few number of alternatives is to be selected and marked. For example, market survey, population survey, objective type answer sheets etc. where choice is restricted to one out of a few choices.

Optical Bar-Code Readers This method uses a number of bars (lines) of varying thickness and spacing between them to indicate the desired information. Bar-codes are used on most grocery items. An optical-bar reader can read such bars and convert them into electrical pulses to be processed by a computer. The most commonly used bar-code is universal product code (UPC). The UPC code uses a series of vertical bars of varying widths. These bars are detected as ten digits. The first five digits identify the supplier or manufacturer of the item. The second five digits identify individual product. The code also contains a check digit to ensure that the information read is correct or not.

A point-of-sale terminal often contains an optical-bar reader. Such a terminal is used to process the sale transactions. It is an on-line terminal connected to a computer for processing. The optical-bar reader reads the bar-code of an item. The bar-code is decoded and data are sent to the computer. The computer prints the name of the item. its price and other necessary informations on the receipt. The stock at-hand and sale records are also updated.

Magnetic-Ink Character Reader (MICR)

MICR is widely used by banks to process large volumes of cheques and deposit is written every day. A special ink called magnetic ink (i.e. an ink which contains iron oxide particles) is used to write characters on the cheques and deposit forms which are to be processed by an MICR. MICR is capable of reading characters on a paper written with magnetic ink. The magnetic ink is magnetized during the input process. The MICR reads the magnetic pattern of the written characters. To identify the characters these patterns are compared

with special pattern stored in the memory. Before cheques are issued to customers the identification number of the bank and the depositor's account number are printed on the lower left-side of the cheques with the magnetic ink. The amount is printed on the lower-right side of the cheque by the bank employee with the same magnetic ink after the cheque is received from the customer. When a cheque is entered into an MICR, it passes through a magnetic field. The iron oxide particles are magnetized under the magnetic field. The read head reads the characters written on the cheque with the magnetic ink. It interprets the characters and sends the corresponding data directly to the computer for processing Upto 2600 cheques are processed per minute, by an MICR.

Voice Input Systems

Data entry into a computer manually using keyboard is a time-consuming and laborious task. It will become very easy if we can talk to a computer. Attempts have been made to develop a computer that can listen to the users and talk to them. The voice input to the computer i.e. voice recognition by a computer is much more difficult than the voice output. It is because of the fact that the rules for generating voice through a speaker or a telephone system can easily be defined compared to the rules for interpreting words spoken by a person. The tones of speech, speed, accent and pronunciation differ from person to person. These differences in speech makes voice recognition a difficult job. In a voice input system the speech is converted into electrical signals employing a microphone. The signals are sent to a processor for processing. The signal pattern is compared with the patterns already stored in the memory. A word is recognised only when a choice match is found, and then the computer gives a corresponding output. At present a voice recognition system is very costly. In future it is expected to become cost effective and will be widely used for direct entry of data. IBM has developed a Talkwriter with 6000 words. It is capable of detecting words with 95% accuracy. It is meant for business correspondence. A voice recognition system can be used in factories at places where both hands of worker are engaged in the job he is doing and he wants to input some data into the computer. It can also be used to assist bedridden and handicapped persons in a number of tasks; to control access to restricted areas; to identify a customer in a bank etc.

Some Other Forms of Input Devices

Microcomputers or microprocessor-based systems are now widely used in industry for automatic control. Physical quantities like temperature, pressure, speed, deflection, strain, stress, force, vibration etc. are measured and controlled by microcomputers. An electrical or electronic device called

transducer is used to sense physical quantity and give proportional electrical signal. The electrical signals are amplified and then converted to digital signals. The digital signals are fed to the processor for measurement, display and control purposes. Transducers. amplifiers, analog-to-digital converter etc. form a circuitry called data acquisition system. The data acquisition system acts as an input device. Electrical quantities like voltage, current, frequency, power, energy etc. are also measured. displayed and controlled by microcomputers'. The data acquisition system for electrical quantities do not need transducers. They employ amplifiers, analog-lo-digital converter, analog multiplexer, sample-and-hold circuits etc. Also in the case of processing of electrical quantities the data acquisition system acts as an input device. In some cases switches are used to supply electrical signals to computers for control purposes. In those cases switches act as input devices.

In many applications it is desired that a computer should be able to see its environment. For example, a robot must be able to sec to perform its job. a computer-controlled security system must be able to see its environment etc. To provide vision to computers, sensors like video cameras, CCD cameras. OPTI-CRAM cameras etc. are employed. These cameras act as sensors to provide signal proportional to the intensity of light falling on the various spots of the image of an object. The computer can process these signals and recognize and display the image of the object. Such sensing devices which provide the required signals to computers act as input devices.

OUTPUT DEVICES

The output devices receive informations from the computer and provide them to users. The computer sends informations to the output devices in binary coded forms. The output devices convert them into a form which can be used by users such as printed form or display on a screen. In some applications (he computer's output may also be converted by an output unit in a form which can be used as to other devices, equipment, machines etc. The commonly used output devices with general purpose computers are: CRT screen and printers.

Computers or microprocessor-based systems are now widely used for automatic control applications in industry and other commercial organizations. In such cases the computer outputs electrical signals which are sent directly for control purposes. In some cases digital-to-analog converters are used as output devices to give control signals to controllers, actuators, relays etc.

There are certain devices which act as both input as well as output devices. Examples are: teleprinter terminal, visual display terminal etc. A teleprinter terminal contains a keyboard for input and a typewriter-like printer for output. A visual (or video) display terminal (VDT) contains a keyboard for

input and a visual display unit for output. The visual display unit is called *monitor* or *video monitor*. Most VDT units contain CRT for visual display. Other types of display units are also available such as LED (light emitting diodes) display, LCD display and plasma screens. The VDT which contains CRT for visual display is also called CRT terminal.

The magnetic disks and tapes are secondary memory. Their additional uses are as input/ouput devices. Programs and data can be directly entered into the computer from such devices. So these devices act as input devices. They can also act as output devices when programs and data arc received and stored onto them, Thus a magnetic disk or tape can act as an input as well as an output device.

CRT Terminals

A CRT terminal consists of a CRT display unit. a keyboard. CRT-refresh RAM, CRT controller and USART or UART for communication with the computer, Modern CRT terminals contain one or more built-in microprocessors to control and co-ordinate keyboard, CRT display unit and data transmission from the terminal to the computer and vice-versa. The data are entered into the computer through the keyboard. Each entered character is also displayed on the CRT screen, so that the user can see what he has typed. When data are keyed in, they an- held in a small memory called a *buffer,* within the terminal itself. The data are not transmitted to the computer until the user presses an enter key on the keyboard. A small square pointer on the screen, called a *cursor* indicates the spot on the screen where the next character to be keyed will be displayed. To correct keystroke errors the cursor is moved to the position where the correction is to be made. Then the key for the correct character is pressed. Since the terminals are used for interaction with operators, fast data transmission is not required. Therefore. usually data are transmitted from the terminal to the computer and vice versa in a serial mode i.e. one bit a time.

CRT Display Unit

A CRT (Cathode Ray Tube) display unit is a commonly used output device. It displays the data or information received from the computer. It can display alphanumeric characters and graphs. Though the CRT is basically an output device it can perform limited input function when used in conjunction with a light pen. The CRT screen is similar to a TV screen. A CRT is a vacuum tube. An electron beam is produced by (lie electron gun located at the back portion of the tube. The electron beam is directed towards the front of the CRT (i.e. CRT screen). A coating of phosphor material is made on the inner surface of the screen. The phosphor emits light when it is struck by electron beam. The

colour of the emitted light depends on the phosphor substance used. A CRT display may be either monochrome (i.e. only one colour) or colour (i.e. multicolour). Monochrome displays are available in green, blue. orange, yellow, pink. amber, red, and white depending on the type of the phosphor material used. Colour displays arc produced on CRT screen on the same principle as they are produced on colour TV screen. To produce colour display three phosphors: red. blue. and green arc used The coating of these phosphor materials is made in such a way that dots of these three phosphors in a triangular pattern arc spread over the entire screen. The three clots of the three colours placed on a triangular spot arc so close that they appear as a single dot. Three separate electron beams arc employed to illuminate dots of three different phosphors. By varying the intensity of the three electron beams the intensity of red. blue and green dots is varied. This gives the appearance of a triangular spot (consisting of red, blue and green of the desired colour. Black and while colours can also be obtained. When all the three beams arc off the spot will be a black one. When red is 30% green 59% and blue 11%;. the spot will become white. By turning on and off the different combinations of red. blue green beams 16 types of colour can be produced. A much wider variety colours can be obtained by controlling the intensity of red blue and green electron beams employing digital analog (D/A) conveners.

Raster Scan and Vector Scan Method of Display

Characters or graphics displayed on the CRT screen are formed of a number of dot points. The dot points are arranged on horizontal scan.lines on the screen. In the raster scan method the electron beam is directed at the top left-hand corner of the screen and then it is moved along the first horizontal scan line. The beam illuminates the selected dots along the first horizontal scan line, which arc needed to produce characters or graphics. When the beam reaches right end of the first scan line, it is turned off (blanked) and retraced rapidly left side to the starting point of the second scan line. Now it moves along the second scan line and illuminates the required dots on it. This process is repeated and all the scan lines of the screen are illuminated to display images, characters or graphics on the screen. When the beam reaches at the end of the last line it is blanked and retraced back to the starting point of the first scan line again and the entire process is repeated again to refresh the illumination of the desired dots so that one can always see the display due to persistence of vision. In this method the beam is scanned over the entire screen.

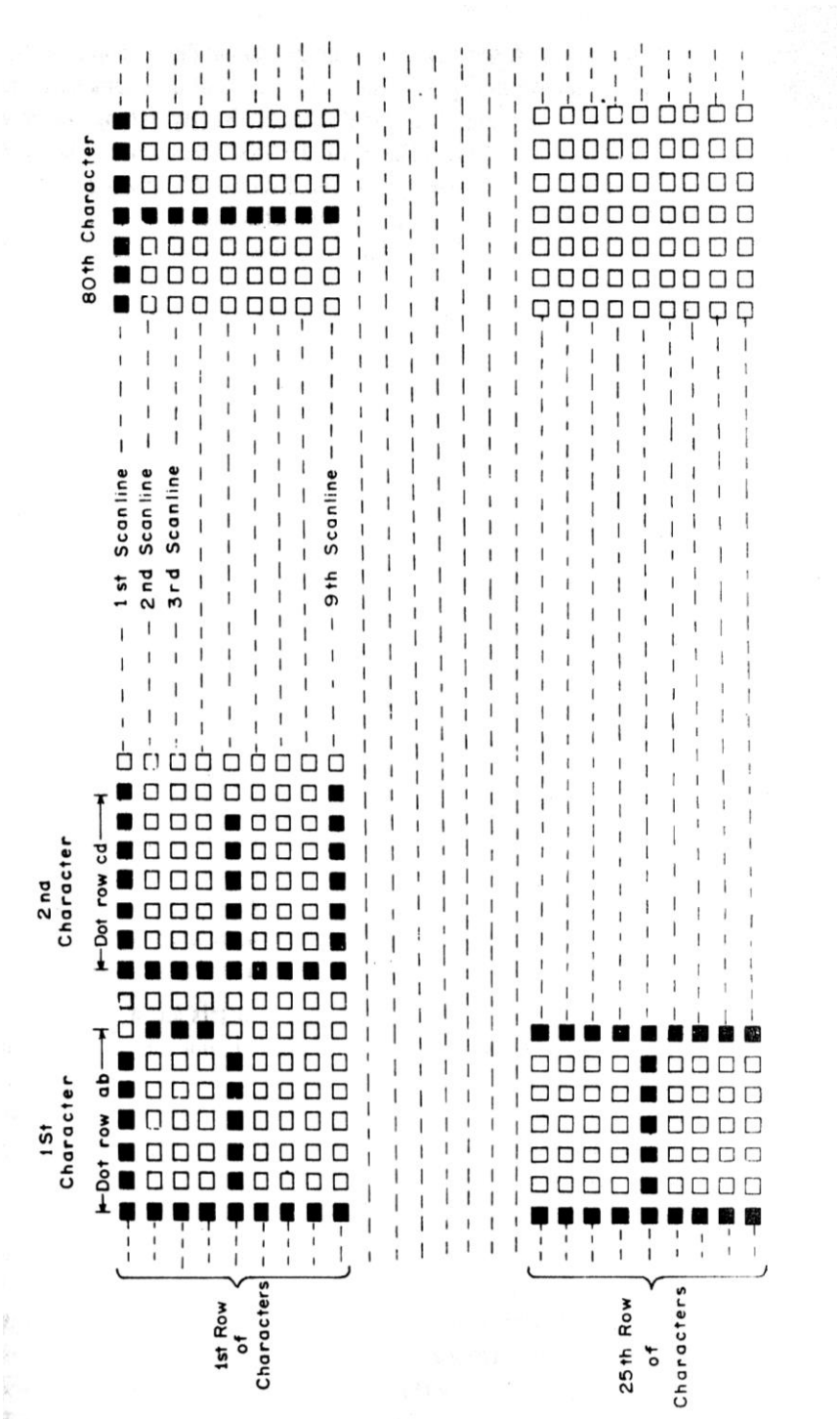
In many applications we want only to draw an array of straight lines. In such cases it will be wasteful to move the electron beam along all the scan lines over the entire screen. Moreover, the diagonal lines displayed by raster

technique look like stair steps. In vector scan (or random scan) method deflecting plates are used to deflect the beam left or right, up or down. The beam can be directed to any point on screen directly. This technique illuminates the selected dots on the screen directly. Straight lines can lie drawn connecting any two points on the screen. By applying the proper analog voltage to horizontal and vertical deflecting plates the electron beam can be directed to any desired spot. D/A converters are used in the circuitry of deflecting plates to give appropriate analog voltages. The vector scan method is quite suitable to display graphics consisting of straight lines. But it is not suitable to display curves.

Display of Characters on CRT Screen

A character is displayed on the screen by light dots. A matrix of dots is used for this purpose. To display a character the size of the dot-matrix may be 5 x 7,7 x 9 or 7 x 12. The desired dots are lighted to display a character. A ROM called *character generator ROM,* stores the dot pattern for the display of each character. The ASCII or EBCDIC codes of the character of a text to be displayed at a time on the screen, are stored in a RAM. called *display RAM* or *video RAM* or *display refresh RAM.* When new text is to be displayed the contents of the RAM are changed accordingly. A CRT screen displays 25 lines (rows), each line (row) containing 80 characters. So 2KB (25 x 80 bytes) display RAM is required for (his purpose. A *row counter* and a *character counter* are employed to address the ASCII code of a character in the display RAM

Each row of the dot matrix is called *dot row.* Therefore, to display one row of characters (i.e. one line of the text) 9 dot rows will be needed, if 7 x 9 dot-matrix is used. The dot-rows of the same characters-row form *scan lines. A* dot-row of dot-matrix is a section of the scan lines dot-matrix is a section of the scan



Character display by dot-matrix

lines as shown in Fig. A schematic diagram to explain the principle of displaying a character is shown in Fig. The ASCII codes of the character to be displayed on the screen are stored in the display RAM. By setting the row counter and character counter the address of the first character of the first character-row is applied to the display RAM. The display RAM gives an output, i.e. ASCII code of the first character of the first character-row. This code is applied to the character generator ROM which contains the dot-matrix pattern of the character.

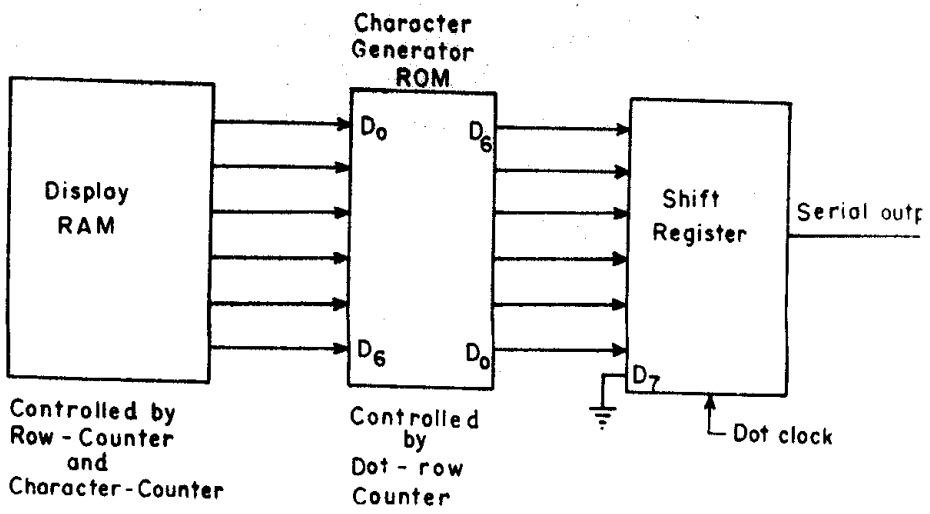
A dot matrix has 9 dot-rows. At a time one dot-row is taken up for scanning by the electron beam. A *dot-row counter* is also employed to count the dot-rows of a character (or scan lines of the characters). The output of this counter controls the character generator ROM. So the ROM will give the dot pattern of the first scane line of the first character. This output is applied to a shift-register. The function of the shift register is to convert the parallel input to serial output because the scanning of dots of a dot-row is to be done one dot at a time. The output of the shift register is amplified and then used to lighten the required dots of the first scane line of the first character (i.e. the dots on). The eighth bit of the data input of the shift register is grounded. This gives one dark dot or undo between adjacent characters. After this the first scan line of the second character of the first character row (i.e. cd) is taken up. Similarly first scane line for all 80 characters is taken up. Then the electron beam is banked and retraced to the starting point of the second scan line of the first row of characters. In this way all 9 scan lines are taken up one by one for the first row of characters. After this the second row of the characters (i.e. second line of the text) will be taken up. This process will be repeated to take up all the 25 character-rows. When the electron beam reaches at the right end of the last scan line of last character row, it is retraced back to the starting point of the first scan line of first character row. The entire process of scanning is again repeated to refresh the characters displayed on the screen. The refreshing is done 60 times per second.

In some arrangements the ASCII codes of the characters arc stored in alternate memory locations of the display RAM. Associated with each character an attribute byte is also stored. The attribute byte specifies the quality of the character, such as underline, increased or decreased intensity, whether it is blinking and so on. In some cases two RAMS are employed. One stores codes of the characters while the other stores attributes.

Bit-Mapped Raster Scan Method

This technique is used to display graphics or pictures. The screen is not treated as 25 rows of characters and each row containing 80 characters. The

entire screen is treated as a matrix of dots. Each dot is programmed whether it will he on or oil. There is no display RAM and character generator ROM. The dot patterns for each 8 dots of a scan line is stored in successive memory locations. A byte is rend



Schematic diagram of the character displaying circuit

from the memory and applied directly to the shift register which gives serial output. The desired dot patterns for a section of the scan line is displayed on the screen. Then next byte from the memory is taken up. The process of the raster scan is followed and the dots of the entire screen are scanned. Each dot is called a picture element or in short *pixel* or *pel.* This method is very flexible. It has two major drawbacks. It requires larger RAM capacity, i.e. 16 KB compared to 2 KB in character display method. To produce colour graphics still more memory locations are required. In this technique tremendous amount of copying is required. It needs a very fast CPU or special hardware for controlling pixels quickly.

Programming of each pixel is a very tedious work. To make programming easy graphics programs are available. One has to learn how to use these programs. In graphics program subroutines are available to draw lines, circles, arcs etc. using which complex drawings can be drawn and print out can be obtained. A mouse is very helpful in preparing such drawings.

A bit-map terminal can support displays having a number of windows. A window is defined as an area of the screen used by one program. The facility of multiple windows allows to run several programs at the same time. Each program displays its results independent of the others

Some video terminals have both facilities: they can work cither as a bit-map terminal or a character-map terminal.

CRT Controllers

A CRT controller contains the necessary electronic circuitry to control CRT display Several controller ICs are available. A few of them arc described below.

Intel 8275

It is a single chip programmable CRT controller to interface CRT raster scan displays. It is compatible with 8085,8086 and 8088 Intel microprocessors. Its basic function is to display characters and refresh the display. It also has graphics capability. It contains a row counter, a character counter, a scan line counter a raster timing circuitry and video control unit. It also contains two 80-byte buffers, one to hold the ASCII codes of characters of the row to be displayed and the other to hold the ASCII codes of characters of the next row. The ASCII codes of characters of a page to be displayed are stored in the main memory of the computer, While the contents of one 80-byte buffer of 8275 arc being used to refresh the display, the other 80-byte buffer is filled up with the ACCII codes for the next row using DMA technique. Character generator ROM and shift register are external chips. The 8275 has capability of 4 types of cursor control. It is also provided with light pen detection capability. It has programmable screen and character format. It possesses 6 independent visual field attributes.

Intel 8276

It is small system CRT controller. It is meant to interface CRT raster scan displays with Intel 8085, 8086, 8088 microprocessors and 8051 single chip microcomputer. It has 4 types of cursor control, programmable screen and character format, 6 independent visual field attributes. It contains all necessary counters, buffers, raster timing circuitry and video control, etc.

Intel 82706

It is an Intel video graphics array (VGA) compatible display controller for IBM PC/XT/AT and PS/2. All video monitors developed for IBM PS/2 system are provided with VGA controller. The 82706 can support 256 KB video memory. It is designed to be compatible with 80286 and 80386 and other microprocessors. It has EGA/CGA/MDA BIOS compatibility. It acts as CRT controller and video memory controller.

Intel 82716

It is a video storage and display device. It is a low cost. highly integrated video controller. It displays texts and graphics. It can manage upto

16 display objects on the screen at any time. It can select upto 16 colours from a range of 4096. It contains on-chip DRAM controller and on-chip D/A converters. It can support upto 512 KB of display memory. It is compatible with 8 - and 16-bit microprocessors and microcontrollers.

Motorola 6845

It is a CRT controller. It is used in both a monochrome monitor and a colour/graphics monitor. It uses 2 external 2KB memory: one to store ASCII codes of characters and the other to store an attribute code for each character. Character generator and shift registers employed are external. A multiplexer is used to allow either the CPU or CRT controller to access the display-refresh RAMs. It can address upto 16 KB of display and attribute memory.

Intel 82786

It is a CHMOS graphics coprocessor. It is compatible with all Intel microprocessors. It can support multiple graphics applications from multiple graphics bitmaps. It has high speed character drawing, fast polygon and line drawing capability. It can support upto 200 MHZ CRTs. It provides upto 256 simultaneous colours. It contains DRAM/VRAM controller for graphics memory upto 4 MB. It contains shift registers and DMA channels. It is a powerful device developed for microcomputer applications including PCs, engineering workstations, terminals and laser printers. High integration makes it cost-effective. It uses advanced CHMOS III process.

Non-CRT Displays

Non-CRT displays include LED, LCD and plasma displays. LED displays are used in microprocessor-based industrial controls, instruments etc. where only a small amount of data are to be displayed. CRT screen display is used where a large amount of data arc to be displayed. In portable battery powered instruments usually LCD displays are used because they consume less power. Non-CRT displays have been described below in brief.

Liquid Crystal Display (LCD)

In LCDs a liquid crystalline material is sandwiched between two glass or plastic plates. The front plate is transparent and the back plate is reflective. There is a coating of thin film on the front plate. The coating is transparent and conductive. Us sections (segments) are in the shape of desired characters. An electrically conductive film or backplane is put on the back plate. A voltage is applied between a segment and the back plate to create electric field in the region under the segment. The electric field makes a change in the transmission of light through (lie region under the segment. Commonly available LCDs arc of two types: dynamic scattering type and field effect type. In dynamic

scattering type the molecules arc aligned in one direction under the segment where field is present. The crystalline molecules reflect more light in this condition and this produces etched-glass-looking light characters on a dark background. In field effect type, molecules are polarized to absorb light where electric field is present. This produces dark characters on a silver-gray background. LCDs do not emit their own light. Therefore, a light source is to be used. LCDs simply change the reflection of available light. Today, most LCDs used are of the type that produce dark images on a silver background. The colour displays have also been developed. Monochrome and colour displays are expected to grow rapidly in future. D.C. voltage is not used in case of LCDs as it will damage them. A square wave signal of frequency 30-150 HZ is used for the purpose. A 2-3 V is required between the backplate and segment.

Screen type LCDs haves also been developed. For screen type LCDs the liquid crystal elements are arranged in a large X-Y matrix of dots. The elements of each row are connected together for driving purpose. Similarly, the elements of each column are also connected together. An individual element is energized by energizing both the row and the column which contain (he element. This type of display has a problem of low resolution. The resolution is (he ability to distinguish things which are close together. LCDs are lightweight and consume little power which make them attractive for portable computers.

Plasma Displays

In plasma displays ionized gas is sandwiched between two glass plates. A number of parallel wires run horizontally as well as vertically. A small amount of current is passed through one horizontal and one vertical wire to cause the gas to glow at a spot at the intersection of the wires. The problems encountered with LCDs are eliminated in plasma displays. The IBM 581 display employs 960 horizontal and 768 vertical pixels as compared to IBM-PC colour graphics adapter which is provided with 320 by 200 pixels in medium resolution, and 640 x 200 in high resolution. The plasma displays screens are costly. These are available on the selected models of portable computers.

Light Emitting Diode (LED) Displays

Three types of LED displays as shown in Fig. are available. A 7-segment display is very simple and it is used to display only digits and hexadecimal letters. To display numbers and entire alphabets 18-segmcnt displays or dot-matrix displays can be used.

The 7-segment displays being simple are widely used. Drivers/decoders for 7-segment displays are available in 1C form. The displays arc interfaced to microprocessors through drivers/decodes. Such displays with buffers can also be connected directly to the processor through ports. There are binary codes to

display digits and some selected alphabets. These codes are stored in memory. For more details including interfacing Ref. 1 may be consulted.

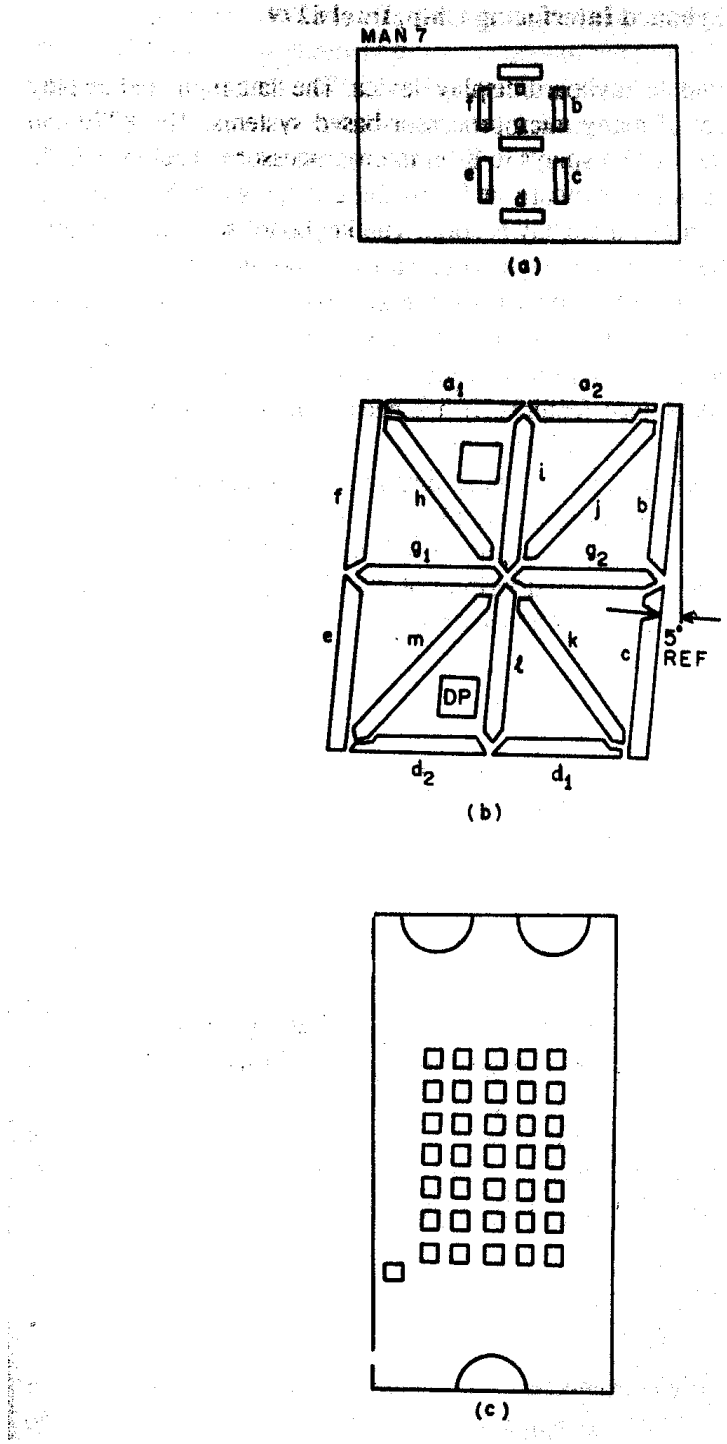


Fig. LED display (a) 7-Segment display, (b) 18-Segment,m (c) 5 x 7 dot matrix display

Display and Keyboard Interfacing Chip, Intel 8279

The 8279 is a programmable keyboard/display device. The data input and display is the basic requirement of many microprocessor-based systems. The 8279 can interface a keyboard and LED displays to 8-bit microprocessors. It relieves CPU from the burden of scanning keyboard and refreshing displays. It has two sections: a keyboard section and a display section. The keyboard section is capable of interfacing a regular typewriter style keyboard or random toggle or thumb switches. It acts as a keyboard encoder for 8 x 8 keyboard. It can provide interface to 64-contact key matrix or to an array of sensors or strobed interface keyboard, such as the Hall Effect and ferrite variety. It has 2-key lockout or N-key rollover with contact debounce features. It has been provided with 8-character keyboard FIFO to store keyboard information.

Its display section drives alphanumeric displays or indicator lights. It can interface LED, incandescent and other popular displays. It controls display and refreshing upto 16 characters. It contains 16 x 8 display RAM which can be loaded by the CPU. Both reading and writing of the display RAM can be made with auto-increment of the display RAM address.

PRINTERS

Printers are commonly used output devices. They provide information in a permanent readable form. They produce printed output of results, programs *and* data. Printers which are used with computers arc classified as follows:

i. Character printers
ii. Line printers
iii. Page printers

A character printer prints one character of the text at a time. A line printer prints one line of the text at a time. A page printer prints one page of the text at a time.

The printers have been classified above as to how they print. There is one more classification which depends on the technology used in their manufacture. According to this consideration the printers arc classified into the following two broad categories:

i. Impact printers
ii. Nonimpact printers

Impact printers use electromechanical mechanism that causes hammers or pins to strike against a ribbon and paper to prim the (ext. Non-impact printers do not use electromechanical printing head to strike against ribbon and paper. They use thermal, chemical, electrostatic, laser beam or inkjet technology for printing the text. Usually a nonimpact type printer is faster than

an impact type printer. The disadvantage of nonimpact type printers is that they produce single copy of the text whereas impact printers produce multiple copies of the text. To solve this shortcoming of the nonimpact printers the manufacturers have developed nonimpact type printers that can be used as offline devices to produce additional copies of computer prepared output. For this purpose the printer accepts -1ata from magnetic tape and produce the output.

Character Printers

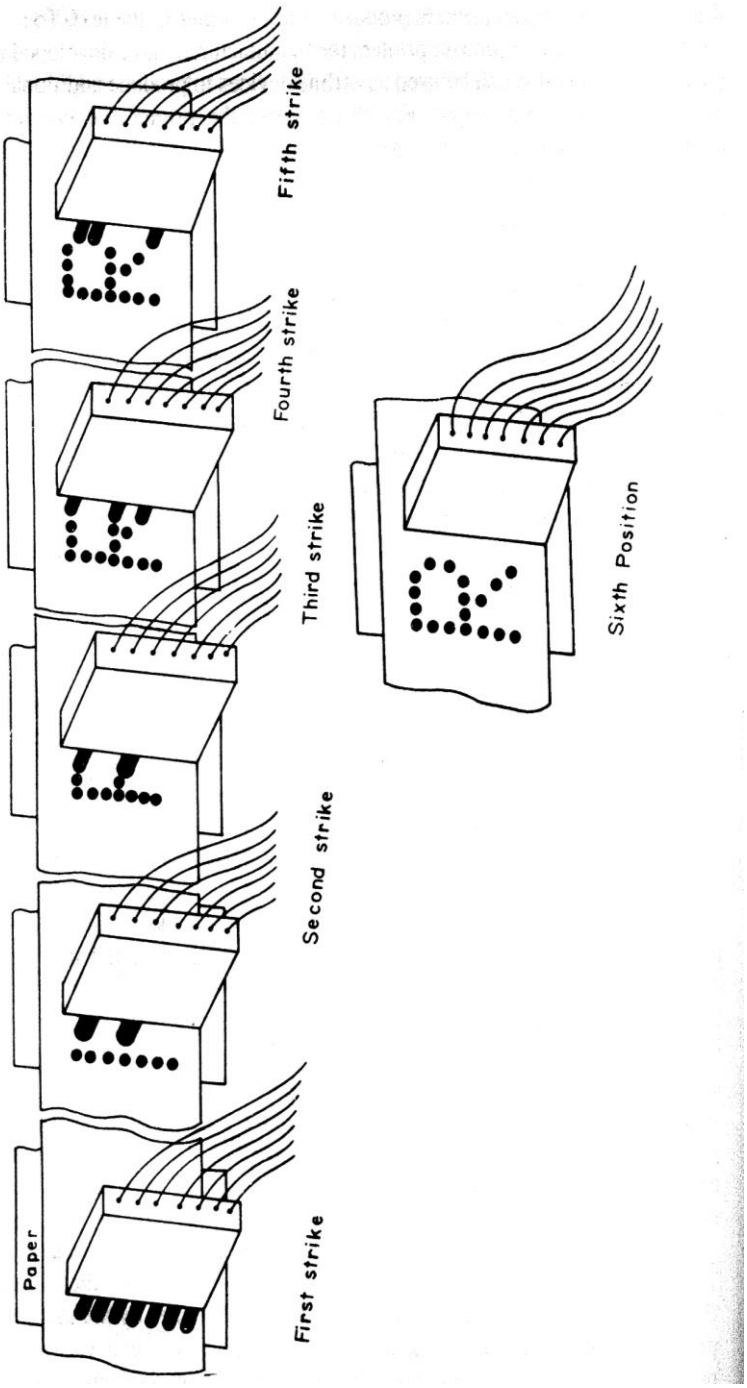
Character printers print one character at a time. They are low-speed printers. Their printing speed lies in the range of 30-600 characters per second depending upon the type of the printer. They are used with personal computers for low volume printing work. Characters to be printed are sent serially to the printer. A modem printer has its own microprocessor and buffer memory. The microprocessor controls the positioning of the print head or decides which pins are to be employed to form the desired character. It allows printer to receive the next set of characters to be printed from the computer while printing of the current set is going on. Two types of impact character printers are available: dot-matrix printers and letter quality printers.

Dot-Matrix Impact Type Character Printers

A character is printed by printing the selected number of dots from a matrix of dots. Fig. shows how a character is printed. The formation of a character has been shown using 5-dot rows and 7-dot columns. This pattern is called 5 x 7 dot-matrix. The print head contains a vertical array of 7, 9, 14, 18 or even 24 pins. A character is printed in a number of steps. One dot-column of the dot-matrix is taken up at a time. The selected dots of a column (i.e. the column of dot-matrix) are printed by the print head a time as it moves across a line. A dot-matrix printer is faster than a letter quality printer. Its printing speed lies in me range of 30-600 cps (character per second). Such printers operate at two or three speeds. Lower the speed better the printing quality. Higher speed is for *draft printing* and the lower speed is for *near-lener quality* (NLQ) printing, i.e printing is as good as that of a letter quality printer. To print near letter quality the printer prints a single line two or three times, each time placing the dots in a slightly different positions. Many dot-matrix printers are bidirectional. A bidirectional printer prints one line of the text from left to right and then it mints next line from right to left.

Dot-matrix printers are very flexible. They do not have fixed character tont. The term font is used to refer to a character set of a printer. As the fonts are not fixed a dot-matrix printer can print any shape of a character by the software. This permits for many special characters such as $\alpha,\beta,\sigma,\surd,\int$, etc;

various sizes of print, bold or expanded characters, italic, character of any language and provides the ability to print graphics. To print graphics the dot pattern for each column of dots arc sent out to the print head from the memory. The principle is similar to



Character printing by dot matrix printer

that used in bit mapped raster scan graphics display on CRT. Dot-matrix primers are cheaper than letter quality printers. But its print quality is not as good as that of a letter quality printer. It is a noisy printer.

Dot-Matrix Printer Controller, Intel 8295

The 8295 interfaces microcomputers to LRC7040 series dot-matrix impact printers and other similar printers. It can be used in serial or parallel communication mode with the processor. In parallel mode data can be transferred using interrupts, DMA or polling. It can provide internal buffering upto 40 characters. It contains a 7 x 7 matrix character generator. The character set includes 64 ASCII characters. It provides programmable character density 10 or 12 characters per inch. Some other features are: programmable print intensity, single or double width printing, programmable multiple line feeds, 3 tab positions and 2 general purpose outputs which can be used to implement functions such as ribbon colour selection, enabling form release solenoid and reverse document feed.

Letter Quality Impact Character Printer

A daisy wheel type letter quality printer is shown in Fig. This is an impact type letter quality printer. It is used where good quality of printing needed. It is much slower compared to dot-matrix printer. Its speed is in the range of 10-90 cps. It is costlier than dot-matrix printer. Its font is of fixed type. It can RibbonPaper

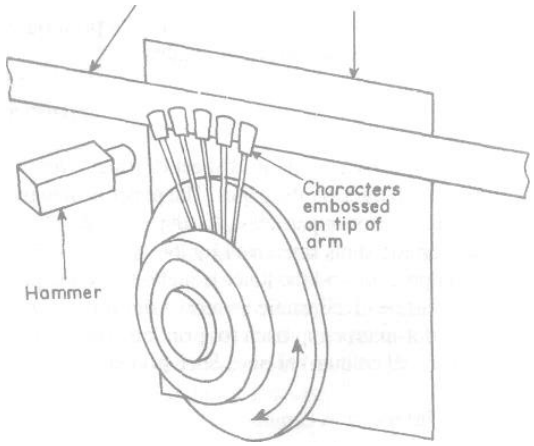


Fig Daisy wheel printer

not print graphics. Two-three types of fonts are available. One can select a font with desired style of characters. Font with italic characters and special characters are also available. Characters are embossed on the tip of the arms. An electric motor is used to rotate the wheel rapidly. When the desired

character comes in the correct position a solenoid-driven hammer strikes it against the ribbon to print the character. Letter quality printers are less common. As it is an impact type printer, it is noisy.

Non impact Character Printers

This type of printers use thermal, electrostatic, chemical and inkjet technologies. They are briefly described below.

Dot-Matrix Type Thermal Character Printers

This type of printers use special heat sensitive paper. Such papers have a special heat sensitive coating. When a spot on the special paper is heated, it becomes dark. A character is printed with a matrix of dots. A print head consists of 5 x 7 or 7 x 9 matrix of tiny heating elements. The heating element is heated by electric current. To print a character the printing head is moved first to the correct character position. Then the heating elements for the desired character are turned on. After a short time they are turned off. Thereafter the print head is moved to the next character position.

The newer machines now available use thermal transfer printing. They use special heat-sensitive ribbon that holds the ink in a wax binder. When the hoi pins of the print head press the ribbon against the paper, the wax melts and the ink is transferred to the paper. Its speed approaches to that of a letter quality printer. Such printers have a speed of about 200 cps. Its print output approaches shaped character (embossed character) printer quality.

Electrostatic Printers

An electrostatic printer moves a continuous sheet of paper over the printing pins which put small electric charges on the paper. The paper is then passed through a bath of oppositely charged toner particles. As the opposite charges attract, the paper picks up toner on the spots sensitized by the print pins. The paper then is passed through fusing process, and the toner is melted onto the paper to form the character impression. Some electrostatic printers print upto 5000 lines per minute. Such printers use dot-matrix approach for printing. The print head contains a vertical array (i.e. a vertical column) of pins. Such printer also produce graphics.

Ink-Jet Character Printers

It uses dot-matrix approach to print text and graphics. One type of earlier ink-jet printers use one or more nozzles in the print head that emit a steady stream of tiny ink drops. Each droplet is charged when it passes through a valve. Then it passes through a horizontal and vertical deflecting plates. These plates deflect the ink drops to direct them to the desired spots on the paper to form the impression of a character. In this type of printers the

continuous-stream of ink-jet approach is used. In another type of ink-jet printers the drop-on-demand ink-jet approach is used. The ink drops are produced when needed. Multiple nozzles are employed in a drop-on-demand type printer. Colour printing is also possible. The speed of inkjet printers lies in the range of 40-300 cps. The average life of an ink-jet print head is about 10 billion characters which is 5 times more than that of the print head of an impact type dot-matrix printer. Some electrostatically deflected ink-jet printers can print upto 45000 lines per minute. InkJet printers have several disadvantages. The print quality high speed is poor. They tend to be messy and difficult to keep working well.

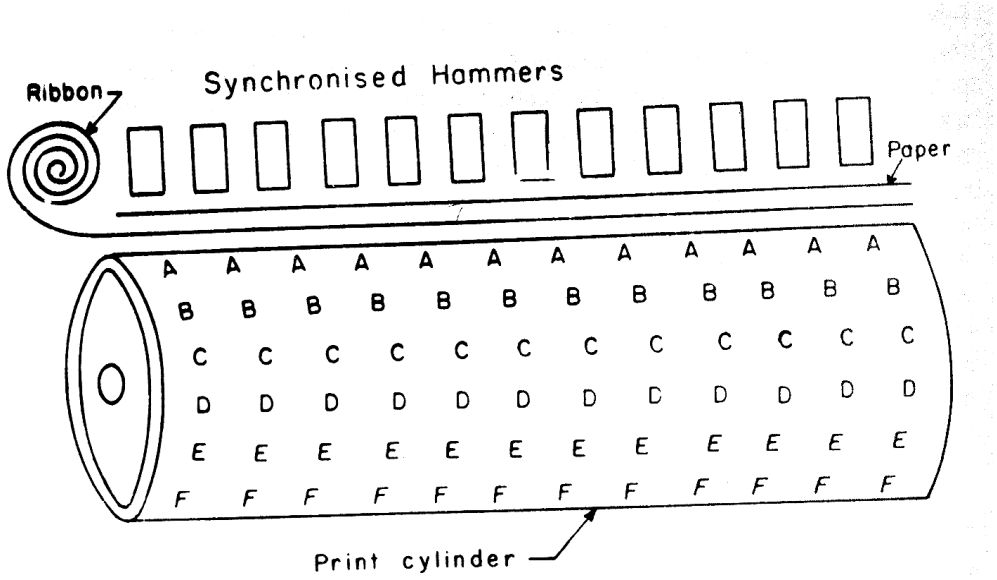
The newer ink-jet primers do not have the disadvantages mentioned above. One of the new ink-jet printers uses ink cartidges containing a column of tiny heaters. When a heater is activated a drop of ink is exploded onto the paper. In another type an electric current is used to explode microscopic ink bubbles from a special ribbon directly onto the paper. These two approaches arc actually hybrid technique of thermal and ink-jet technologies. The print quality of such printers is very near letter-quality. Speed of such printers is in the same range as that of a slow dot-matrix printer.

Line Printers

A line printer prints one line of the text at a time. Its printing speed lies in the range of 300-3000 lines per minute. It is used for large-volume printing job. It may be used with mini and large computers. The impact type line printers are of the following types:

i. Drum printer
ii. Chain printer
iii. Band printer

Drum Printers. A drum printer uses a rapidly rotating drum (cylinder) which contains a complete raised characters set in each band around the cylinder. Each character position along the text line contains a band of raised character set. There is a magnetically driven hammer in each character position of the line. The printer receives all characters to be printed in one line of the text from the processor. The hammers hit the paper and ribbon against the desired character on the drum when it comes in the printing position. Its noise level is high. Its speed varies from 200 to 2000 lines per minute.) A schematic diagram is shown in Fig.



drum printer

Chain Printers Chain printers use a rapidly rotating chain which is called print chain. The print chain contains characters. Each link of the chain is character font. Magnetically driven hammers are there in each print position. The printers receive all the characters to be printed in one line from the processor. Primers print one line at a time. A chain may contain more than one character set, for example 4 sets. around it. When the desired character comes in the print position the hammer strikes the ribbon and paper against the character. The noise level of the printer is high. Its speed lies in the range of 400-7400 lincs/min.

Band Prunei's. Band printers are just like chain printers. They contain fast rotating scalloped steel print band in place of a chain. The print band contains raised character set. Hammers strike the ribbon and the paper against the character to print the character. Some printers can print upto 3000 lines/min. Their noise level is high.

Non impact Line Printers

A line printer may use electrostatic and thermal technologies. A typical thermal type line printer contains healing elements for each dot position on print line. It prints an entire line of dots at a time. To print characters and graphics paper is moved through the printer one-dot-line at a time. Such printers can print upto 400 lines/min.

Page Printers

Page printers are nonimpact type printers. They print one page at a lime. Theses printers use laser or other light source to produce an image on a photosensitive drum. The computer controls the laser beam to turn it on and off

when it is sent back and forth across the drum. An image is produced on the raster scan principle as it is produced on a CRT. The laser-exposed areas attract toner (an ink powder). Thereafter the drum transfer the toner to the paper. The paper then moves to a fusing station where the toner is permanently fused on the paper with heat or pressure. After this the drum is discharged and cleaned. Now the drum is ready for processing the next page. The laser printers are quiet and they produce high-quality output. These printers are expensive and require a lot of maintenance. Low-speed laser printers producing 10 pages or more per minute are used with microcomputer. High-speed laser printers producing upto 300 pages per minute are manufactured for mini and large computers. The laser printers have become popular for large printing work.

Some low-speed printers now available use flashing light-emitting diodes to expose the drum.

The difference between a xerox machine and a laser printer is that in a xerox machine the image of the original text is formed on the photosensitive drum with a camera lense whereas in laser printer image is formed by scanning laser beams using computer's control. The computer sends the characters of a page of the text to be printed in the printer's buffer memory.

PLOTTERS

Plotters are output devices. They are used to produce precise and good quality graphics and drawings under computer's control. They use ink pen or ink-jet to draw graphics or drawings. Either single colour or multicolour pens can be employed. The pens are driven by motor. Drawings can be prepared on paper, vellum or mylar (polyster film). Colour transparency can also be prepared.

Pen plotters are slow devices. The graphics and drawings produced by pen plotters are uniform and precise, and they are of very good quality. They are used for low to medium volume job. A pen plotter can take from several seconds (for simple drawings) to several minutes (for complex drawings) to produce a drawing. But it takes much less time as compared to traditional hand methods of producing drawings. A complex drawing which can take about a month by traditional hand method can be produced in less than an hour using plotters.

The pen plotters may be classified into the following types:

Drum plotters A drum plotter contains a long cylinder and a pen carriage. The paper is placed over the drum (i.e. cylinder). The drum rotates hack and forth to give up and down movement. The pen is mounted horizontally on the carriage. The pen moves horizontally along with the carriage left to right or right to left on the paper lo produce drawings. Under the

computer control both the drum and the pen move to produce the desired drawings. Several pens with ink of different colours can be mounted on the carriage for multicolour drawings Since each pen is program selectable, a multicoloured drawing can be produced.

Microgrip Plotters. Such plotters do not use drums. The paper or any other medium is held (gripped) on both sides at the edges by pinch wheels which give back and forth paper movement. With such printers high performance is attained at a low cost.

Flat-Bed Plotters. Such plotters use horizontal flat surface on which paper, vellum, mylar or any other medium can be Fixed. The pen moves along both axes: the X axis and Y axis. The pen carriage is controlled by computer in both the axes.

InkJet Plotters. Some plotters employ ink-jets in place of ink pens. The paper is placed on a drum and the ink-jets with different-coloured ink are mounted on a carriage. Such printers are capable of producing multicolour large drawings.

Hard Copy Devices for Fast Plotting of Drawings

In this technique the drawing is first displayed on a CRT screen. The hard copy device copies the drawing from the CRT screen and prepares a hard copy i.e. copy on a paper. It is less expensive and it produces output much more quickly. Whatever is on the CRT screen is copied by simply a touch of a button It includes any combination of graphic and nongraphic (text) display. The entire process takes only a few seconds. Quality of drawings is not as good as those produced by pen plotters.

The techniques used are electrostatic method, photo plotter, ink-jet process etc. Dot-matrix printers also produce hard copy of the drawings displayed on the CRT screen. The raster approach is used to produce the drawings. The output is in the dot-matrix from.

OTHER FORMS OP OUTPUT DEVICES

Computer Output on Microfilm and Microfiche

In this technique the output from the computer is recorded on a microfilm as microscopic film images. The information recorded on the microfilm can be read with the aid of a microfilm viewing system. The computer output is first displayed on the CRT screen. It is reduced in size 48 times or more and then recorded on a roll or sheet of microfilm. A high-speed camera takes the photographs of the information displayed on the CRT. This is very fast. 10 to 20 times taster than high-speed printers. The photograph can be taken at the speed; upto 32000 lines/ minute. As it is very costly system, it is

suitable for a very large, volume job. The film storage is less costly than to keep printed information on paper.

A microfiche is a 4 by 6 inch film sheet. The word 'fiche' is pronounced fish. It is a French word which means card. A microfiche can store upto pages of information. Some ultrafiche can store upto 1000 standard pages of information in the same space. It is easier to read a microfiche as compared to a microfilm. It is also easier to send microfiches from one place to another.

Voice Response

Voice recognition (voice input) by a computer is a difficult problem while voice response (voice out) is very simple. 'As the rules for producing voice through a speaker or a telephone system can easily be formulated, a voice response system can easily be designed and developed. The banks are the largest user of voice response techniques. The bank computer gives voice response to telephone. inquires of customers regarding the present position of their bank accounts. The voice response system usually is considered for applications requiring low-speed human-machine interaction. Audio response system is inexpensive. Such systems can be used with PCs.'The Texas Instrument Co. has developed a "Speak and Spell" system to teach children to spell and pronounce over 200 elementary words.

s

SELF ASSESSMENT – QUESTIONS

Questions

07. The function of memory is to store_____
08. RAM & ROM are _____ memory
09. ROM is a Volatile memory. True or false

Answer

07. Information
08. Semiconductor
09. No

Important Questions

Section – A

01. What is a hardware?
02. What is CPU?
03. What is input devices?
04. What is printers?
05. What is VDU?
06. What is main memory?
07. What is peripheral controller?

Section - B

08. Write short notes about hardwares.
09. What is primary memory? Explain briefly
10. Enumerate the difference between RAM and ROM
11. What is computer peripherals? Explain briefly

Section – C

12. Explain the main components of a computer neatly?
13. Explain the role of CPU
14. Explain about peripheral controllers

NOTES

UNIT – IV

NEED AND TYPES OF SOFTWARES

A sequence of instructions given to a computer to perform a particular task is called a *program.* A set of programs written for a computer is called *software.* The software required to execute user's program is known as *system software.* The term software includes both system software and user's programs. The system software includes operating system, assembler, compiler, interpreter, debugging programs, text editors, etc. The *operating system* is a collection of programs which controls the overall operation of a computer. The term *monitor is* used for a simple operating system which allows user to enter a program, make alterations in a program, to run programs, and to observe the status of the various sections of the computer. The programs stored in ROMS, PROMS, EPROMS or E^2 PROMs are called *firmware.* Nowadays a large variety of prewritten programs are available to solve specific tasks. Users need not prepare programs for such tasks. They should simply know how to use such prewritten programs. Prewritten programs for specific tasks are called *application programs* or *application packages.* Important application packages available are Wordstar for text manipulation, LOTUS 1-2-3 for preparation 6f spreadsheets; dBASE, ORACLE, UNIFY and FOXBASE for handling database, etc. Software packages for designing buildings, structures, power systems, inventory control, accounting, dealing with projects, etc. are available.

The first electronic spreadsheet program was VisiCalc (Visible Calculator). It became very popular software program ever sold. Lotus 1-2-3 was a second generation spreadsheet program. It was the first integrated spreadsheet program. It provided graphics and database management capabilities in conjunction with an improved version of spreadsheet program. Suppose a person wants to prepare an annual report including text and balance sheet, and an income statement in the form of spreadsheet. The spreadsheet needs information from a database. Graphs are also to be prepared from information available from the spreadsheet. If a person uses separate application programs for word processing. database management and graphics, he will face a lot of difficulty. The job becomes very complex and tedious. An integrated application program allows the user to take data from a database directly into the spreadsheet, send the spreadsheet data for the preparation of graphs by graphics program, and then use word processor program to incorporate spreadsheet and the graphs into a report to be prepared. An integrated package permits users to change from one application program to another and in the process to pass information to and from between application programs. The third generation of spreadsheet program has the concept of

integration by including a word processor, increased spreadsheet capability, additional-database management and graphics functions, and a communication capability. Popular third generation spreadsheet programs are Framework (introduced by Ashton-Tate) and Symphony.

SOFTWARE DEVELOPMENT

While pre paring programs the following factors should get due considerations:

Reliability : A program must work reliably. It should perform the task properly it has been developed.

Speed : A program must execute the specified task quickly. The time taken to perform a given task should be as minimum as possible. A faster and should -give more output in a given time than a slower one.

Programming Time and Cost : The cost of processors, memory and peripherals decreasing but the cost of programming is rising. Due to this reason more is being given on programming techniques like structured programming and top down design which increase programmer's output. Proper design, testing, debugging and documentation reduce the overall cost of programming.

Ease of use : A program must be easily understood by others. A program with strictly defined and complicated data formats is difficult to use and expensive to debug maintain.

Error Tolerance : A program must react to errors. It should give some information regarding errors or malfunctions without shutting the entire system down.

Extendibility : A program that can be extended to tasks other than for which it has been designed and developed is definitely a better program. The modular programming is more useful in attributing the feature of extendibility to a program.

STAGES OF SOFTWARE DEVELOPMENT

Software development may be divided into the following stages:

Problem Definition. At (his stage the problem to be solved or the task to performed is defined. Inputs, outputs, processing requirements, system constraints such as execution time, accuracy etc, and error handling methods are specified.

Program Design. At this stage the program is designed to meet the specified requirements according to its definition. The important design techniques are top-down, structured programming, modular programming and flowcharting. 'The flowcharts help in explaining programs and describing

program structure. Flowcharts are more helpful in documentation than in design; The program design has already been discussed in detail.

Preparation of Actual Program. At this stage computer instructions are written according to its design.

Testing. At this stage the program is tested to check whether it performs the required task or solves the given problem. This stage is also called *validation.*

Debugging. At this stage errors in the program are detected and corrected. This is also called *verification.* This has already been discussed in detail. Important debugging tools are simulators, logic analyzers, breakpoints, trace routines, memory dumps, etc.

Documentation. It indicates what functions are performed by the program and how these functions are carried out. It helps users to understand and maintain the program. Important techniques of documentation are flowcharts, comments, program listings etc.

Maintenance. At this stage programs are corrected and updated to meet the need of changing conditions. It should be corrected or modified on the basis of field experience.

Extension and Redesign. A program can be extended to other tasks. If necessary, it can be redesigned to get its improved version or 10 perform other tasks.

SELF ASSESSMENT QUESTIONS

Questions

01. Set of programs written for a computer is called _____
02. Types of soft wares are _____, _____
03. General purpose application program and application specific programmes are

Answers

01. soft ware
02. application, system
03. application softwares

OPERATING SYSTEMS

An operating system is a collection of programs that controls the overall operations of a computer. It allows users to format disks; create, print, copy. delete and display files; read data from files, write data to files, control most input/output operations, execute programs, allocate memory locations, process interrupts etc. It provides users an interface to computing resources. It processes user's commands. In a multiuser system it allows several users to share CPU on the time-share basis, to share other system resources; it performs job scheduling, prevents interference between different users, between users and operating system; provides memory management etc. In short we can say that an operating system monitors the execution of user programs and the use of resources. The physical resources available in a computer are CPU. memory and I/O devices. In a multiuser system a resource is used by a number of programs and hence the operating system has to maintain scheduling. The scheduling will decide the order in which a resource will be. allocated if several programs want to use it.

Usually, operating systems are large. Most of them are too large to be stored in memory at a time. Therefore, they can be divided into a number of parts. Some portions of the operating system must always be present in the memory. These sections perform the basic operations such as starting and terminating user programs. allocations of memory and files, and basic input/output operations. Interrupts are also handled by these resident portions of the operating system. The portion of the operating system which is always present in the memory is called *iuclous or kernell.* The kernel is a master program of operating system. It coordinates all other parts of the operating system. It is also called *supervisor* or *monitor*. Other portions of the operating system which are brought into the memory when needed and removed when not needed, arc called transient programs. In MS-DOS the commands like DIR. TYPE and COPY arc always present in the memory. On the other hand, the commands like FORMAT, D1SKCOPY and CHKDSK are loaded from the disk prior to execution.

The term *monitor* is also used for a simple operating system which allows user to enter and modify programs, to run programs, and to observe the status of the various sections of the computer.

Booting (or Bootstrapping)

The process of loading the operating system into memory is known as *booting.* When a computer is turned on the operating system must be brought into the computer's memory from the hard disk memory. The process is normally started by a small program called *bootstrap loader*. This program

resides in a ROM as a firmware. A computer is designed to fetch its very first instruction from the ROM when power is turned on. The first instruction is bootstrap loader. It is a very simple program sufficient only to direct the CPU to look for a specific file (i.e. operating system file) on the disk memory, and execute the instructions stored in (he file. The file contains machine codes of the operating system. The first part of instructions in the file contains codes to direct the CPU to continue loading the rest of the operating system into the memory. When the operating system is fully loaded into the memory, the computer is ready to accept user's commands. Some important operating systems are described in the following sections.

MS-DOS or PC-DOS

MS-DOS is a single user operating system developed by Microsoft. Microsoft is a software company in Redmount, Washington. U.S.A. The abbreviation MS-DOS stands for Microsoft-Disk Operating System. It was introduced in 1981. It became very popular as it was used by IBM for its PC. PC/XT and PC/AT personal computers. It is also used by a large number of oilier computer manufacturers. The IBM version of this operating system is known as PC-DOS.

MS-DOS is a text-oriented user interface, i.e. a user types commands using keyboard to get computer's response. The response is displayed on the screen. MS-DOS does not provide graphics facility but some application programs which run under MS-DOS may provide graphics facilities. MS-DOS can use only up to 640 KB of memory, not more than this. This much capacity is not suitable for larger and more advanced programs, but normally it is quite sufficient for most business and home application programs.

The file names under MS-DOS must not be more than 11 characters long. with 8 character primary file name and a 3-character file extension, separated by a gap. All file names should be in uppercase letters. Some commands of MS-DOS are actually programs stored in the disk memory and hence their names do not contain more than 8 characters.

Some disk and file maintenance commands of MS-DOS, are as follows:

DIR	Directory
TREE	This command displays all disk subdirectories (if any) and their subdirectories. It helps in locating a file
TYPE	The contents of a data file can be displayed on the screen using this command.
REN	Rename a disk file.
DEL	Delete. It is used to erase files from a disk.

COPY	It is used to copy files from one disk to another.
DISKCOPY	This command is used to copy 'he entire diskette.
FORMAT	It is used to format a new hard disk or floppy disk.
CHKDSK	Check disk. It indicates how much space has been used and how much space are unused.
SYS	MS-DOS operating system files can be copied using this command.
DATE	This command allows to enter today's dale. The data are recorded every time when a file is created or modified. The DIR command shows the date of creation/ modification with every file.
TIME	This command allows to (ell time. The time is also recorded with every file.
VER	This command shows the version of the operating system being used.

OS/2 (Operating System/2)

This operating system has been developed by IBM and microsoft. It was introduced in 1987. It is a multitasking operating system for PS/2 line of computers, IBM AT and some AT clones. One can run multiple program under OS/2. One can start one program and then start a second program while the first is still running. It needs 2MB of memory space. It is not a multiuser operating system whereas UNIX is a multiuser and multitasking operating system. Each program is displayed on its own window on the screen. It has optional graphics/mouse facilities. It can support large amount of memory, 16 MB. It provides virtual memory, protection, swapping and multiprogramming techniques. It has been designed specifically for 80286 and 80386 CPU. It provides a wide variety of I/O service to user programs. In OS/2, 2 indicates second generation. It is a second generation operating system for computers that were previously using MS-DOS or PC-DOS.

It includes all basic MS-DOS commands and some new commands to support to multitasking. The filenames should not be of more than 11 characters, all uppercase characters. It has DIR. TYPE, FORMAT. CHKDSK. TREE. DATE. TIME. REN. DEL. COPY. DISKCOPY. VER etc.

UNIX and XENIX

UNIX is a multitasking and mutliuscr operating system developed by Bell Telephone Research Laboratories (which arc now a part of AT and T Information System) in 1969. It was developed for larger machines. Now it runs on mini, mainframe and supercomputers. It is also used with powerful 32-

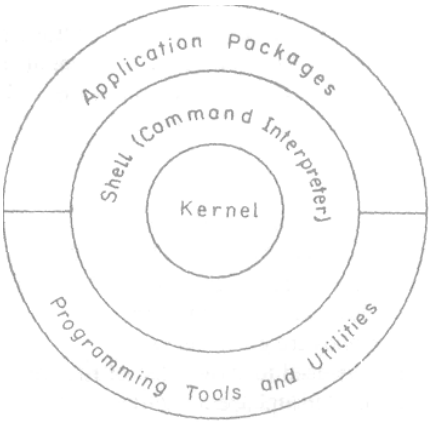
bit personal computers. In this system a user is identified with a user ID. A user has to enter a password to get access to the computer. UNIX requires 8-10 MB of memory. This makes it difficult to be used on a smaller system.

UNIX was designed for engineers and programmers. For nontechnical persons. it is an extremely difficult and awkward operating system. On the other hand for technical persons it is very strong and powerful operating system.

XENIX is a version of UNIX. It has been developed by microsoft. It is a widely used multiuser operating system.

A multiuser system consists of two or more layers. This technique is used from protection point of view. Its inner layers are well protected. Users can not write into the memory area where these layers are stored because user programs can only access operating system resources through very specific mechanism rather than simple, accidental call or jump. UNIX consists of three layers as shown in Fig 8.9. The innermost layers, *kernel,* is the most important layer. It contains a process scheduler, a hierarchal file structure and mechanisms for processes to communicate with each other. The middle layer is called *shell* which contains command interpreter. The user's commands are decoded and interpreted by this layer. The shell executes user commands and programs. This layer of UNIX provides interface to users. The outermost layer contains programming tools and application programs. The programming tools include assemblers, compilers, editors, debuggers etc. The application programs include packages for database management, wordprocessing, graphics etc.

UNIX is a multiuser operating system. It permits many users to share a CPU on a time-slice basis. Each user's program is known *as a process.* If multiple program or tasks are to be processed by a CPU. a schedule must he prepared so that they can be processed properly. The parts of the operating system, which perform the task of scheduling is called *scheduler, dispatcher or supervisor.*



UNIX Layers

The UNIX Kernel

The major functions of the UNIX kernal are:

i. To schedule and to service the needs of processes (i.e. tasks or programs).

ii. To maintain the system file structure

iii. To provide a means of communication between processes.

The UNIX Shell

This layer of UNIX executes users commands and programs. To perform these tasks it calls kernel procedures (sub routines) as required. Some important features of UNIX shell are:

i. A feature of UNIX shell is pipe command. Using pipe command the output data from one program can be sent directly as input data to another program.

ii. The UNIX shell permits a user to execute two commands concurrently.

iii. A simple method is provided by the UNIX shell to execute a series of commands over and over again.

iv. The shell and kernel provide spooling facility. A spooler alternate the user's ongoing activity and controlling of another activity such as printing. A user can send files for printing without worrying about the printer whether it is free at that time. If printer is available the printing work is done by stealing small amount of lime between other operations. If printer is not free the print request is put in the queue.

UNIX Utilities/Applications Layer

UNIX has many utilities such as powerful editors, compilers for many high-level languages, debuggers etc. It also includes a large number of application programs. Examples are: data management packages, accounting packages. computer-aided engineering design packages, etc.

Some UNIX Commands

File names under UNIX may consist of any length. A File name may contain uppercase and lowercase characters freely mixed. All UNIX commands must be in small letters. UNIX has a broad range of disk-related commands. Besides disk commands it also provides more than 100 small commands or utility programs. Some examples of commands are given below.

Is — This command is used to show a list of files on the disk. The files are normally arranged in alphabetical order.

mv	mv stands for move. This command is used in renaming a disk file.
rm	This command will erase (i.e. remove) a file from the disk.
Cat	cat stands for concatenate. This command is used 10 display the contents of a data file. It is also used to combine two or more files.
Grep	It is the short form of "global replace". This command is used to search particular word or phrase in one or more data files. It provides a means to locate a particular file even if some one has forgotten its name.
Login	It is used to log in to a computer. It means that one can inform the operating system to be identified. When one logs in the operating system will ask for a password.
Passwd	This command is used to give the password.

CP/M Operating System

CP/M stands for Control Program/Monitor. It was developed by Digital Research Laboratory. It was very popular operating system in 1970s and early 1980s for 8-bits PCs using 8080, 8085 and Z80 microprocessors. Today it is not used on new computers. It can handle only upto 64 KB memory. It formed the basis for MS-DOS which is very similar to CP/M.

Apple DOS

It is an operating system for Apple II family of computers. It is very simple for home or small business applications. It is not multitasking. It can process only one program at a time. It is a text-oriented operating system. Application programs running under this operating system may use graphics and a mouse as a pointing device. It can handle upto 128 KB memory.

The filenames under Apple II DOS may be upto 64 characters long with both upper and lowercase letters. Some examples of its commands are:

CATALOG	This command is used to show a list of files stored on me disk. It also indicates file size, date and time.
CAT	It is the short form of CATALOG. It shows only the name of the files.
BLOAD	Binary load. It is used to load binary files.
BRUN	Binary run. This command executes a program after loading of the program using BLOAD.
BSAVE	Binary save. It is used to save binary information onto disk.

RUN	It begins the execution programs written by the user.
PREFIX	This command informs the computer which subdirectory it has to search to locate files.

Finder

It is an operating system for Apple Macintosh family of computers. It was introduced in 1984. It is an example of WIMP type user interface. WIMP stands for window/icon/mouse/pointer. Icon means small graphical symbol. Macintosh computers display icons which represent disks and files. In this system the user need not type a command, rather he has to point to one of the commands displayed on the screen using a pointer device such as mouse. The user tells the computer to execute commands by using the mouse to point either to an icon or to a command listed in a menu of available commands. Finder is a multitasking system. Each program is displayed on a window on the screen. Each window can be moved around, enlarged or reduced as needed.

The Finder has five menus to show its basic commands. Each menu shows a list of certain commands to be selected by the user. The user selects an individual command by first pointing to the menu, and then pointing to the command which the user wants to use. The menus are as follows:

Apple Menu

About Finder	This command shows the current version of Finder and its author.
Control Pane	This command permits a user to change the speed of the mouse pointer, volume of the speaker etc.
Key Caps	This command allows to change the arrangement of the keys on the keyboard.

File Menu

New *Folder*	This command is used to create a new folder or subdirectory.
Open	It begins the execution of a program. A new window will appear on the screen. The output of the program will be displayed on this window.
Close	This will stop the execution of a program. The window which was being used by the program will disappear.

Edit Menu

Undo	It helps user to 'undo' the last command that user executed.

View Menu

This displays some choices how to show the lists to contents A the disk. The choices are: Small Icon, Icon, Name of file. Day of last modification. Size of file and Kind of file.

Special Menu

Erase Disk This command will erase all the files on a disk. The files are

Empty Trash not erased permanently, if they are erased dragging them into the trash can icon. A file which has be erased can be retrieved, if the trash has not been emptied. So erase a file permanently one must erase the trash.

Windows is a new operating system environment for PCs, recently developed by Microsoft Corporation. It provides graphical interface to users. Earlier graphical user interface was treated as a luxury and was not available to persons working in business environment with personal computers. It was available to persons working on mini and large computers and desktop publishing system. Today, in almost all environments related to management, finance, sales, marketing, development and other general office functions need a rapid access to information and powerful tool to manipulate, analyse, exchange and present information. Windows with graphical user interface facility is capable to meet these requirements.

Windows runs under DOS 3.1 or its higher version. It needs at least 80286 CPU (or 80386 SX or some more powerful CPU), extended memory and a pointing device (i.e. mouse). 1024 KB memory is needed with 80286 CPU, and 2048 KB with 80386 CPU. Windows can use virtual memory resources on a computer with 80386 CPU.

Windows is challenging IBM's OS/2 operating system. Microsoft corporation has also developed spreadsheet, Lotus 1-2-3, and Word processing packages which run under Windows At-present Windows 3.1 version is available and Windows 4.0 is expected soon.

LISP. It stands for LISt Processing. This language was developed by McCarthy in the early 1960s. It is suitable for nonnumeric operations involving logical operations. It is used extensively in artificial intelligence and pattern recognition. It is also used in game playing, theorem proving etc. It is capable of searching, handling and sorting long strings or lists of text. So it has often been used to implement computerized translators. It is used primarily on larger computers but LISP compilers are also available for PCs.

SNOBOL. It stands for StriNg Oriented SymBOlic Language. This language was developed by a group led by Griswold in the mid 1960s. It can manipulate strings of characters and hence it is used in text processing. It is capable of performing various types of operations on strings of characters such as combining strings, splitting strings, matching strings etc.

LOGO. It was developed by Seymour Papcrt and his colleagues at MIT in the late 1960s. It is used in serious scientific work in universities. It has also been popularized as a first educational language that children can use to achieve intellectual growth and problem-solving skills. LOGO has graphics capability. Children can easily use it to make drawings. They can draw, colour and animate images. It runs on PCs. It is used to compose music, manipulate text, manage data etc.

APT. It stands for Automatically Programmed Tooling. It is used in manufacturing applications to control machine tools.

MODLA-2. It has been developed by Nicklaus Wirth, the creator of PASCAL. Although it retains the merits of PASCAL, it is more powerful and easier to use. PASCAL programs can easily be translated into MODULO-2 codes, It is a strongly structured language. It is easier for the compiler to find programming errors than it is with other languages. Structured programming also results in well planned program steps which produces more efficient and trouble-free software.

Operating system is a software. Software is the set of programs, procedures and related documentation with a computer system. Operating system controls the operation of the computer's activities. It manages the flow, entry and display of software and data to and from each part of a computer. A program is a coded set of instructions that interprets the information you give to computer with keyboard or mouse and directs your computer to carry out a task. In this chapter, you will learn the various operating systems such as DOS, UNIX, Windows and Novell Netware. DOS operating system was developed by Microsoft Corporation. Windows is most widely used operating system till date for a personal computer. UNIX was first developed at Bell LABs of AT&T. Now, various flavours of UNIX are available, for example SCO UNIX etc. UNIX operating system is a very stable system and widely used in the world. The most of the servers on the INTERNET are UNIX servers. Windows was developed by Microsoft Corporation, the "users interface" has made it popular and the people familiar with DOS can easily switch over to Windows. Windows is used on personal computers. Novell Netware was developed by the NOVELL. Novell operating system used in an environment where people are familiar with the DOS operating system and the machines are networked.

MS-DOS OPERATING SYSTEM

MS-DOS is a single user operating system. The Disk Operating System (DOS) is widely used on the personal computers. The latest version of DOS is 6.22. as we go to the press!

MS-DOS COMMAND LINE

It is the line on the monitor screen where user type commands. DOS indicates the command line by displaying the command prompt, e.g. C:\>

The command prompt consists of a drive letter followed by a backslash (\) or a backslash and the name of the directory, e.g. C;\DOS>

The drive letter indicates current drive in use. DOS searches for the information on the current drive, for the command given by the user. Whenever a user presses ENTER key, command is executed by the DOS.

DOS COMMANDS

A command is a set of instructions, e.g. time will display the current time and allow user to change it, if necessary.

Part of commands

Every command has a command name. Some commands need one or more parameters. Some commands can also include one or more switches, which will format the output.

The command line

The command name indicates what action to be performed. Some of the commands consist of only the command name, e.g. clear is used to clear the screen, Ver command will display the OS version being used.

b) Parameters

DOS sometimes requires the additional information, known as parameters. A parameter defines the object user wants to act on, e.g. to delete a file, command del will be needed, Number of parameters depend upon the command. In some of the commands, parameters are optional, e.g. in dir command, which gives a list of the files in the directory, may or may not have parameters.

Switches

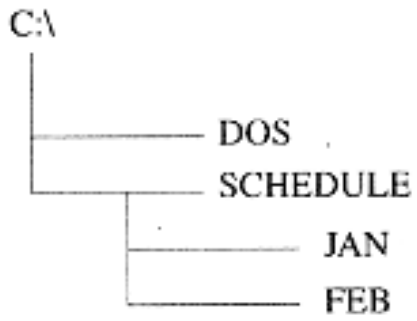
Switches are optional. Switch consists of a forward slash (/) followed by a letter or a number. User can use switches to modify the way a command performs a task, e.g. dir command used with switch, will list the files one screen at a time. If command has more than one switch, the user should type them one after the other. Optionally switches can be separated by a space.

USING FILES AND DIRECTORIES

Information is stored in a file. It is a primary unit of storage on a computer. Program files are that which stores instructions to be executed. Data files are those in which the information created the user is stored. Every file is identified by unique filename. Filename should be meaningful so that the user can identify the contents of the file.

D*irectories*

A disk can store many files. If the number of files are more, it becomes difficult to keep a track of files. To make work easier, files can be grouped into directories. The concept of directory is very similar to concept of a file cabinet that contains related documents. Directory will have a unique name to identify it, e.g. the directory 'schedule' contains the schedule for a year. A directory itself can hold a directory. The directory within a directory is called as subdirectory, i.e. in the schedule directory, month-wise schedules are to be kept, then for every month the subdirectory can be created. The subdirectory will be named after a month, e.g.



a) Root Directory

The root directory is the starting point of all other directories. A root directory does not have any name and is represented by backslash (\). As it is a basis for all other directories, user cannot delete a root directory. There is a limitation on the number of files that can be stored under a root directory. Whenever a disk is formatted, root directory is created. All the directories created by the user are then a subdirectory of a root directory.

Organisation of directories, subdirectories and files in an hierarchical order is called a directory tree.

b) Current Directory

DOS indicates, in which directory user presently is in, by displaying the directory name along with the drive letter in the command prompt, e.g. C:\DOS> represents directory in which user is in and is called a current

directory. This helps to locate, move to another directory and manipulate the files.

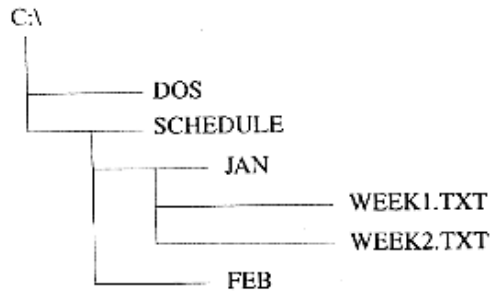
C:\> indicates that user current directory is root directory.

c) Drives

A drive is always represented by a drive letter. Every drive has a one root directory. Drives are associated with a disk. The types of disks are hard disk, floppy drive and compact disk. The first hard disk is called drive C.The subsequent hard disk drives are assigned letter E, D, etc. Floppy disks are drive A and B, i.e. C:\> indicates that the current drive is C and the current directory is a root directory.

Path

Path specifies the location of a file in a directory tree. Path starts from the root directory of a drive to the specified file. Consider a directory tree of C drive as



Suppose, user wants to access the file called week1.txt that is located under the subdirectory JAN, under the directory SCHEDULE in the root directory, then the path to the week-1 .txt is

c:\schedule\]an\week1 .txt

The first letter and colon indicate the drive name. The first backslash represents the root directory, After the first backslash the subsequent backslashes are used as a separator.

DOS recognises paths up to 67 characters that includes drive name, colon and backslashes.

MANAGING FILES AND DIRECTORY COMMANDS

Nam*ing Files and Directories*

The filenames have two parts—the name of the file and it's extension. The exception to this is a root directory.

The rule for naming a file and directories are as follows:

- Name can be up to 8 characters long. Extension of a file can be up to 3 character long.
- File names are not case sensitive.
- Name of a file must be unique.
- Name contains only letters A to Z, digit 0-9 and special characters: underscore (_), caret (∧), dollar sign ($), tilde (~), exclamation (!), number sign (#), percentage (%), ampersand (&), hyphen (-), braces ({}), at the rate sign (@), single quotation ('), apostrophe (') and parenthesis (). Name cannot contain spaces, commas, backslashes or periods. Period is used to separate name from extension.

Ext*ensions*

The following are the examples of commonly used extensions for filenames:

.ExE,.COM,.BAT—These extensions are used for files that contains programs. These are called as executable files.

.TXT —These extensions is commonly used for unformatted text files.

.SYS—This extension is commonly used for device drivers, which enables computer to communicate with hardware devices.

Usi*ng Wildcards*

It a task is to be carried out for a group of files whose names have something in common, user use wildcards to specify the group of files.

There are two wildcards: the asterisk (*) which represents one or more characters that a group of files has in common and the question mark (?) represents a single character that a group of file has in common. Wildcards can be used in the filenames as well as in extensions, e.g. dir *.txt, dir? lst.txt

FILE COMMANDS

Viewing a Text File

*vi*ew the contents of a text file, use the type command, e.g.

type c:\autoexec.bat

This will display the contents of a file called autoexec.bat located in a root directory.

If a file is a large file requiring more than one screen display, the output of the command will scroll. To view the file, one screen at a time, more command is used preceded by I symbol, e.g. c:\autoexec.bat I more

Type command will need one parameter that contains filename along with the path. Examples

type a:\autoexec.bat

type config.sys

type c:\schedule\jan\week1 .txt

Copying a File

With the help of copy command, user can mate copies of tiles. Copy command can be used to:

Copy a file from one directory or disk to another.

- Copy a group of files by using wildcards.
- Give a different name when you copy.
- Combine one or more files into one file.

When copy command is used, it requires the location of a file and a filename to copy from the source followed by the location and filename to copy to destination. The first filename is called a source file and the latter is destination file, e.g.

copy autoexec.bat a:

This will copy the autoexec.bat file from the current directory to disk in drive A with the same name. This is used when user wants the source and destination files to have a same name. This command is same as copy autoexec.bat autoexec.bat

After a copy command is executed, the DOS will display on the screen how many files were copied. An error message will be displayed if the source file is not found or there is no enough space on destination disk.

To copy a group of files from one disk or directories to another wildcards are to be used. For example,

copy *.txt a:

This will copy all the files with extension as .txt on to the floppy in drive A. Copy a:\mydocs\letter?.txt c:

DOS copies the files that are there in mydocs directory have first 6 letter filename beginning with letters and ? can be replaced by any other letter or digit. Suppose the files letter1.txt, letter2.txt and letter3.txt are there in mydoc directory all these files will be copied on the current directory of the hard disk.

User can specify different names while copying the file, e.g.

copy Autoexec.bak autoexec.org.

Use of wildcards are allowed while copying, e.g. copy *.txt *.old

Combining text files

Plus(+) sign is used to combine two unformatted text files into one while copying the files.

e.g.copyc:\schedule\jan\week1.txt+c:\schedule\jan\week2,txt c:\schedule\jan\fnight.txt

If the destination file name is omitted, DOS combines all files in the first specified file. e.g. copy mytext.txt+mytextl .txt then the file mytext-l .txt will be appended to mytext.txt. Wildcard are used to combine group of files, e.g. copy *.txt all.txt

R*ename a File*

Rename a file ren command is used, e.g.

ren mytext.txt myobs.txt

This command will change the name of a file without changing its location. Wildcards can be used to rename a group of files, e.g. ren *.txt *.tmp

P*rinting text files*

User can print unformatted text files from DOS using the print command. With this print command, user can start a job and do other tasks while printing is going on. User can list of files to print. When a print command is issued, a print queue is set up. To print a file, print config.sys command issued at the DOS prompt.

Print command without arguments will show the contents of the print queue. To cancel printing and empty the print queue, print command with /t switch is used, e.g. print/t.

D*elete Files*

The delete (del) command will allow user to remove unwanted files from a directory or disk. User can delete single file, group files or all files in a directory or disk.

It is not always possible to recover the deleted files.

To remove a file from disk, del (erase)command is used, e.g.

Del mytext.txt, del c:\schedule\jan\week1.txt.

To delete group of files from a directory or drive, wildcards are used, e.g. del *.txt.

Del *.* will delete all files from the directory.

Del c:\schedule\jan*.* will delete all the tiles from jan subdirectory of a schedule directory on the hard disk.

File Attributes

Every file can have four qualities associated with it. These qualities are called as file attributes. The file attributes are:

- The archive attribute (a) is used with backup, xcopy to control which files are to be copied.
- The read only attribute (r) prevents files being changed or deleted. The file can be viewed or copied.
- The hidden attribute (h) prevents DOS from displaying a tile in a directory list. The file remains in a directory but user cannot see the file. A tile can be used only it filename is known. This attribute is useful when user is handling confidential files.
- The system attribute (s) indicates that file is a system file. The files with system attribute will not be displayed in the directory listing.

a) View file attributes

To see the attributes of file, attrib command is used, e.g.

attrib mytest.txt

b) Changing file Attributes

To change an attribute of a file attrib command is used with attribute letter, e.g. (a, r, s or h) and

Plus (+) or Minus (-) file.

To set an attribute plus(+) is used.

To remove an attribute, minus(-) is used, e.g.

attrib +r mytext.txt, attrib -r mytext.txt, attrib +h *.txt

WORKING WITH DIRECTORIES

With each and every file in the directory DOS stores the information about the size of the file, date and time it was created or modified. This information is displayed when directory (dir) command is issued. While displaying the output of directory command separator (.) will not be displayed. First column displays the name of the file without separator. Second column will display the size of the file in bytes. If the file is a directory itself then instead of a file size <DlR> will be displayed, third and fourth column will display the date and time when the file was created or last modified.

The size of a file, date and time gives additional information about the file that helps in keeping track of files, e.g. if you have two files with the same name in the different directories, then looking at the date and time, user can decide the most recently updated file.

Viewing the entire directory

To view the contents of a directory, dir command is used, e.g. dir, dir a-., dir c-.\schedule\ian.

Viewing group of files

Use of wildcards are made to view group of files in a directory,

e.g.dir *.txt

dir c'.\schedule\)an* .txt

Arranging the directory display

To view the contents of a directory, one screen at a time, /p switch is used with dir command.

This is most commonly used, e.g. dir /p, dir *.txt /p.

To view an abbreviated directory, e.g. only filenames and directory names /w switch is used, e.g.

dir /w

The directory listed in this will be enclosed in [ ],e.g.[DOS].

View directory tree

To view the organisation of a directory, and its subdirectories tree command is used, e.g. tree c:\ will list all the directories and subdirectories under the root directory of the hard disk. The output will be somewhat

c:\

The tree command will list all the levels, which are not possible with dir command. To include i:he filenames along with the directories /f switch is used, e.g. tree /f

Create a directory

To create a new directory, mkdir (md) command is used. This command will create a directory under the current directory, e.g. if a user is in c:\schedule directory. Here, users issue a md feb command, then the subdirectory feb will be created in the schedule directory.

If a user is in the c:\schedule\jan directory and wants to create a directory under c:\schedule, Tid c:\schedule\feb command is to be given. The another way to do this is md.Afeb command. The path specified is. Afeb is called a relative path. This path is relative to the current directory 3:\schedule\feb is called absolute path, which starts from the root directory.

The absolute or relative paths can be used in any DOS command such as dir, copy, ren, etc.

Moving between directories and drives

If a machine has one hard disk and two floppy drives, user can move between one drive to another. To do so, issue a command with drive letter followed by the colon, e.g.

c:\> a:

To move between directories on the current drive change directory (cd) command is used, e.g.

cd c:\schedule will move to the directory schedule under the root directory of a hard disk. To move one directory up cd.. will be used, e.g.

If user wants to go to the directory jan that is under the directory called schedule one of the following command can be used, e.g.

cd c:\schedule

cd jan

or

cd c:\schedule\jan

To see in which directory you are, the command cd without any parameter is used, e.g. cd

Moving a directory

To remove a directory, rmdir (rd) command is used, e.g. rd c:\schedule\jan

The will remove the subdirectory 'jan' under schedule directory, provided that the jan directory is empty. None of the files or subdirectory should be present in the directory when a remove directory command is issued. If there are files in the directory, these files should be removed first.

To delete files and subdirectories beneath the directory, deltree command is used, e.g. deltree c:\ schedule will delete all the files and subdirectory of the directory schedule.

THE STRUCTURE OF MS-DOS

DOS is partitioned into three layers. These layers are:

- ❖ The BIOS (basic input/output system)
- ❖ The DOS kernel
- ❖ The command processor

The *Basic Input Output System (BIOS) module*

The BIOS is specific to the computer that contains the default resident hardware dependent driver for the following devices:

i. Console display and keyboard (CON) Printer

ii. Auxiliary devices

iii. Boot disk device

DOS kernel communicates with these device drivers that then translate the requests into proper commands for the various hardware controllers.

The resident drivers are those drivers that are built in the BIOS and installable drivers are those drivers that are installed using DEVICE command in the config.sys file.

The BIOS is read into random access memory (RAM) during system initialisation as a part of IO.SYS file. The attributes of this file are system and hidden.

The *DOS Kernel*

Kernel is nothing but program that provides a collection of hardware independent services called system functions. This function includes file and record management, memory management, character-device input/output, spawning of other program and access to real time clock.

The DOS kernel is read into memory during system initialisation from MSDOS.SYS that has system and hidden attributes.

The Command Processor

The user interface to the operating system. It is responsible for parsing and then carrying out the user command. These commands can include loading and executing programs from a disk.

The default shell can be replaced with other with the help of SHELL variable is to be set in the config.sys file.

ABOUT COMMAND.COM FILE

The command.com is used while system initialisation. Command.com is divided into three parts :

- **Res*ident portion***

  This is responsible for issuing out the error message. It contains routines for user initiated breaks or user interrupts, critical errors and final exit from the command.

- Ini*tialisation section*

  It is responsible for processing the AUTOEXEC.bat file, if any.

- Tra*ansient section*

- It is responsible for issuing out the user prompt, reading the commands from user prompt and executing the same.

The user commands fall into three categories:

- ❖ Internal commands
- ❖ External commands
- ❖ Batch files

Internal *commands*

These are those commands carried out by the code embedded in the command.com. These commands are dir, cd, copy, ren, del, md, etc.

External command

These are the commands that are stored on the media such as hard disk, floppy disk. Before executive these programs, they must load into memory from secondary devices, i.e. chkdisk, format etc. After the execution of these programs are over, these programs are discarded from the memory. DOS will search for the program on the current directory and the all the directories specified in the PATH variable in the autoexec.bat file.

Batch fi*les*

These are text files with extension as BAT. The batch file can contain internal, external or batch commands. These are processed by an interpreter. The interpreter reads the batch file, one line at a and then carries out the specified operation in order. Autoexec.bat file is a special file that is being read when system comes up.

SELF ASSESSMENT QUESTIONS

Questions

04. DBMS and operating systems are _____softwares.
05. Hardwares and softwares both are same. True or false
06. What is operating system?

Answers

04. system
05. false
06. collection of program that controls the overall operation of the computer

UNIX OPERATING SYSTEM

UNIX OVERVIEW

UNIX is an operating system of immense power. The kernel is the master program that controls computer resources. It is also responsible for allotting resources to different users and to different tasks. But kernel does not deal with a user directly. It starts up as a separate, interactive programme called a shell. On logon for each user, the shell then acts as an interface between user and the system. Shell acts as interface. The shell takes commands for execution. The kernel stores the commands of the shells of different users and then decides when each requested program run. The kernel and shell together provide UNIX service. There is only one kernel to serve several shells. Multiple shells can handle more than one user or task at a time. Actually, only one computer process one task at any one moment but UNIX can switch rapidly from one task to another. The different shells provide a way to separate one user or task from another while kernel maintains unified overall control.

KERNEL

As we have seen kernel controls the computer's resources. When a user logs in, kernel is one that runs in it and gets ready to check whether a user is authorised one and has the correct password. The kernel is responsible for validating a user name and password. The kernel also keeps a track of all various running tasks. Kernel also allots time to each running program deciding when one to stop and another to start. Kernel assigns the storage space for file. Kernel handles the transfer of information between the computer, terminal, tape drive and printer. Kernel runs the shell program. It is the heart of the UNIX system.

Time sharing and processes

One of the most important tasks of the kernel is to run time sharing system. UNIX uses tin sharing to solve the problem of multiple demands on a single processing unit. Time sharing means the kernel maintains a list of current tasks (processes) and allots a bit of time to one process then to the next, and so on. In other words, kernel shares the available time sequentially among the waiting processes. Kernel switches from one task to another very fast. So us cannot feel the delay.

At any point of time, on a system, several processes are active. Each process is identified by a unique process (PID).This helps kernel to identify the process uniquely. The process that is actually running is said to have run status. The waiting processes are said to have sleeping status.

The kernel and system calls

Another task of kernel is that it serves as an interface between the shell, UNIX commands and system hardware. Kernel collects the input typed using keyboard and delivers it to the shell Kernel directly communicates with the hardware, i.e. process scheduling or if a user gives the command to copy a file (cp command). Kernel will find a space on the disk and maintains relevant details such as location and size of the file.

Whenever a new kind of computer is introduced, then kernel should be rebuilt to adopt the changes.

Users can write his/her own program without knowing or directly interacting with hardware, e.g. writing a new program will copy a file. This is done using the system calls. This is done using the system calls.

System calls are basic routines used in the kernel normally using C programs. Whenever a system call is made, the portion of the kernel is run with relevant programming. Each system call performs specific task. The system calls are a part of the kernel and are used to do its work. System calls are basic building blocks. System calls remain the same for any computer independent of hardware being used. The same program performs the same task on different hardware such as VAX, IBM PC. This makes UNIX portable.

SHELL

Whenever a user logs in, the kernel starts up a program (shell) that handles user interaction with the system. The shell prompts a symbol ('$' for c shell) on the screen and waits for input.

When a user types a command and a press ENTER key then shell executes it if possible and returns a prompt to user.

The shell also has its own programming languages which contains both the loop construct as well as the branch construct.

As shell translates typed command, it is also termed as command interpreter. To translate the commands, shell will either search for a few built-in commands that are the part of shell or for a separate program, stored somewhere else, i.e. if user issues date command then the shell searches for a file named date. If an executable file for date is found, then shell starts executing the program and goes into a waiting mode. When the program terminates, the shell resumes. The program, e.g. a process that shell starts, is the child process of the shell. The shell looks for a particular program in the predefined directories. This is mentioned into the PATH shell variable. Typically PATH variable will contain user current directory and system directories such as /bin and /usr/bin. To see the directories in path issue echo

$PATH command on the shell prompt. The directories listed will be separated by colon (:). If the program for the command issued is not found in the path, shell will give an error message. For the shell, kernel and system calls, code is stored in files on UNIX system.

FILES AND DIRECTORY

Files

Whenever a file is created, Kernel is responsible for allotting space to the file. Data in the file is stored in bytes. When a file is created, then following changes are made in the system:

- Inode entry is created on a disk in predefined section. Inode contains almost all information regarding a file that includes the location of a file on disk where it starts, the size of the file in bytes, date and time of a file when last created or updated, various permissions, creator (owner) of a file and other administrative details. Each file has unique inode number. System uses this number to refer to a file.
- A directory entry is created. Each directory entry consists of two items that includes the inode number of a file and the user selected name of the file.

So, the contents of tiles are stored in one place, inode information in other place and name in the third place.

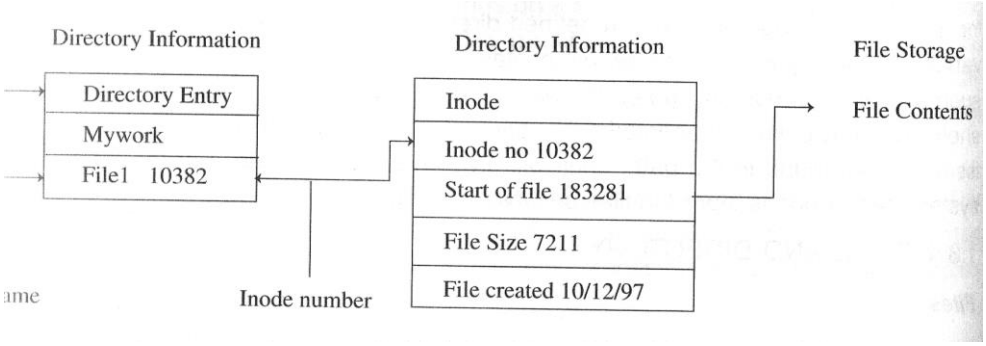
If the user issues a command to display the contents of a file, e.g. cat file1, then the kernel collects this command and passes it to the shell. The shell starts a cat command process. The process will ask kernel to check the directory to find inode number of the file and with the help of inode the kernel locates the starting point of a file. Kernel input/output functions display the contents of the file onto the screen. This continues till end of the file. End of file is checked with the number of characters transmitted and file size stored in the inode entry. After cat process terminates, the prompt will be displayed onto the screen.

System calls in a user program, typically a C program, uses these inode entries for file processing.

To view inode entry for a file, Is -i command is issued. Inode number does not change even if you move a file from one directory to another. The target directory wilt contain the entry for a file. It is not valid, if a user moves a file from one file system to another, as file system represents a different hardware storage area.

A file can be linked with other files using link (In) command. No new inode will be created. Two files will have same inode number. Inode contains

the number of link entry that will be increased by one. The directory in which file is linked will contain the entry for a file and inode. So In command allows several different names to indicate the same file with same inode number. Whenever a file is removed from the directory, directory entry for that file is removed and in inode number the number of links count will be decreased by one. When all names linked to a file are removed, storage space in the memory freed and inode entry is removed.



Directories

Every file is under a directory. Directory is a special file that contains all files. Within a directory, another directory can be created which is typically known as subdirectory. This makes treelike structure. Each user has a home directory where he can create subdirectories, sub-subdirectories and files. The number of subdirectories that can be created in a directory is limited to 35 approximately. Home directory is a directory where user will be placed soon after he logs in. The root directory named as slash (/) is the primer (parent) directory of all directories. All the directories are the subdirectories of the root directory.

The command cd will allow user to change the current directory, e.g. cd / will take user to root directory that, then becomes user's current working directory.

To view the present working directory, pwd command is issued. If the file users want to refer to be not in the present working directory, then users need to give complete path of the file.

File *security and permission*

Creator or owner of a file can decide who can access the file and in what way. UNIX divides the users into three categories: the user (owner), group in which user belongs to and others. Group of the user is decided by the administrator while creating a user. For each category, system keeps the track of the three permissions: read, write and execute. A read permission (r)

indicated that user can read a file. Write permission (w) to a file allows to alter a file. It includes changing the contents of a file, deleting a file. An executive permission (x) to a file allows to run a file that contains a program.

To see the permission, Is -I, command is used.

If the permission is missing then '-' will be displayed in the listing instead of a permission letter.

UNIX allows to change the permissions for each category. To do so, chmod command is used. This command is divided into three parts. First part consists of one or more letters indicating category of the user (u: user, g:group, o:other). Second part indicates whether permissions are to be set to yes or no. Finally, a string of one or more chars indicates the permissions that are affected (r: read, w: write, x: execute), e.g. chmod g+w letter.

FILE SYSTEM

Disk or portion of a disk is set aside to store files and file system. The disk or the part of disk is partitioned into blocks, normally 512 bytes. The blocks are organised into three groups. The first group consists of block" and is called as superblock. It contains information about the particular file system, e.g. it tells how may blocks are in the entire system, how many blocks are allotted to inode and how many blocks are free. The second group consists of the blocks allotted to inodes and final portion of a file system consists of blocks for storing the files themselves.

Multiple File System

In a typical UNIX system, more than one file system can exists together. A root directory and essential system files are kept in on file system. Whenever a UNIX starts up, root file system is automatically included. The other file system, then needs to be mounted to the root system. Multiple file system is transparent to end users while using commands like cp, cd. But in case of In command, as directory is a file in the particular file system, any links to that directory can be to the files in the same file system. User cannot link files across the file system.

The commands that are used to check and mount a file system are df (disk free) and mount mounting a file system).

Each device connected to UNIX system is represented by file in the /dev directory. Is -I command "dev directory gives the list of files. Typical Is -I gives an output that can be divided in six parts.

First part contains 10 characters known as mode. The first character indicates that what type file it is. D is used for directory and—for ordinary file.

Next 9 characters indicate the permissions ' the user, group and other. Second part shows number of links to the file.

This is followed by the name of owner. The fourth column shows the size of the file in bytes.

Fifth column shows date and time at which file was created or modified.

The last column shows the name of the file.

In case of the files in the /dev directory, the first letter in that mode string is c or b. indicates that the device character device as terminal and b indicates that is a block device like tape drive. This letter tells UNIX that the file is a special file that is associated with a device.

In the column, size of the file parameter, device file shows a number pair separated by comma. First number is major device number which indicates type of device and second is known as user device number indicating the individual specimen of that type.

There are two special devices /dev/tty and /dev/null. /dev/tty is a synonym for the terminal, user is using, /dev/null is used to dump unwanted output.

UNIX COMMANDS

The UNIX popular commands that include we for counting the words, grep for pattern matching in a file, finding a file in a directory tree, etc. UNIX provides way to use its many commands as building blocks from which one can construct new commands. These commands can be included in shell programming. Using a simple, single command, UNIX can solve user's problem e.g. to t the output alphabetically, sort command available. In UNIX two commands can be combined to solve a problem. Output of the first command is directed as the input to the next command. The pipe symbol (I) is used to do so, e.g. Is -I I we will display number of files in the current directory. UNIX command can have argument passed to it along with the options i.e. in Is -I /dev command -I is an option and /dev is the argument passed to the Is command.

Many times, a single command is not sufficient to solve the problem. In that case, more than one command are joined together to do the job. The tools that are used to do so are pipe and redirection.

Red*irection*

It changes the assignment for standard input and output. Typically which are a screen and /board. The redirection operators are > and <. > Operator makes the filename followed by > a new standard output and < operator makes the file name followed by < as a new standard it, e.g.

cat file1 file2 > file3

In this case, the output of the cat command is sent to the a file, called file3, instead of the standard output device, that is, screen. File3 will contain the contents of file2 followed by the contents of the file file2.

cat < file3

In this case, the standard input is taken from file3, instead of the keyboard and contents of the file3 will be displayed on the screen.

Pipe

Pipe is used to connect programs. Output of the first command is given as input to the next command, e.g.

grep week1 schedule I sort

Grep command is used for pattern matching. The pattern 'week1' will be searched in the file schedule and the output of this command will be given to sort command.

The redirection and pipe can be used together in a command, e.g.

grep week1 schedule I sort > week, then sorted output of grep command will be stored in a file called week.

Summary of the popular UNIX commands

Command	*Remarks*
Is	Lists the files in the directory.
Mkdir	Make a new directory, e.g. mkdir /usr/txt.
Cd	Change the directory, e.g. cd /usr/txt.
Cat	Contents of a text the file.
Who	See the users who have logged in.
Whoami	It gives the information about the terminal number, user name and date and time of the currently logged user.
Tty	It gives information about the terminal number user is using.
Grep	Pattern matching.
Find	Finds a file in a directory and its subdirectories.
Wc	Counts the number of words, lines, characters in a file.

WINDOWS

WHAT IS WINDOWS?

Windows is developed by a Microsoft Corporation. Windows provides an operating environment that runs under MS-DOS. It is a graphics based multitasking windowing environment. It has a consistent appearance and command structure. This makes windows easier.

For the user, window is rectangle portion of the screen that is application independent. For application developer, windows provide built-in subroutine to control the objects such as scroll. bars, icons, dialog boxes. Windows also provides the device independent environment to; application developer because the same application can run identically on variety of hardware configuration.

FEATURES OF WINDOWS

The *major benefits of Windows are:*

a) Standardised User Interface

The standardised graphical user interface (GUI) is the most important and convenient to users. This interface uses pictures, known as icons, to represent drives, tiles, subdirectories, etc. Most of the windows applications has the keyboard and mouse interface. Mouse interface is easier for many operations than the keyboard. Each and every window displayed in the window; will have the same look, e.g. function key F1 will invoke help in all applications.

b) Multitasking

A multitasking operating systems allows the user to have several applications running concurrently or several instances of the same application. In windows environment, user can have multiple application running on his computer at a time. User can switch between the different applications and exchange information among windows, e.g. on a computer, a calculator and a word (used for word processing) are running simultaneously. User can switch between calculator and word document. The result in calculator then can be taken to word document.

An active application is the one receiving the user's attention. Only one application can be processing at a time. But, there can be any number of concurrently running tasks. This is achieved by partitioning up the microprocessor's time, e.g. user may be typing a document in word but at the same time floppy is being formatted in the background. Under windows all the valuable resources like input and output devices, memory must be shared.

c) Memory management

One of the shared resources is memory. Many applications running at the same time, share the memory available. Windows consolidates the free memory available.

User can have many instances of the same program running at a time. In such a case, windows share the same code. The files that contain shared routines are called dynamic link libraries (DLL). At the run time, codes for the routines in the dynamic link library are linked.

d) Queued input

Another shared resource is the keyboard and mouse input. Windows receives all input from the keyboard, mouse and timer in a system queue. It is the queue that redirects the input to the appropriate application queue.

e) Messages

Even if some event occurs, message will be sent to windows. The event may be generated by user such as clicking of mouse, selecting menu option. The event could be generated by an application also. The roles of messages are:

1. With the help of messaging system, windows achieves the multitasking. The messages that are responsible for sharing the resources amongst the different applications. Whenever messages are send to windows, it allocates the processor time.
2. Messages enables an application to respond to events. Each time an event occurs, then after notifying it windows distributes the message to appropriate application.

One can say that the major task of windows application is to process messages.

f) Device independence

One of the major features of windows is hardware independence. In windows environment, each driver need only be written once. The hardware company provides drives for each device they manufacture. Microsoft includes most of the drivers with windows and others can be made available from hardware manufacturer. When windows is installed, it includes the drivers for all connected devices. Whenever a command is sent to a device, from any application, windows sends it to the appropriate driver. Application program directly does not deal with any device. An application interacts with windows and windows in turn interact with the device, i.e. a printing command is send from word, it will be passed to windows and windows gives the output through the appropriate drivers. If a document needs to print from another machine,

windows will use the drivers installed on that machine. Application program need not take care of it.

g) Object Linking and Embedding (OLE)

This feature allows user to transfer and shares the information between windows-based applications and accessories i.e about data sharing. There are two ways of doing it. The object that is a piece of information that can be embedded or linked. Consider an example, in a word document you want to add the logo of the company. The logo, being a picture, user can create it using a paintbrush application. This picture is embedded in the word document. If the picture is changed later on, the logo that is embedded in the document will not be changed. Consider another example, where a graph is drawn based upon the data collected, using lotus for windows. This graph is to be included in the report which is a word application. The graph can be linked to the word document. The advantage of using it is, whenever the data is changed, graph will be changed in the lotus as well as word document.

h) Support for DOS based applications

Windows provides support for most of the DOS based applications. There is no need to change the DOS application to work on windows. All the applications works exactly same under windows as they use to work under DOS. You can directly run those applications from windows. Example of such application is WordStar. User can invoke WordStar which is DOS based application from windows.

COMPONENTS OF WINDOWS

All windows application has the same interface. Every window has a border, control box, scrollbars, minimise, maximise buttons, etc.

Border

All windows have a border around them. The border consists of the lines that frame a window. Border servers as a screen boundary. It also indicates the active window. By using mouse, one in change the size of the window.

Title bar

The title bar displays the name of the application program. The title is centred at the top of the associated window. This title can be used to indicate the type of application.

Control Box

All window applications use a control box. The control box is a small white box. The control box flat-shadowed rectangle in window's upper left corner. Clicking on the control box by mouse display the system menu.

System Menu

Clicking on the control box, system menu will appear. It gives the standard application option such as restore, move, size, minimise, maximise and close.

Minimi*zation*

The upper right corner of each window displays two vertical buttons. The left button represents minimise box. Minimise box contains a downward pointing arrow. Clicking on minimise button will cause the window to shrink down to a small icon.

Maximise box appears on the upper right corner of the window. Right most is maximise box. ward pointing arrow represents the maximise button. The Maximise box is used to make an application window fill the entire screen. Maximised window will cover other running applications.

Vertical scroll bar

Below maximise box is the vertical scroll bar. The vertical scroll bar has an arrow at the either end pointing in opposite direction, a coloured band and transparent window block. The window block the current position of the currently displayed contents. This is shown in the relation to the document as a whole represented by coloured band. Clicking the mouse on either arrow shifts the display one line at a time. Clicking the mouse on the transparent window block below the upward arrow, and dragging it, causes screen output to be quickly changed to any portion of the application's screen output. With this block, user can change to any portion of the application output. Vertical scroll bar is normally used to move through pages in a multiple page document.

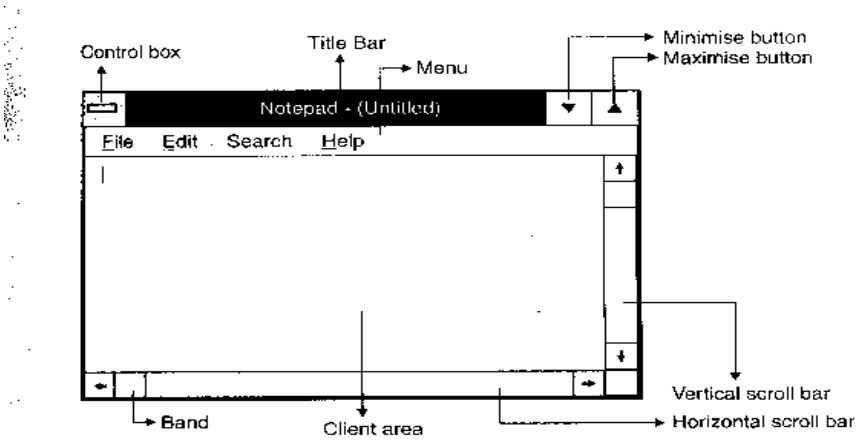


Fig. Components of windows

Horizon*tal scroll bar*

*The hori*zontal scroll bar is at the bottom of each window. It has arrows at the extreme ends in an opposite direction. Vertical scroll bar also has a

coloured band and a transparent window block along with the arrows. The window block shows the position of the currently displayed contents relation to the document as a whole, represented by the coloured band. Clicking on the mouse on either arrow causes the screen image to be shifted to one character at a time horizontally. The horizontal scroll bar is useful to move through multiple columns of a spreadsheet application.

Menu *bar*

*Be*low the title bar, menu bar for an application program appears.The items on the menu bar are menus and submenus. The items on the menu bar can be selected using a mouse. The other way to select menu item is "HOT Key'. Hot key is a combination of the ALT key and a letter. Hot key is shown in bold and underlines, e.g. 'F' for the command file.

Client Area

The client area is the primary output area for the application. It occupies the largest portion of each window. Only the application can output to client area, e.g. notepad is an editor provided by windows. If a notepad is started, it shows the name of the application along with the name of the file as a title of the window. In the client area, user can type the document. Using file option, user can perform file operations, e.g. save, print, close, etc. Using horizontal and/or vertical scroll bars, user can go through the whole document. Using maximise button the user can maximise the notepad application. At the end, user can select close option from the control box's system menu.

LANGUAGE TRANSLATORS

MACHINE LANGUAGE

A computer understands information composed of only zeros and ones and hence it uses binary digits for its operation. The computer's instructions are coded and stored in the memory in the form of Os and Is. A program written in the form of Os and 1s is called *machine language program.* There is a specific binary code for each instruction. For example, to add the contents of register A and register B. the binary code is 10000000 for Intel 8085. The binary code (machine code or object code) for a certain operation differs from computer to computer. Each microprocessor has its own instruction set and corresponding machine codes.

ASSEMBLY LANGUAGE

The writing of programs in machine language is very difficult, tiresome and boring job for a programmer. Moreover, it is errorprone. To solve this problem and to facilitate programmer easily understandable languages have been developed. Assembly language is one of them. Programs can easily be

written in alphanumeric symbols instead of Os and 1s. Meaningful and easily rememberable symbols are selected for this purpose. For example, ADD for addition, SUB for subtraction, CMP for comparison, etc. Such symbols are known as *mnemonics.* A program written in mnemonics is called *assembly language program.* The writing of programs in assembly language is easier and faster as compared to the writing of programs in a machine language.

Assembler

When a program is written in a language other than the machine language of computer, the computer will not understand it. Hence, the programs written in other languages must be translated into the machine language of the computer before they are executed. Such translation is performed with the aid of software. A program which translates an assembly language program into a machine language program is called an *assembler.* An assembler which runs on a computer for which it produces object codes (machine codes) is called a self assembler (or resident assembler). A less powerful and cheaper computer may not have enough software and hardware facilities for program development and convenient assembly. In such a situation a faster and powerful computer can be used for program development. The programs so developed are to be run on smaller computers. For such program development a cross assembler is required. A *assembler* is an assembler that runs on a computer other that for produces machine codes.

One-Pass Assembler. It is an assembler which reads the assembly language programs only once. Such assembler must be equipped with some means to assign addresses to the labels used in the assembly language program.

Two-Pass Assembler. It is an assembler which goes through the assembly language program twice. On the first pass the assembler reads the assembly language program and collects all labels. It assigns addresses to the labels counting their position from the starting address. On the second pass the assembler produces the machine code for each instruction and assigns address to each.

Advantages of Assembly Language

The advantage of assembly language over high-level languages is that the computation lime of an assembly language program is less. An assembly language program runs faster to produce the desired result.

Disadvantages of Assembly Language

i. Programming is difficult and time consuming.

ii. The assembly language is machine oriented. The programer must have the detailed knowledge of the structure of the computer he is using. He

must have the knowledge of registers and instruction set of the computer, connections of port? to the peripherals etc.

iii. The program written in assembly language for one computer can not be used on any other computer, i.e. the assembly language program is not portable. Each processor has its own instruction set and hence its own assembly language.

iv. An assembly language program contains more instructions compared to high-level language program. Each statement of a program in a high-level language (such as FORTRAN. PASCAL etc.) corresponds to many instructions in an assembly language program.

Compiler

A program which translates a high-level language program into a machine language program is called a compiler, A compiler is more intelligent than an assembler. It checks all kinds of limits, ranges, errors etc. But its program execution lime is more. and occupies a larger part of the memory. It has low speed and low efficiency of memory utilization. If a compiler runs on a computer for which it produces the object code. then it is known as a *self or resident compiler*. If a compiler is runs on a computer other than that for which it produces object code. then it is called a *cross-compiler*.

Interpreter

An interpreter is a program which translates statements of a high-level language program into machine codes. It translates one statement of the program at a time It reads one statement of a high-level language program, translates it into machine code and executes it. Then it reads the next statement of the program. translates it and executes it. In this way it proceeds further till all the statements of the program are translated and executed. On the other hand a compiler goes through the entire high-level language program once or twice and then translates the entire program into machine codes. A compiler is 5 to 25 times faster than an interpreter. An interpreter is a smaller program as compared to compiler. It occupies less memory space. It can be used in a smaller system which has limited memory space. The object program produced by the compiler is permanently saved for future reference. On the other hand the object code of the statement produced by an interpreter is not saved. If an instruction is used next time. it must be interpreted once again and translated into machine code. For example, during the repetitive processing of the steps in a *loop,* each instruction in the *loop* must be reinterpreted every time the loop is executed.

PROGRAMMING LANGUAGES

A computer can only do what a programmer asks to do. To perform a particular last; the programmer writes a sequence of instructions, called *program.* An *instruction* is a command given to the computer to perform a certain specified operation on given data. A set of programs written for a computer is called *software.* The software needed to execute the user's program is known as *system soft\\'are.* The system software consists of operating system, assembler, compiler, interpreter, debugging programs, text editors etc. A program which is prepared by a programmer to solve certain problem or to perform certain specified task is known as *user's program.* The *operating system* is a collection of programs that controls the overall operation of a computer. The term *firmware* is used for the software stored in read only storage devices. Those programs which are rarely or never expected to be changed are stored as firmware. Very important programs which must be in the primary memory and must not be lost when power goes off. are stored as firmware such as monitor of a computer, programs of a microcontroller etc. The microprograms of computers are stored as firmware. The term software includes both system software as well as user's program. The user's program is stored in RAM. The CPU takes one instruction of the program from the RAM at a time and executes it. It executes all the instructions of the program one by one to obtain the desired result.

The softwares which are helpful to users in developing, willing, debugging and documenting programs are referred to as *utility programs.* These are software tools to help users while preparing programs. There are two types of utility programs: file management utilities and program development utilities. The file management utilities are helpful to users in coping, printing, erasing and renaming the files. These programs are a part of the operating system. The program development utilities are useful in writing and testing programs. These are text editor, assembler, compiler, loader, linker, locator, debugger etc. A simple text editor forms a part of the operating system whereas an elaborate editor is stored separately. Compilers are stored separately. Programs loaded separately also run under the control of the operating system.

A large variety of prewritten softwares is available nowadays to solve specific tasks. Users need not prepare programs for many specific tasks. They should simply know how to use such prewritten softwares. Special purpose softwares are available for word processing, billing, inventory control, computer based engineering design such as design of electronic circuits, design of different aspects of power systems, building, structure etc. Some important

application packages (programs) available are: dBASE, LOTUS, Wordstar, Ventura etc.

LOW-LEVEL AND HIGH-LEVEL LANGUAGES

A language in which each statement is directly translated into a single machine code is known as *low-level language.* Examples of the low-level language arc the assembly languages of various processors. The demerits of assembly language were already discussed. The basic problem of an assembly language is that it is more closely related to the structure of a computer than to the performance of the task which is to be performed. The programmer spends more time in manipulating registers and considering instruction sequences than solving actual problems. The programmer must have very detailed knowledge of the instruction set. architecture and connection of peripherals to the ports etc.

To overcome the difficulties associated with assembly languages *lush-level* or *procedure-oriented* languages have been developed. High-level languages permit programmers to describe tasks in a form which is problem oriented rather than computer oriented. One can formulate problems more efficiently in a high-level language and need not have a precise knowledge of the architecture of the computer he is using.

The instructions written in a high-level language are called *statement.* The statements more clearly resemble English and mathematics as compared to mnemonics in assembly languages. Examples of high-level languages are BASIC, PASCAL. FORTRAN, COBOL. ALGOL, PL/I, PROLOG. LISP. ADA, SNOBOL, etc. A high-level language is independent of a computer. The same program will run on any other computer which has a compiler for that language. The compiler is machine dependent but not the language. The advantages of high-level languages are:

i. They are easier to learn as compared to assembly languages.
ii. They make programs easier and faster to write.
iii. Provide better documentation.
iv. The programmer does not have limitations to use a single type of machine.
v. programs are portable, i.e. they will run on any computer which has a similar compiler.

One statement of a high-level language corresponds to many instructions of the assembly language program. Hence, a high-level program is much shorter compared to assembly language program. Many high-level languages have been developed; some are for general purposes and some for special purposes. For example. PASCAL. PL/I and ADA are general purpose

languages. FORTRAN and APL for scientists and engineers. They are designed to solve mathematical problems. COBOL is for business applications. BASIC is for newcomers to programming. PROLOG is based on logical reasonings and used for artificial intelligence (i.e for expert systems). SNOBOL is suitable for text processing. APT is used in manufacturing applications to control machine tools.

Source Language and Object Language

The language in which a programmer writes programs is called *source language.* It may be a high-level language or an assembly language. The language in which the computer works is called *object language* or machine language. Machine codes are also known as *object codes.* A program written in a source language is called a *source program.* When a source program is converted into machine code; by an assembler or compiler it is known as an *object program.* In other words a ; machine language program ready for execution is called an object program.

Brief Description of High-Level Languages

BASIC. It is an abbreviation for Beginners All-purpose Symbolic Instruction Code. It is a very simple and easy language. It is suitable for scientific computations. But it is not as powerful as FORTRAN. It was introduced in 1965 by Dartmouth College. It is a widely used language for simple compulation and analysis. It is now by far the most popular high-level language used in personal computers. To translate BASIC instructions into machine-language codes interpreters are frequently used in PC systems. But BASIC language compilers are also available For these systems,

FORTRAN. It is an abbreviation for Formula Translation. It was introduced by BM in 1957. It is a very useful language for .scientific and engineering computaions as it contains many functions for complex mathematical operations. It is a impact programming language. Huge libraries of engineering and scientific programs written in FORTRAN are available to users. It is not suitable for possessing large business files as COBOL is. It has a number of versions. Earlier. FORTRAN IV was very popular. In 1977 the American National Standards institute (ANSI) published a standard for FORTRAN called FORTRAN 77 with an idea that all manufacturers may use the same form of the language.

COBOL. It is an abbreviation for Common Business-Oriented Language. It was developed specially for business data processing. It was introduced by U.S. industry/Government committee in 1960. It is used for large business and commercial applications such as handling of ledgers, accounts, payroll files etc. It supports simple and limited numeric operations, but it can

handle complex nonnumeric operations. It is more suitable to manipulate alphanumeric characters in FORTRAN. It can be written in a quasi-English form that may employ commonly used business terms. Its English like statements can be understood very easily. for example, SUBTRACT WITHDRAWALS FROM OLD BALANCE

PASCAL. It is a high-level language named in honour of Blaise Pascal, a seventh century French mathematician, philosopher and inventor. The first mechanical calculator was invented by him. The language was developed by Prof. Nicklaus Wirth at Switzerland's Federal Institute of Technology in the ealy 1970s. It is a multipurpose language suitable for both scientific and business applications. Besides numbers it can also manipulate vectors, matrices, strings of characters, sets, records, files and lists. As it is a compact language its compiler is quite suitable for a smaller system. Program design and debugging is piled. It produces very efficient machine-code program. The program com-from PASCAL runs several times faster as compared to the same program complied from FORTRAN or BASIC. Like ALGOL it is block-structured. It is an offspring of ALGOL. It is more versatile than BASIC and more modular than IRAN. PASCAL is quite similar to C language, but it is not used in professional programming as much as C language is. It became an ANSI standard language in 1983.

ALGOL. It is an abbreviation for A Programming Language. It has been developed by IBM. It is a very powerful language. It permits users to define instructions. It contains a large library of predetermined functions. It is used with personal computers and larger systems. It can perform complex arithmetic-logic operations with a single command. It is designed for mathematical work to provide more facilities than FORTRAN. It is very complex and has no commercial application. Mathematicians may like to use it. It requires special keyboard and terminal because its instructions are comprised entirely of geometric shapes and symbols.

C Language. It is a general purpose high-level language. This language has been designed by a group at Bell Telephone Laboratories, U.S.A. in the early 1970s. It has features similar to PASCAL. It permits manipulation of internal processor registers and hence a programmer can write low-level machine instructions. It has the features of assembly language programming. It is a small and concise language. It makes use of a library of functions that are equivalent to subroutines. C program can use modular and structured concept. A problem may be divided into smaller tasks, a function may be used to solve each task. C program may represent a grouping of functions that are linked together to produce the solution of the problem. C programs can be shifted

from one machine architecture to another without much difficulty. This language is used by system programmers to develop complex programs such as an operating system and application program. AT and T (Bell Lab's parent) produce C compiler and UNIX operating system tools as a single software package. It has many versions which run on PCs and larger machines.

PROLOG. It is a suitable language for developing programs involving complex logical operations. It is used primarily for artificial intelligence. It was developed in France. The Japanese have chosen this language as a standard language for their fifth generation computer project. It is quite suitable for handling large databases and for producing rules-based expert systems applications. PROLOG stands for PROgramming in LOGic. It is based on mathematical logic. Most of today's high-level languages like BASIC, COBOL, FORTRAN or PASCAL are 101 based on the principles of mathematical logic. These languages were designed to provide efficient computation and data manipulation. They enable us o use computers for these purposes. But today computers are also being used to provide conclusions based on intelligent reasoning. For such a purpose program-fling languages based on the principle of mathematic logics are needed. PROLOG is based on the first order predicate calculus. PROLOG consists of a set of acts and rules that describe objects and relations between objects in a given domain. The statements that are unconditionally true are called facts, while rules provide properties and relations which are true depending on given conditions. Many expert systems have been developed. They perform operations based on logical reasoning and provide conclusions.

LISP. It stands for LISt Processing. This language was developed by McCarthy in the early 1960s. It is suitable for nonnumeric operations involving logical operations. It is used extensively in artificial intelligence and pattern recognition. It is also used in game playing, theorem proving etc. It is capable of searching, handling and sorting long strings or lists of text. So it has often been used to implement computerized translators. It is used primarily on larger computers but LISP compilers are also available for PCs.

SNOBOL. It stands for StriNg Oriented SymBOlic Language. This language was developed by a group led by Griswold in the mid 1960s. It can manipulate strings of characters and hence it is used in text processing. It is capable of performing various types of operations on strings of characters such as combining strings, splitting strings, matching strings etc.

LOGO. It was developed by Seymour Papert and his colleagues at MIT in the late 1960s. It is used in serious scientific work in universities. It has also been popularized as a first educational language that children can use to

achieve intellectual growth and problem-solving skills. LOGO has graphics capability. Children can easily use it to make drawings. They can draw, colour and animate images. It runs on PCs. It is used to compose music, manipulate text. manage data etc.

APT. It stands for Automatically Programmed Tooling. It is used in manufacturing applications to control machine tools.

MODULA-2. It has been developed by Nicklaus Wirth, the creator of PASCAL. Although it retains the merits of PASCAL, it is more powerful and easier louse. PASCAL programs can easily be translated into MODULO-2 codes. It is a; strongly structured language. It is easier for the compiler to find programming errors than it is with other languages. Structured programming also results in welt-planned program steps which produces more efficient and trouble-free software.

A computer understands information composed of only zeros and ones. A program written in terms of Os and 1s is called a *machine language* program Computer instructions are written in binary codes. A machine language uses only binary codes. To write a program in a machine language is a very difficult.' tiresome and very boring job. Moreover, it is error prone. To overcome this difficulty a program can be written in alphanumeric symbols instead of Os and Is. Meaningful symbols called *mnemonics* are used for this purpose. For example, ADD is used for addition, SUB for subtraction, CMP for comparison, etc. A language which uses mnemonics is called an *assembly language. A* program written in an assembly language is called an assembly language program.

An *instruction is* a command given to a computer to perform specified task. The instruction set of a processor is the collection of instructions that the processor is designed to execute. In assembly language a mnemonic is an instruction. Instructions are classified into groups like data transfer, arithmetic, logical, branch control, and I/O and machine control. Data transfer group includes instructions for transferring data from register to register, register to memory and memory to register. Instructions of arithmetic group perform addition, subtraction, multiplication, division, etc. on data placed in a register or memory. Logical group instructions perform AND, OR, EX-OR, comparison, rotate, etc. operations on the contents of registers. Instructions of branch control group perform conditional and unconditional jumps, subroutine call and return, and restart. I/O and machine control group instructions perform input, output, stack and machine control operations.

When a program is written in a language other than machine language, the computer will not understand this. Therefore, a program written in other

languages must be translated into machine language before it is executed. The task of translation is done by software.' A program which translates an assembly language program into a machine language program is called an *assembler.'*

A language in which each statement or an instruction is directly translated into a single machine code is known as a *low-level* language. Each mnemonic of an assembly language has a unique machine code. An assembly language is a low-level language. An assembly language depends on the internal architecture of a processor. Each processor has its own assembly language. Assembly language of one processor cannot be used for another processor. In other words it is *not portable.To* write an assembly language program, a programmer must have the detailed knowledge of the instruction set of the particular processor, its internal architecture, registers, and connection of pheripherals to ports etc. It is not very fast and efficient programming language. To overcome the difficulties associated With assembly language, high-level or procedure-oriented languages have been developed. In a high-level language an instruction is called *statement* rather than mnemonic. Statements more closely resemble English and Mathematics than mnemonics. High-level languages permit programmers to describe tasks in the forms which are problem oriented rather than computer oriented. Programming in a high-level language does not require precise knowledge of the architecture of a computer which is to be used. A program written in a high-level language will run on any computer which has a compiler for that language. In other words a high-level language is portable.

A program which translates a high-level language program into a machine language program is called a *compiler*. An *interpreter* is also a program which translates a high-level language program into machine language program. It reads one statement at a time. translates it into machine codes, executes it and then goes to the next statement of the program. On the other hand a compiler reads an entire program once or twice and then translates it. A compiler is faster and more powerful than an interpreter. A compiler is a larger program and occupies more memory space. It is costlier than interpreter.

Important high-level languages are: BASIC, FORTRAN, COBOL, PASCAL. C Language. PROLOG, etc. BASIC is an abbreviation for Beginners All-purpose Symbolic Instruction Code. It is a very simple and easy language for beginners. It is suitable for scientific calculation. FORTRAN stands f^r Formula Translation. It is a powerful language for scientific and engineering computations. COBOL stands for Common Business Oriented Language. It is suitable for business data processing. PASCAL is a multipurpose language

suitable for both scientific and business applications. This language has been named in honour of Blaise Pascal, a great mathematician and inventor. PROLOG stands for PROgramming in LOGic. It is suitable for artificial intelligence applications. It has been chosen for fifth generation computers. A large number of high-level languages have been developed. A particular language may be very efficient for a particular field.

SELF ASSESSMENT QUESTIONS

Questions

07. Machine language and assembly language are _____
08. What is a language translator?
09. FORTAN, PASCAL, C, C++, are _____ level programming languages.

Answers

07.Low level languages

08. A program which translaters the high level languages into machine language.

09. High

Important Questions

Section – A

01. What is a software?
02. What is system software?
03. What do you understand by the term application software?
04. What is an operating system?
05. What is a language translator?
06. What is programming language?

Section - B

07. Briefly explain about the need for softwares.
08. Briefly explain about the softwares types
09. What is the difference between a compiler and a translator
10. Write short notes about

    (a) M/C language b) Assembly language

Section -C

11. Explain about system software
12. Bring out the importance of operating systems and its various types
13. Explain about programming languages.
14. Explain about recent programming languages.

NOTES

UNIT – V

TECHNOLOGY BASED PRODUCTS IN BANKING

AUTOMATED TELLER MACHINES

Automated Teller Machines (ATMs) require special security measures due to the following:

- Financial nature of transactions conducted
- Unattended 24-hour self service operation
- High value of negotiables contained within unit
- Remote/off premises locations
- Possible offline operation
- PIN protected access only

Most ATMs require the protection of a safe to provide security for the negotiables dispensed by, or deposited in, the unit. Most ATMs manufactured today incorporate an integrated safe which houses only the modules requiring protection. Elements of the ATM which do not require the security of the safe are packaged within a cabinet external to the safe and can be serviced replenished without entering the safe. The alarm system for an ATM safe will normally detect and report—safe door unlocked, safe door open, attack by wedging, drilling, cutting, blasting etc. The technologies used to detect attack include simple vibration and heat sensing devices, alarm grids, and seismic detectors. For various reasons installers of ATMs may use security [y] cameras to capture a record of customers conducting transactions at the terminal.This may be necessary to resolve a dispute between a customer and the bank. Containers within ATMs are used to hold: currency to be dispensed, currency rejected or retracted by currency dispenser, deposited envelopes/cheques, retained cards. The security for the ATM-cards is similar to that of the EFT/POS cards and smart cards, depending on the card type. At the time of conducting a transaction, once the PIN (Personal Identification Number) is entered at a ATM, it must be verified that PIN and the card are a matching pair. The methods of achieving this depends upon whether an ATM is running in online or offline mode. Often the PIN checking is referred to as local authentication if the process takes place within the ATM and remote authentication is when the process is performed by the host.

The future trends in ATMs will probably be towards providing further and better security systems. These will be necessary for the following reasons:

- increasing value of negotiables held in ATMs,
- automation of additional financial transactions,

- the wider public knowledge of the PC-based processors and operating systems
- networking of the ATMs etc.

Increasing use of smart card technology in the future will improve security of card data.

SHARED ATM SYSTEMS

When a group of banks join together to make their ATMs available to the customers of the sole group, the task of approving payments takes on a new dimension. Banks could not be expected to trust other banks with their secret keys for verifying PINs and it would not be practicable for lists of all the PINs against card identity to be stored in all the banks. From this, allows that PIN verification must be done centrally by each card issuer, that all the ATMs must be online when they serve customers of other banks with central hub.

Within this network the banks must exchange authenticated messages, they must be able to carry PINs securely from one bank's processor to another and they must maintain accounts of transactions carried out which are satisfactory to all the banks, so that settlement can take place for payments that have been made by one bank to another's customer. All this implies the exhange of secret keys between the banks for authentication. The system must keep to a minimum the opportunities for fraud by employees of one bank against another. Clearly the banks must share secret keys if symmetric ciphers are used for authentication and encipherment. These keys must be handled in a way which reduces the dependence of one bank on another's security. In a shared ATM system, the security requirements of enciphering PINs and authentication messages can be met by public key ciphers and signatures. If the shared ATM system becomes very large and expands rapidly by combining with other systems, keeping in each ATM the public key of each issuer becomes difficult. Then a central authority can be established as the key registry and each card contains the public key of its issuer, signed by the registry. The ATMs hold the registry's public key and check the issuer's public key before using it to encipher the (signed) request message. There is a more radical approach which braces shared ATMs, EFT Point-Of-Sale and other payment systems, employing a 'smartcard' to originate a transaction with a digital signature.

EFT/POS

Electronic payments in shops are EFT/POS or Electronic Funds Transfer at Point of Sale. More strictly, POS can be interpreted as 'Point of Service' where service includes the sale of goods. T/POS schemes present interesting and somewhat difficult problems of security.

Consider a way in which an EFT/POS transaction progresses. The transaction begins by the reading of data from the cardholder's card. This serves to identify the card and may to some extent authenticate the card as genuine. A smart card is more able to provide authentication than a magnetic stripe card. Since the card might have been stolen and it is really the person wish to authenticate, not the card, the next step is to require something from the person, namely either a signature on a piece of paper or a Personal Identification Number (PIN). This PIN is no more than a password, usually rather short such as four decimal digits. If a signature is used, authentication of the person depends on the sales person comparing this signature with the one on the card. But, sometimes this process is skipped. Consequently, from a security point of view the use of a PIN is preferable. The next part of the procedure is to authorise the payment. First, the PIN is checked to see that it matches the card. Secondly, the card is matched against a register of stolen cards and other cards for which the issuer wants to stop payments. Thirdly, the amount of payment is compared with the cardholder's account to see if the funds are sufficient. When all these checks have been made, the shopkeeper wishes to know that the payment has been successful. The easiest way to signify completion is to prepare a printed receipt for the cardholder.

An EFT/POS card is debit-card which depends on funds being present and debits the cardholder's account before crediting that of the shopkeeper.

Compared with magnetic stripe card, the smart card is expensive but it has a number of virtues. Because it can undertake processing, it greatly widens the range of possible security schemes. It can store secret values and perform cryptographic operations, taking part in authentication protocols. All this depends on the assumption that the storage and processing of the card is physically protected from outside interference. By means of advanced semi-conductor techniques it may be possible to explore the functioning and read data from any chip, though at considerable cost. This means that a smart card cannot be used to protect a global key - one which, if revealed, would endanger the security of other parts of the system. The cost of physically attacking a smart card is too great to justify simply for the purpose of exploring one card or defrauding one account.

The most important of the tasks it can perform is to verify the card-holder's PIN. This solves in a simple way the problem of PIN security except for the short time that the PIN exists in transit between the PIN pad and the card itself. Even this vulnerability can be avoided by having a PIN pad on the card itself.

Home Banking

A person sitting at home can perform all bank transactions. For this type of work a PC or special input device attached to TV set can be employed. A communication packages is used for the purpose. Information is transmitted over telephone lines. One can see his balance, make payment of bills, apply for loans, and deposit money. He can make payment for purchasing securities and can perform other kinds of banks transactions.

SELF ASSESSMENT QUESTIONS

Questions

01. ATM means_____
02. EDI means_____
03. What is home banking

Answers

01. Auto mated teller machines
02. Electronic data interchange
03. Doing bank transactions sitting at the home

Magnetic-Ink Character Reader (MICR)

MICR is widely used by banks to process large volumes of cheques and deposit is written every day. A special ink called magnetic ink (i.e. an ink which contains iron oxide particles) is used to write characters on the cheques and deposit forms which are to be processed by an MICR. MICR is capable of reading characters on a paper written with magnetic ink. The magnetic ink is magnetized during the input process. The MICR reads the magnetic pattern of the written characters. To identify the characters these patterns are compared with special pattern stored in the memory. Before cheques are issued to customers the identification number of the bank and the depositor's account number are printed on the lower left-side of the cheques with the magnetic ink. The amount is printed on the lower-right side of the cheque by the bank employee with the same magnetic ink after the cheque is received from the customer. When a cheque is entered into an MICR, it passes through a magnetic field. The iron oxide particles are magnetized under the magnetic field. The read head reads the characters written on the cheque with the magnetic ink. It interprets the characters and sends the corresponding data directly to the computer for processing Upto 2600 cheques are processed per minute, by an MICR.)

Internet Banking

The electronic payment systems play an important role in e-commerce. Electronic banking provides the platform for settling money transactions for consumers, merchants, professionals, governments and financial institutions. Cyberspace is a term used for imaginary shared networks of computers. Therefore the term cyber banking means the banking in cyberspace. Some of the people use term cyberspace for the Internet. Cyber banking allows the customer to do banking from anywhere at anytime in a simple, flexible, and instant way. Advanced cyber banking tools and techniques provide security in the form of advanced encryption systems which ensure safety of client's name, address, credit card and transaction details. Cyber banking involves credit cards, smart cards, electronic cheques, electronic cash, etc., use of telecommunication networks, various communication protocols and security techniques.

Business on the Internet has been cheapest and fastest way and provides global coverage with increasing number of users. The Internet itself provides various services to carry out business tasks. Serious Internet applications can be developed to do the secure business on the Internet. Increasing volume of home PCs accessing the Internet helps the customers to do shopping, ordering the goods, paying for the goods etc. by sitting at the home. Lot of softwares exist which allow secure on-line banking over the Internet. A person can open an account, transfer the funds, pay for the goods and access the on-line banking services from anywhere in. the world. Use of hypermedia made it very easy to navigate through various banks, their products and services. Banks products are basically various services provided by banks, the Internet can be thought as a delivery vehicle for these services to millions of homes, spread all over the world eliminating the need to have costly brick-and-mortar branches. New payment schemes on the Internet like e-cash, electronic cheques and smart cards are replacing today's traditional cheques and credit cards that have been primary methods of payment. Using the Internet a community bank can move quickly to establish an electronic presence as well as update that presence in timely manner. World Wide Web browsers provide dial-only access to navigate through fabulous information pertaining to different vendors, merchants, their products, services with colourful graphics, images, pictures and sound. What user have to do is to dial a number and click the specific service sitting at kitchen, study room or car - anywhere convenient; Many browsers providing on-line services (OLS) have already come into the market to impart various services related to banking and financial transactions. They are also provide various levels of securities over the Internet.

REAL TIME GROSS SETTLEMENT (RTGS)

Real time gross settlement systems in which the transactions are communicated electronically over a network to the bank which maintains accounts and instantaneously updates the balances.

SECURITY WEAKNESSES AND ATTACK POINTS

Because the Internet as a whole is so complex, as are the hardware and software components that make it up, the system as a whole is riddled with programming and operating defects. Clearly, there is no way without going to inordinate lengths of testing programs of ten thousand lines and over to ensure that they will work perfectly under all conditions. This means that any commercial software runs the potential security risk of someone taking disadvantage of programming errors. When the components concerned are accessible to large number of users via a computer network, the risk of isolated weaknesses being misused multiplies.

FAULTY SOFTWARE-DESIGN

One of the main reasons why there are so many security problems on the Internet is the basic architecture of the TCP/IP and UDP protocols. Neither of them was developed originally with the intention of ensuring really secure communications paths. When sending data via the Internet using TCP/IP, for example, there is no way of knowing by which nodes the transmission will be routed. If hackers succeed in installing so-called "sniffer" programs at one or more nodes, any passwords sent in plain text will be disclosed.

Another reason why hackers are so successful is that system configurations are poor, and that there are few or no safeguards on Internet access systems. In purely technical terms, there are five areas of weakness: lack of safeguards (no firewalls), poorly configured and administered systems, basic security problems with communications protocols (IP, TCP, UDP), faulty service programs, and basic security problems with service programs (e.g. WWW, FTP etc.), and reliability and integrity of applications based on them.

INTERNET-BASED BANK AS SECURITY RISK

Apart from purely technical problems, many of the reasons why security standards are so poor are to be found in the organization of Internet-based banks themselves. No security officers, no focus on further training for systems managers and little or nothing in the way of internal security guidelines. This means a lot of care should be put into formulating a security strategy and in implementing the security measures. This strategy can then be used as the basis for appropriate organizational action and ultimately the procedures for implementation.

According to the hit list of the CERT (Computer Emergency Response Team)—coordinating-center at the Carnegie Melton University in Pittsburgh, so-called "sniffer attacks" are number one on the hit list of most successful break-in methods. These use "invisible" miniature programs smuggled in on Internet hosts to monitor data flows and retrieve passwords and system IDs.

Another trick that is used almost as often is IP-spoofing. The attacker gives his own data packets addresses which are in the address range of the target network and that therefore appear to have been generated by users on that network, hence the term "spoofing." This is mainly used to overcome packet filters and proxy firewalls whose authentication measures are based on Internet addresses.

In third place on the hit list, are attacks that use faults in the mail server application "sendmail," which exploits the weaknesses in the program. In fourth and fifth place are attacks via NFS (Network File Systems) and NIS (Network Information Service) applications. The various threat scenarios can be broken down into five areas:

i. Access control management (authentication systems)
ii. Communications protocols (IP, TCP, UDP)
iii. Internet applications (Telnet, DNS, etc.)
iv. Information services (WWW, Gopher, FTP) and
v. Computer viruses.

CYBER-CRIMES AND HACKING

As the Internet becomes a strategic resource for conducting banking activities, it opens up the market to professional cyber-criminals and hackers. In fact, cyber-crime and hacking are itself a professions by themselves, which are growing very rapidly. Some of these are recruits from the computer-underworld and some are paid Internet-specialists. These professional hackers are given concrete tasks of doing undesired/unethical/destructive things as quickly as possible. These hackers and cyber-criminals often consult underworld Bulletin Boards to find out how to get into the system they want. As mentioned earlier, the dramatic increase in the economic importance of the Internet makes it to appear that the number of cyber-criminals and the cyber-crimes / hacking they commit is increasing at the same rate. One reason, the number of (undisclosed) successful break-ins into corporate networks is so high that so far most of the hackers have come from relatively less-harmful computer underworld. Once they broke into a system, they left as silently as they had come in, without doing any significant damage in many cases so far. However, the hacking world is changing very fast. Increasingly, it is being populated by cyber-

criminals whose only aim is to sell their sophisticated technical skills to the highest bidder (criminal). In most of the Indian organisations (including banks) those which are on the Net, the corporate IT-security arrangements are often so preliminary that even part-time / weekend hackers find it easy getting into a system.

In order to emphasise the importance and seriousness of computer-crime and hacking-related issues in such environment, we are giving below a few of the major computer-crimes and hacking events occurred in this decade in the advanced countries.

During 1993, IEEE (Institute of Electrical and Electronic Engineers, USA) discovered sniffer-programs on an Internet-gateway-computer-system, which monitored and saved login-ids and passwords automatically. Initial estimates reckoned that over 1,00,000 passwords were captured.

AT&T (USA) reported that Telephone fraud costed them over 2 Billion US$ during 1993.

In 1994, Martin Janku, an employee of Czeck savings bank in Sokolov, was sentenced for eight years' imprisonment in the first major case of computer-crime in the Czech Republic. He had transferred 1.2 M US$ to his account using a computer-program which he himself had written.

In February 1995, the FBI (Federal Bureau of Intelligence, USA) caught Kevin Mitnick (31), "Wanted No.1 Hacker", after a two-year man-hunt. He was accused of stealing thousands of files and unlawfully using over 20,000 credit-card numbers.

In July 1995, Vladimir Levin, a Russian, managed to siphon-off 90 million US$ from Citibank of New York and other banks (collectively).

There may be many other computer-crimes and hacking events which are not detected so far, or detected but were not made public for various reasons. Therefore, the real extent of seriousness of this issue is something we can only speculate about.

In view of this increasing danger, the Committee on Technology Upgradation in the Banking Sector, which was setup by RBI under the chairmanship of Dr. Vasudevan (ED, RBI), has suggested that the Tiger Teams (Hackers Team) should be developed to determine strength (and especially weaknesses) of the Firewalls and other Internet-based systems, (ref. Report of the Committee on Technology Upgradation, July 1999, para. 3.2.8).

INTERNET SECURITY DESIGN AND ITS IMPLEMENTATION

The first step when setting up a network security system is to establish Network Security Policy and lay down appropriate corporate guidelines (refer

Appendix for Sample Network Security Policy).These then serve as the basis for an implementation plan that can be translated into reality.

SELF ASSESSMENT QUESTIONS

Questions

04. What is MICR cheque?
05. ATM networking is used_____
06. MICR cheque employes _____coat on it's the surface

Answer

04. Magnetic ink character recognistion cheque
05. to connect the Atms
06. magnetic

CORPORATE GUIDELINES FOR NETWORK SECURITY

The corporate guidelines state what the bank requires in terms of the proper use of computer systems and data networks. They define ways of preventing violations of those rules and what to do if a breach occurs. The main thing about security guidelines is that they must not go against current law or other existing corporate guidelines/works agreements.

a) Goals

The starting point for producing corporate network security guidelines is usually to make an overall definition of how data networks and computer systems work and what they do. This specifies what services are to be provided and what security and availability requirements the information technology has to meet.

To the banks and other financial institutions, network security required is something considerably different from that in most small companies. This means that the overall network and security objectives depend mainly on the nature of the organisation concerned. What is important is that the guidelines produced should be technically and commercially feasible, and should be backed up by the management. The contents should be devised in talks between IT-staff on the one hand and management on the other. It is also necessary to indicate who is responsible for interpreting guidelines in each case.

b) Risk analysis

To ensure that the measures defined in the corporate guidelines are realistic, the first step is to draw up as detailed risk analysis as possible. The assessment of what is to be protected, whom it is to be protected against, and

how (well) it is protected provide the basis for an appropriate security strategy. Both inadequate security precautions and exaggerated ones can have serious financial implications for banks. Identifying objects to protect is one of the main tasks in this early stage of security planning. Any errors here will affect the entire strategy and usually leave major security gaps. The list given below may help in covering them:

1. *Hardware:* Workstations, PCs, keyboards, printers, disk drives, networks (LANs, WANs, Internet), terminals, routers, bridges, etc.
2. *Software:* Source code, executable programs, diagnostics software, operating systems, communications software, games, etc.
3. *Data:* Data while executing software, data saved online, data filed offline, backup data, data from monitoring software, data while sending via e-mail/Internet, private data, etc.
4. *People:* Users, system managers, guests, consultants, service staff, etc.
5. *Documentation:* Program documentation, hardware documentation, system management documentation etc.
6. *Accessories:* printers, disks, tapes, etc.

Once we have defined the objects to be protected, we can start setting up potential attack scenarios and assessing their impact on the bank. These fall into three main categories:

Penetration by unauthorised persons Disrupting the network.

Loss of confidential information.

c) Formulating security guidelines

By using the results from the risk analysis, we can now start formulating the security guidelines. Security guidelines for people should define the rights and obligations of everyone user of the network. In most banks, these will include:

i. Staff
ii. Visitors and temporary staff
iii. Systems managers
iv. Service staff and outside consultants
v. Customers (who are receiving Net-based services)

As a rule, guidelines that cover all staff are gathered under the heading "General rules for using network-based systems". The questions are:

Who is authorised to use what systems or services?

What do we mean by authorised use of systems or services?

- ❖ Not getting into outside systems. Not capturing passwords.
- ❖ Not reading or tampering of other people's files. Not sharing your account with other people or staff.
- ❖ Not copying copyright software.

Who is authorised to set up system access (user accounts) for users? What are the duties of system users?

- ❖ Keep users' passwords secret.
- ❖ Change passwords regularly.
- ❖ Make backup copies of your own files. Keep secret data secret. Follow the guidelines for using system resources (memory space, etc.).
- ❖ Follow guidelines for using the internet.
- ❖ Adhere to guidelines for using DP systems for private purposes.
- ❖ Monitor your own account for unauthorised use.

The people who have the most (in practice, usually unlimited) rights in terms of the IT-infrastructure are systems managers. What people often forget is, this means they are also potentially the greatest threat to the system. So as well as choosing people carefully, it is essential to define systems managers'jobs, their rights and duties. Typical problem areas that should be tackled are:

i. Who is authorized to receive systems manager rights (super-user access)
ii. Who allocates those rights?
iii. On what basis are user rights granted (basic rule is never give users more rights than they need to do their job).
iv. To what extent is the systems manager authorised to analyse user data in diagnosing problems?
v. Does the system administrator have the right to monitor individual systems or the network as a whole?

The best way of ensuring that security guidelines are followed is to train the people concerned and make regular checks to see that the guidelines are being followed. A comprehensive security strategy should also include further training for staff on Data and Network Security and Security Audits.

The best security measures in the world are not so useful if the hardware components that make them up are not protected properly. Guidelines for protecting IT systems should be divided into two categories:

i. Safeguards for individual hardware components (servers, routers, terminals, system cabinets, etc.) and

ii. Safeguards for the bank as a whole (fire alarms, water alarms, air-conditioning systems, etc.)

All the critical components of IT infrastructure (such as File servers, Application servers, root terminals, routers, bridges, remote terminals, etc.) should be protected against theft, power-interruption, excess voltage, excess temperature, unauthorised intruders etc.

One area that is very important in terms of security but that is often over-looked is control cabinets. Very often, they are installed unprotected at central locations in a building without any serious access-controls being used. This means anyone can easily get at hubs, bridges, routers or cable terminals.

Checking the application-software systems the bank uses is another major component of a total security strategy. Computer systems configured individually by local-users are often the targets for external or internal hackers, or lead to data being lost, inadequate backups and compatibility problems. Privately installed applications or computer-games can open the way to viruses and Trojan horses. So the system-management must be aware of and properly document how each computer system is configured and what the components of the network are. Time to time changes required in the system-configuration should be done only by authorized people. Lastly, the protection of user data should be given top-most importance by having a systematic backup strategy.

Before the user is allowed to access a service, you need to define whether (and if so to what extent) confidential data are likely to be involved. There is no point in saving such data on systems unless those systems are suitably protected. So users must be told what data is to be regarded as confidential and how to deal with it. The questions to ask here are:

What data is to be regarded as secret or confidential?

What levels of classification are there?

Which users have access to that data?

What services involve or enable access to confidential data?

What systems can that data be saved on?

What security checks apply to those systems?

How is confidential data sent over data lines (encryption)?

How are backup copies of confidential data kept?

How are printouts of confidential data kept/disposed of?

Setting up outside data links, while at the same time keeping the network secure, is one of the hardest tasks, especially if the banks are linking

up to the Internet. There are three basic guidelines the banks should follow when setting up outside data links:

i. The banks must guarantee the security and integrity of their own inhouse network.

ii. The banks must keep the risk of unauthorised people getting in via outside data links to a minimum.

iii. At the same time, the security measures used should not restrict staff from using outside services.

The security guidelines should also include a detailed list of the services available and the user groups authorized to use them. These can then be used as the basis for setting up the firewall system. The security guidelines for using the Internet include:

i. Any Internet services not expressly authorized must be disabled

ii. Registered and authorized users should have access to the following Internet services like: WWW, FTP, e-mail, Gopher, Archie.

iii. Non-registered and unauthorised users cannot access the Internet. Access management is via a dedicated firewall system.

iv. There must be no direct links between the bank's inhouse network and the Internet. The only access to the Internet is via the its firewall system.

v. The firewall system must have monitoring and alarm systems for detecting breaches or impending breaches of security rules (outside attacks, changes in configurations, breaches of data integrity, etc.).

If the system administrator or IT-security officer or IT-auditor finds that there has been a breach of the security rules, it helps to have counter measures already in place. This means the corporate guidelines should have a separate section telling people what to do in the event of different security incidents. Basically, there are two very different strategies that can be used:

1) Protect and continue working and 2) Catching and punishing.

In many cases, it may be best to use a combination of the two, depending on how serious the breach is. The aim of the "protect and continue" guideline is to ensure that things get back to normal as soon as possible once the breaches of security have been plugged. The "catch and punish" strategy involves allowing the security rules to be breached (preferably in a controlled fashion) until the offender is caught. In addition to the experienced systems and network specialists who look for the offender, however, this also involves being ready to accept further breaches of security and hence ultimately of losing data. The following guidelines may help in choosing the appropriate strategy:

i. Using the make safe and continue strategy:

Data and computer systems are inadequately protected

Further breaches of security are an incalculable risk

You are not prepared to put resources into bringing charges against the offender

You don not know exactly who is in what user group

Users are unfamiliar with computing

ii. Using the catch and punish strategy:

Data and computer systems are adequately protected.

You have backup copies available for all the areas concerned.

The risk of damage from further breaches of security, which you are prepared to accept to catch the offender is reasonably proportional to damage from possible future offences

The attacks are frequent and massive; the bank's internet-communication-server itself is an attractive target for hackers and is frequently subject to security breaches.

You have experienced network managers and sufficient monitoring tools available.

The management is prepared to pursue and punish offenders.

Evidence shows that many breaches of security rules occur unwittingly or through the negligence of the internal staff. Bringing criminal charges is usually inappropriate in these cases. Alternatively, therefore, the banks should think about specific training for this type of security incident or consider disciplinary action in serious cases.

IMPLEMENTING AN INTERNET SECURITY ARCHITECTURE

Now that we have looked at corporate network security guidelines, it is possible to create the security architecture itself. To do this, it is necessary to convert the corporate guidelines into a detailed working draft. In the next stage, the implementation phase, this functional architecture will be installed, tested and put into use. Some security guidelines may involve organisational changes and structural measures as well as technical changes.

a) Designing a functional Internet security architecture

Designing a working security architecture is based on the dictates of the existing IT-infrastructure such as: Operating system, Network topology, Network protocols/Network-Operating systems, and Outside data links/communications protocols.

On this basis, the next step is to find a solution for each of the services required. From these solutions as a whole, one can ultimately build up a

firewall-architecture and detailed specifications for the security system. From this specification, it is possible to choose the products for creating our proposed security system and, after a risk analysis of the firewall configuration (cost/risk assessment), thus one can decide on how the final security system will look.

Therefore, planning and implementing a firewall system include the following milestone:

Corporate Guidelines

Risk Analysis

Formulation

Implementation

Working Security Architecture

Solutions

Cost/risk Assessment

Selecting Systems

b) Implementing the firewall system

A firewall is a gateway system that controls access to and from the internal network. This presumes that all individual internal systems utilise the internal network for connection to Internet or other outside networks. By forcing all connections to go through a "firewall" system, which is more closely supervised and monitored, chances are greatly improved for preventing and detecting an assault on the internal network. The firewall also acts as a "choke point", forcing all connections to the outside world to go through a small number of portals. The centrality of the firewall systems also increases their attractiveness to attack; however, the firewall is also better defended than an average system, thus limiting vulnerability.

At first, the firewall components are installed completely separate from the operating network and subjected to a series of tests. The results of the working and integration tests are fedback into the design of the system as a whole until it is working satisfactorily. The implementation phase finishes by producing the full documentation and putting it on the network.

c) Introducing working procedures

Introducing reliable operating procedures for the security system is just as important as implementing the firewall system itself. This should be based on the documentation of the security-architecture, consisting of the three components: System documentation, Operating documentation, and Logbook.

System documentation should include information of importance to all systems managers such as: Network configuration, Firewall configuration,

Internet services configuration, and Documentation of installed monitoring and alarm systems.

Operating documentation should contain descriptions of all operations that have to be used while using the different firewall components. These include: Making backups, Maintenance (DNS, etc.), Analysing and interpreting the different monitoring and alarm systems, Instructions for shutting down/starting up the system, What to do if operating problems occur, and what to do if there is a security breach. Lastly, the logbook should record everything the systems manager and other users do.

FUTURE TRENDS AND DIRECTIONS IN ELECTRONIC BANKING SECURITY

Technology development is moving forward very quickly. This section therefore discusses briefly the security issues which are helping to shape the security directions likely to be taken by the banks.

i. Non-Repudiation

The continual expansion of private banking networks has started a trend where the banks have to relinquish a degree of control to the security of customer. The absence of the ability to sign transactions will continue to become a difficult issue. There is a business need for a trust in the business trading relationships between the two parties, as well as defined contractual responsibilities. This type of trust and responsibility relationship is now beginning to be made by the deployment of digital signature schemes.

Some banking systems in the advanced countries have already implemented digital signature security schemes, and others are more likely to introduce such measures with the newer EDI/EFT developments within the corporate banking sectors. However, much work is still needed in the definition of acceptable standards, for smart card solutions, before widespread deployment is likely to become a reality within the personal banking market place. ii. Contact-less Cards and DSV Techniques

The use of Dynamic Signature Verification (DSV) schemes have many benefits in terms of customer acceptability. When such approaches are combined with the benefits of contact-less smart cards, the solution becomes very attractive for widespread deployment. Perhaps the approach can be viewed as the most suitable method for non-repudiation within the personal banking market. However, widespread agreement between banks will be needed if the approach is to gain favour as the best way forward.

A customer is already used to physically signing for most of the financial transactions. The DSV approach if properly implemented offers an acceptable transition from existing to enhanced security solutions.

Similarly mass exploitation of smart cards will require an extremely durable token which can sustain a long life span. The contact-less smart card avoids many of the hazards of the contact card, is easier to keep clean, avoids the potential for damage from the accepting device, and has no electrical contacts which can be subject to damage. However, the costs of the technology will have to be significantly reduced to enable the approach to be widely implemented.

iii. Super Smart Tokens

Smart card tokens of this nature offer the ability for data processing independent of the banking terminals. However, the super smart card will at some stage need to communicate with some type of banking system terminal to allow the receipt or dispatch of data. Consequently the wear and tear issues of the surface mounted contacts may constrain its handling and durability. In many ways, the token can be viewed as an off-line portable system, but if deployed as an answer to the identity verification process it will have some limiting features, i.e. the ability to bring together the combination of features at the time of transaction initiation has so far been a major security reason for a bank to invest in card technology.

iv. Magnetic Stripe Cards

It is likely that magnetic stripe cards will be enhanced, to allow further interchange agreements on a global basis.

SELF ASSESSMENT QUESTIONS

Questions

07. What is EFT?
08. What is internet banking?
09. what is RIGS

Answers

07. Electronic fund transfer
08. Banking on internet
09. Real time gross settlement

Important questions

Section – A

01. What is ATM?
02. What is homes banking?
03. What is MICR cheque?
04. What is electronic fund transfer?
05. What is internet banking?

Section - B

06. Write short notes about ATM and its networks
07. What are the advantages of home banking?
08. How fund is transferred in EFT?
09. What is network security? Explain

Section – C

10. Explain about technology bank products in banking
11. What is internet banking? Explain with its advantages and limitations
12. Bring out the importance of security.

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NOTES