CHAPTER 1
CONCEPT OF DATA PROCESSING

"You can't always predict, but you can always prepare"

LEARNING OBJECTIVES

1.1 Back to the Past - History of Computers
1.2 Parts of the Machine – Components of a Computer System
1.3 Range of Computers
1.4 Advantages & Limitations of Computers
1.5 Data Representation
1.6 Data Processing – Elements & Types
1.7 Computer Files

1.1: Back to the past – History of Computers

An Overview

The history of computers and computing is of special significance to us, because many of its most important events have occurred within our lifetime. Historians divide the history of the modern computer into generations, beginning with the introduction of the UNIVAC I, the first commercially viable computer, in 1951. But the quest for a mechanical servant - one that could free people from the more boring aspects of thinking is centuries old. Why did it take so long to develop the computer? Some of the "credit" goes to human foibles. Too often brilliant insights were not recognized or given adequate support during an inventor's lifetime. Instead, these insights would lay dormant for as long as 100 years until someone else rediscovered—or reinvented—them. Some of the "credit" has to go to workers, too, who sabotaged labor-saving devices that threatened to put them out of work. The rest of the "credit" goes to technology; some insights were simply ahead of their time's technology. Here, then, is an abbreviated history of the stops and starts that have given us this marvel of the modern age, the computer.

0^{th} Generation

Manual devices

3000 B.C: The Abacus

The abacus is probably considered the original mechanical counting device (it has been traced back 5000 years). It is still used in education to demonstrate the principles of counting and arithmetic and in business for speedy calculations.

1642: The Pascaline

The Pascaline used a counting-wheel design: Numbers for each digit were arranged on wheels so that a single revolution of one wheel would engage gears that turned the

wheel one tenth of a revolution to its immediate left. Although the Pascaline was abandoned as impractical, its counting-wheel design was used by all mechanical calculators until the mid-1960s, when they were made obsolete by electronic calculators.

1793-1871: Charles Babbage
Everyone from bankers to navigators depended on mathematical tables during the bustling Industrial Revolution. However, these hand-calculated tables were usually full of errors. After discovering that his own tables were riddled with mistakes, Charles Babbage envisioned a steam-powered "differential engine" and then an "analytical engine" that would perform tedious calculations accurately. Although Babbage never perfected his devices, they introduced many of the concepts used in today's general purpose computer.

Mechanical devices

1801: Jacquard's Loom
A practicing weaver, Frenchman Joseph-Marie Jacquard (1753-1871) spent what little spare time he had trying to improve the lot of his fellow weavers. (They worked 16 hours days, with no days off!) His solution, the Jacquard loom, was created in 1801. Holes strategically punched in a card directed the movements of needles, thread, and fabric, creating the elaborate patterns still known as Jacquard weaves. Jacquard's weaving loom is considered the first significant use of binary automation. The loom was an immediate success with mill owners because they could hire cheaper and less skilled workers. But weavers, fearing unemployment, rioted and called Jacquard a traitor.

1842: Babbage's Difference Engine and the Analytical Engine
Convinced his machine would benefit England, Babbage applied for—and received—one of the first government grants to build the difference engine. Hampered by nineteenth century machine technology, cost overruns, and the possibility his chief engineer was padding the bills, Babbage completed only a portion of the difference engine before the government withdrew its support in 1842, deeming the project "worthless to science". Meanwhile, Babbage had conceived of the idea of a more advanced "analytical engine". In essence, this was a general-purpose computer that could add, subtract, multiply, and divide in automatic sequence at a rate of 60 additions per second. His 1883 design, which called for thousands of gears and drives, would cover the area of a football field and be powered by a locomotive engine. Babbage worked on this project until his death. In 1991 London's Science Museum spent $600,000 to build a working model of the difference engine, using Babbage's original plans. The result stands 6 feet high, 10 feet long, contains 4000 parts, and weights 3 tons.

1816-1852: Lady Ada Augusta Lovelace
The daughter of poet lord Byron, Lady Ada Augusta Lovelace became a mentor to Babbage and translated his works, adding her own extensive footnotes. Her suggestion that punched cards could be prepared to instruct Babbage's engine to repeat certain operations has led some people to call her the first programmer. Ada, the programming

language adopted by the Department of Defense as a standard, is named for Lady Ada Lovelace.

1860-1929: Herman Hollerith

With the help of a professor, Herman Hollerith got a job as a special agent helping the U.S. Bureau of the Census tabulate the head count for the 1880 census—a process that took almost eight years. To speed up the 1890 census, Hollerith devised a punched-card tabulating machine. When his machine outperformed two other systems, Hollerith won a contract to tabulate the 1890 census. Hollerith earned a handsome income leasing his machinery to the governments of the United States, Canada, Austria, Russia, and others; he charged 65 cents for every 1000 people counted. (During the 1890 U.S. census alone, he earned more than $40,000---a fortune in those days) Hollerith may have earned even more selling the single-use punched cards. But the price was worth it. The bureau completed the census in just two and half years and saved more than $5 million.

1890: Hollerith's Tabulating Machine

Hollerith's punched-card tabulating machine had three parts. Clerks at the U.S. Bureau of the Census used a hand punch to enter data into cards a little larger than a dollar bill. Cards were then read and sorted by a 24-bin sorter box (right) and summarized on numbered tabulating dials (left), which were connected electrically to the sorter box. Ironically, Hollerith's idea for the punched card came not from Jacquard or Babbage but from "punch photography". Railroads of the issued tickets with physical descriptions of a passenger's hair and eye color. Conductors punched holes in the ticket to indicate that a passenger's hair and eye color matched those of the ticket owner. From this, Hollerith got the idea of making a punched "photograph" of every person to be tabulated.

1924: IBM'S First Headquarters Building

Herman Hollerith founded the Tabulating Machine Company which, in 1911, merged with several other companies to form the Computing-Tabulating-Recording Company. In 1924 the company's general manager, Thomas J. Watson, changed its name to International Business Machines Corporation and moved into this building. Watson ran IBM until a few months before his death at age 82 in 1956. His son, Thomas J. Watson, Jr., lead IBM into the age of computers.

1920s-1950s: The EAM Era

From the 1920s throughout the mid-1950s, punched-card technology improved with the addition of more punched-card devices and more sophisticated capabilities. The *electromechanical accounting machine (EAM)* family of punched-card devices includes the card punch, verifier, reproducer, summary punch, interpreter, sorter, collator, and accounting machine. Most of the devices in the 1940s machine room were "programmed" to perform a particular operation by the insertion of a prewired control panel. A machine-room operator in a punched-card installation had the physically challenging job of moving heavy boxes of punched cards and printed output from one device to the next on hand trucks.

1939: John V. Atanasoff

In 1939 Dr. John V. Atanasoff, a professor at Iowa State University, and graduate student Clifford E. Berry assembled a prototype of the ABC (for Atanasoff Berry Computer) to cut the time physics students spent making complicated calculations. A working model was finished in 1942. Atanasoff's decisions---to use an electronic medium with vacuum tubes, the base-2 numbering system, and memory and logic circuits---set the direction for the modern computer. Ironically, Iowa State failed to potent the device and IBM, when contacted about the ABC, airily responded, "IBM will never be interested in an electronic computing machine". A 1973 federal court ruling officially credited Atanasoff with invention of the automatic electronic digital computer.

1942: The First Computer, the ABC

During the years 1935 through 1938, Dr. Atanasoff had begun to think about a machine that could reduce the time it look for him and his physics students to make long, complicated mathematical calculations. The ABC was, in fact, born of frustration Dr. Atanasoff later explained that one night in the winter of 1937, "nothing was happening" with respect to creating an electronic device that could help solve physics problems. His "despair grew", so he got in his car and drove fore several hours across the state of Iowa and then across the Mississippi River. Finally, he stopped at an Illinois roadhouse for a drink. It is in this roadhouse that Dr. Atanasoff overcame his creative block and conceived ideas that would lay the foundation for the evolution of the modern computer.

Electromechanical devices

1944: The Electromechanical Mark I Computer

The first electromechanical computer, the *Mark I,* was completed by Harvard University professor Howard Aiken in 1944 under the sponsorship of IBM. A monstrous 51 feet long and 8 feet high, the MARK I was essentially a serial collection of electromechanical calculators and was in many ways similar to Babbage's analytical machine. (Aiken was unaware of Babbage's work, though). The Mark I was a significant improvement, but IBM's management still felt electromechanical computers would replace punched-card equipment.

Electronic devices

1946: The Electronic ENIAC Computer

Dr. John W. Mauchly (middle) collaborated with J. Presper Eckert, Jr. (foreground) at the University of Pennsylvania to develop a machine that would compute trajectory tables for the U.S. Army. (This was sorely needed; during World War II, only 20% of all bombs came within 1000 *feet* of their targets). The end product, the first fully operational electronic computer, was completed in 1946 and named ENIAC (Electronic Numerical Integrator and Computer). A thousand times faster than its electromechanical predecessors, it occupied 15,000 square feet of floor space and weighted 30 tons. The ENIAC could do 5000 additions per minute and 500 multiplications per minute. Unlike

computers of today that operate in binary, it operated in decimal and required 10 vacuum tubes to represent one decimal digit.

The ENIAC's use of vacuum tubes signaled a major breakthrough. (Legend has it that the ENIAC's 18,000 vacuum tubes dimmed the lights of Philadelphia whenever it was activated). Even before the ENIAC was finished, it was used in the secret research that went into building the first atomic bomb at Los Alamos.

1st Generation of Computers

1951: The UNIVAC I

The first generation of computers (1951-1959), characterized by the use of vaccum tubes, is generally thought to have begun with the introduction of the first commercially viable electronic digital computer. The Universal Automatic Computer (UNIVAC I for short), developed by Mauchly and Eckert for the Remington-Rand Corporation, was installed in the Bureau of the Census in 1951. Later that year, CBS News gave the UNIVAC I national exposure when it correctly predicted Dwight Eisenhower's victory over Adlai Stevenson in the presidential election with only 5% of the votes counted. Mr. Eckert is shown here instructing news anchor Walter Cronkite in the use of the UNIVAC I.

1907-1992: "Amazing" Grace Murray Hopper

Dubbed "Amazing Grace" by her many admirers, Dr. Grace Hopper was widely respected as the driving force behind COBOL, the most popular programming language, and a champion of standardized programming languages that are hardware independent. In 1959 Dr. Hopper led on effort that laid the foundation for the development of COBOL to run on many types of computers. Her reason: "Why start from scratch with every program you write when a computer could be developed to do a lot of the basic work for you over and over again?"

To Dr. Hopper's long list of honors, awards, and accomplishments, add the fact that she found the first "bug" in a computer—a real one. She repaired the Mark II by removing a math that was caught in Relay Number II. From that day on, every programmer has debugged software by ferreting out its bugs, or errors, in programming syntax or logic.

2nd Generation of Computers

1959: The Honeywell 400

The invention of the transistor signaled the start of the second generation of computers (1959-1964). Transistorized computers were more powerful, more reliable, less expensive, and cooler to operate than their vacuum-tubed predecessors. Honeywell established itself as a major player in the second generation of computers. Burroughs, Univac, NCR, CDC, and Honeywell—IBM's biggest competitors during the 1960s and early 1970s—become known as the BUNCH (the first initial of each name).

1963: The PDP-8 Minicomputer

During the 1950s and early 1960s, only the largest companies could afford the six and seven-digit price tags of *mainframe computers.* In 1963 Digital Equipment Corporation introduced the PDP-8. It is generally considered the first successful minicomputer (a nod, some claim, to the playful spirit behind the 1960s miniskirt). At a mere $18,000, the transistor-based PDP-8 was an instant hit. It confirmed the tremendous demand for small computers for business and scientific applications. By 1971 more than 25 firms were manufacturing minicomputers, although Digital and Data General Corporation took on early lead in their sale and manufacture.

3rd Generation of Computers

1963: The IBM System 360

The third generation was characterized by computers built around integrated circuits. Of these, some historians consider IBM's System 360 line of computers, introduced in 1964, the single most important innovation in the history of computers. System 360 was conceived as a family of computers, with *upward compatibility,* when a company outgrew one model it could move up to the next model without worrying about converting its data. System 360 and other lines built around integrated circuits made all previous computers obsolete, but the advantages were so great that most users wrote the costs of conversion off as the price of progress.

1964: BASIC—More than a Beginner's Programming Language

In the early 1960s, Dr. Thomas Kurtz and Dr. John Kemeny of Dartmouth began developing a programming language that a beginner could learn and use quickly. Their work culminated in 1964 with BASIC. Over the years, BASIC gained widespread popularity and evolved from a teaching language into a versatile and powerful language for both business and scientific applications. From micros to mainframes, BASIC is supported on more computers than any other language.

4th Generation of Computers

1971: Integrated Circuits

Although most computer vendors would classify their computers as fourth generation, most people pinpoint 1971 as the generation's beginning. That was the year large-scale integration of circuitry (more circuits per unit of space) was introduced. The base technology, though, is still the integrated circuit. This is not to say that two decades have passed without significant innovations. In truth, the computer industry has experienced a mind-boggling succession of advances in the further miniaturization of circuitry, data communications, and the design of computer hardware and software.

1975: Microsoft and Bill Gates

In 1968, seventh grader Bill Gates and ninth grader Paul Allen were teaching the computer to play monopoly and commanding it to play millions of games to discover gaming strategies. Seven years later, in 1975, they were to set a course which would revolutionize the computer industry. While of Harvard, Gates and Allen developed a

BASIC programming language for the first commercially avoidable microcomputer, the MIS Affair. After successful completion of the project, the two formed Microsoft Corporation, now the largest and most influenced software company in the world. Microsoft was coined by Bill Gates to represent the company that was devoted to MICROcomputer SOFTware. Originally christened Micro-Soft, the '-' was removed later on. Microsoft was given an enormous boost when its operating system software, MS-DOS, was selected for use by the IBM PC Gates, now the richest man in America, provides the company's vision on new product ideas and technologies.

1977: The Apple II

Not until 1975 and the introduction of the Altair 8800 personal computer was computing made available to individuals and very small companies. This event has forever changed how society perceives computers. One prominent entrepreneurial venture during the early years of personal computers was the Apple II computer. Two young computer enthusiasts, Steven Jobs and Steve Wozniak (then 21 and 26 years of age, respectively), collaborated to create and build their Apple II computer on a makeshift production line in jobs garage. Apple was favourite fruit of founder Steve Jobs. He was three months late in filing a name for the business, and he threatened to call his company Apple Computers if the other colleagues didn't suggest a better name by 5 o'clock**.** Seven years later, Apple Computer earned a spot on the Fortunes 500, a list of the 500 largest corporations in the United States.

1981: The IBM PC

In 1981, IBM tossed its hat into the personal computer ring with its announcement of the IBM Personal Computer, or IBM PC. By the end of 1982, 835,000 had been sold. When software vendors began to orient their products to the IBM PC, many companies began offering IBM-PC compatibles or clones. Today, the IBM PC and its clones have become a powerful standard for the microcomputer industry.

1982: Mitchell Kapor Designs Lotus 1-2-3

Mitchell Kapor is one of the major forces behind the microcomputer boom in the 1980s. In 1982, Kapor founded Lotus Development Company, now one of the largest applications software companies in the world. Mitch Kapor got the name for his company from the lotus position or 'padmasana.' Kapor used to be a teacher of Transcendental Meditation of Maharishi Mahesh Yogi. Kapor and the company introduced an electronic spreadsheet product that gave IBM's recently introduced IBM PC (1981) credibility in the business marketplace. Sales of the IBM PC and the electronic spreadsheet, Lotus 1-2-3, soared.

1984: The Macintosh and Graphical User Interfaces

In 1984 Apple Computer introduced the Macintosh desktop computer with a very "friendly" graphical user interface—proof that computers can be easy and fun to use. Graphical user interface (GUIs) began to change the complexion of the software industry. They have changed the interaction between human and computer from a short, character-oriented exchange modeled on the teletypewriter to the now familiar WIMP interface—Windows, Icons, Menus, and Pointing devices.

1985: Microsoft Windows

Microsoft introduced Windows, a GUI for IBM-PC-compatibles computers in 1985; however, Windows did not enjoy widespread acceptance until 1990 with the release of Windows 3.0. Windows 3.0 gave a huge boost to the software industry because larger, more complex programs could now be run on IBM-PC computers.

1.2: Parts of the Machine – Components of the Computer

A complete computer system consists of four parts: hardware, software, one or more users and data

Hardware:

1. The physical devices that make up the computer are called **hardware**.
2. Hardware is any part of the computer that can be physically touched.
3. A computer's hardware consists of interconnected electronic devices that you can use to control the computer's operation, input and output.
4. The generic term **device** refers to any piece of hardware

Software:

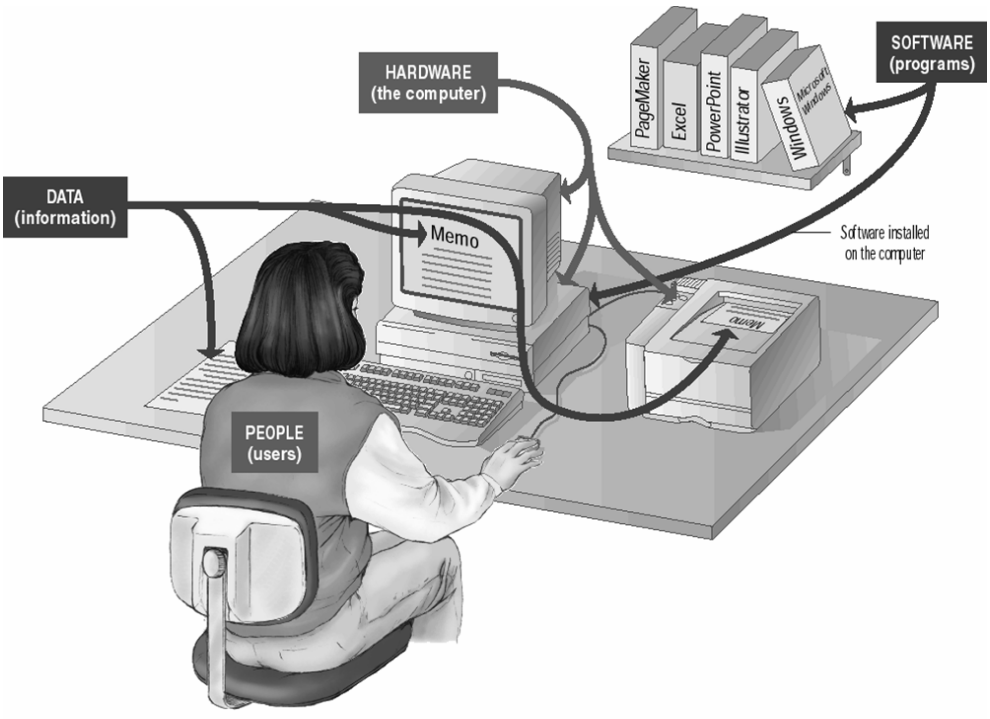
1. Software is a set of instructions that makes the computer perform tasks.
2. In other words, software tells the computer what to do.
3. Some programs exist primarily for the computer's use, helping it perform tasks and manage its own resources.
4. Other types of programs exist for the user, enabling him or her to perform tasks such as creating documents.
5. The term **program** refers to any piece of software.

Users:

1. People are the computer operators, also known as **users**
2. It can be argued that some computer systems are complete without a person's involvement; however, no computer is totally autonomous.

Data:

1. **Data** consists of individual facts or bits of information, which by themselves may not make much sense to a person.
2. Computerized data is **digital**, meaning that it has been reduced to digits, or numbers.
3. Within the computer, data is organized into **files**.
4. A file that a user can open and use is often called a **document**.



1.3: Range of Computers – Size of Computer

Generally speaking, the larger the computer, the greater it's processing power. Computers are often classified into five sizes: tiny, small, medium, large and super large.

1. **Microcontrollers (tiny):** Microcontrollers, also called embedded computers, are the tiny, specialized microprocessors installed in "smart" appliances and automobiles. These microcontrollers enable microwave ovens, for example, to store data about how long to cook your potatoes and at what temperature. Microcontroller applications includes washing machines, cellular phones, car dashboard, car security systems, music systems, home theatres, refrigerators, room air conditioners, television sets, etc.,

2. **Microcomputers—Personal computers:** Microcomputers are small computer that can fit on or beside a desk or are portable. Microcomputers are considered to be of two types: personal computers and workstations.

   Desktop and tower units: Even though many personal computers today are portable, buyers of new PCs often opt for nonportable systems, for reasons of price, power, or flexibility. For example, the television-tube-like (CRT, or cathode-ray

tube) monitors that come with desktops have display screens that are easier to read than those of many portables. Moreover, you can stuff a desktop's roomy system cabinet with add-on circuit boards and other extras, which is not possible with portables.

Desktop PCs are those in which the system cabinet sits on a desk, with keyboard in front and monitor often on top. A difficulty with this arrangement is that the system cabinet's "footprint" can deprive you of a fair amount of desk space. *Tower PCs* are those in which the system cabinet sits as a "tower" on the desk or on the floor next to the desk, giving you more usable desk space.

Laptops: A laptop computer is a portable computer equipped with a flat display screen and weighing about 1.5 to 6 kgs. The top of the computer opens up like a clamshell to reveal the screen. The two principal types of laptop computers are *notebooks and sub-notebooks*, a category sometimes called *ultra lights (thin).*

A *notebook* computer is a portable computer that weighs 2 to 4 kgs and is roughly the size of a thick notebook, perhaps 8½ by 11 inches. Notebook PCs can easily be tucked into a briefcase or backpack or simply under your arm. Notebook computers can be just as powerful as some desktop machines. Indeed, we are now at the point where a notebook may fulfill just about all the needs of a desktop. (viz IBM R series)
A *sub-notebook* computer weighs 1.25 to 2 kgs. To save weight, sub-notebooks in the past have often had external hard-disk drives, which were available as separate units. This category is for those who are frequent / extensive travelers. (Viz. IBM X series)

Pocket PCs: Pocket personal computers, or handhelds, weigh about 600 grams or so and can fit in a jacket pocket. These PCs are useful in specific situations, as when a driver of a package-delivery truck must feed hourly status reports to company headquarters. Another use allows police officers to check out suspicious car license numbers against a database in a central computer. Other pocket PCs has more general applications as electronic diaries and pocket organizers.

In general, pocket PCs may be classified into three types: (a) Electronic organizers are specialized pocket computers that store appointments, addresses, and "to do" lists. Recent versions feature wireless links to other computers for data transfer. (b) Palmtop computers are PCs that are small enough to hold in one hand and operate with other. (c) Pen computers lack a keyboard or a mouse but allow you to input data by writing directly on the screen with a stylus, or pen. Pen computers are useful for inventory control, as when a store clerk has to count merchandise, for package-delivery drivers who must get electronic signatures as proof of delivery; and for more general purposes, like those of electronic organizers and PDAs. Personal digital assistants (PDAs), or personal communicators, are small, pen-controlled, handheld computers that, in their most developed form, can do two-way wireless messaging.

Microcomputers—Workstations: Workstation looks like desktop PCs but far more powerful. Traditionally, workstation were sophisticated machines that fit on a desk, costs few lakhs, and was used mainly by engineers and scientists for technical purposes. However, workstations have long been used for computer aided design and manufacturing, software development, and scientific modeling. Workstations have caught the eye of the public mainly for their graphics capabilities.

Two recent developments have altered the differences between workstations and PCs: (1) Decline in workstation prices: A workstation that not long ago cost Rs 500,000 or more is now available at Rs 100,000, which certainly puts it within range of many PC buyers. (2) Increase in PC power: In 1993 Intel introduced the Pentium chip; in 1994 Motorola (with IBM and Apple) introduced its PowerPC chip. Both of these very powerful and microprocessors and their successors are now found in PCs. In addition, Microsoft introduced Windows NT, the first operating system designed to take advantage of more powerful microprocessors.

3. **Minicomputers/midrange computers:** Minicomputers are machines midway in cost and capability between microcomputers and mainframes. They can be used as single-user workstations. When used in a system tied by network to several hundred terminals for many users they are known as midrange computers. The minicomputer overlaps with other categories of computers. A low-end minicomputer may be about as powerful as a high-end microcomputer may equal a low-end mainframe. Traditionally, minicomputers have been used to serve the needs of medium-size companies or of departments within larger companies, often for accounting or design and manufacturing (CAD/CAM). Now many minicomputers are being replaced by groups of PCs and workstations in networks.

4. **Mainframes:** The large computers called mainframes are the oldest category of computer system. The word "mainframe" probably comes from the metal frames, housed in cabinets, on which manufacturers mounted the computer's electronic circuits. Occupying specially wired, air-conditioned rooms and capable of great processing speeds and data storage, mainframes traditionally have been water or air-cooled computers that are about the size of a Jeep and that range in price from Rs 25 Lakh to Rs 25 crores. Such machines are typically operated by professional programmers and technicians in a centrally managed department within a large company. Examples of such companies are banks, insurance companies, and airlines, which handle millions of transactions. Indeed, Federal Aviation Administration flight controllers are still using 1960s-era mainframes—Univac computers, which are no longer, made—to keep air traffic safe.

Today one hears, "mainframes are dead", being supplanted everywhere by small computers connected together in networks, a trend known as "downsizing". Is this true? It has been estimated that the world has $1 trillion invested in this kind of computer—perhaps 50,000 mainframes, 60% of them made and sold by IBM. But what are the future prospects for people working with mainframes? Although mainframe manufacturers will probably promote new uses for their equipment, there

appear to be three trends: (1) Old mainframes will be kept for some purposes. (2) Networks of smaller computers will grow. (3) Mainframes are being reinvented.

1.4: Advantages & Limitations of Computer System

Advantages of Computer System:

1. *Speed: (200 miles/millisecond):* Computers perform various activities by executing instructions, such as *computation operations* and *logic operations*. These operations are measured in **milliseconds, microseconds, nanoseconds** and **picoseconds** (one thousandth, one millionth, one billionth and one trillionth of a second, respectively)

Measurement	Seconds	Fractions of a second
Millisecond	0.001 second	One thousandth of a second
Microsecond	0.000001 second	One millionth of a second
Nanosecond	0.000000001 second	One billionth of a second
Picosecond	0.000000000001 second	One trillionth of a second

2. *Accuracy: (Zero errors):* Computers are not only accurate, but their accuracy reflects great *precision*. Computations are accurate within a paisa, a micron, a Picosecond, or whatever level of precision is required. Errors do occur in computer-based information systems, but precious few can be directly attributed to the computer system itself. The vast majority can be traced to a program logic error, a procedural error, or erroneous data. These are human errors.

3. *Consistency: (All strikes):* Computers always do what they are programmed to do – nothing more, nothing less. Computers follow GIGO concept of consistency. GIGO – Good in Good out. Alternatively GIGO – Garbage in Garbage out. The ability to produce consistent results gives us the confidence we need to allow computers to process mission-critical information.

4. *Reliability: (No downtime):* Computer systems are particularly adept at repetitive tasks. They don't take sick days and coffee breaks, and they seldom complain. Anything below 99.9% **uptime**, the time when the computer system is in operation, is usually unacceptable. For some companies, any **downtime** is unacceptable. These companies provide **backup** computers that take over automatically should the main computers fail.

5. *Memory Capability: (Virtually Unlimited):* Computer systems have total and instant recall of data and an almost unlimited capacity to store these data. A typical mainframe computer system will have trillions of characters and millions of images stored and available for instant recall. High-end PCs have immediate access to two or three billion characters of data and thousands of images.

Limitations of Computer System:

1. *Program must be reliable:*

- When we write a program, we are solving a *problem*. To solve a problem we must use our powers of *logic* and develop a procedure for solving the problem.
- Creating a program is like constructing a building. Much of the brainwork involved in the construction goes into the blueprint.
- The location, appearance and function of a building are determined long before the first brick is laid.
- With programming, the design of a program, or its *programming logic* (the blueprint), is completed before the program is written (the building is constructed).
- The traditional computer program consists of a sequence of instructions that are executed one after another.
- These instructions are executed in sequence unless their order is altered by a "test-on-condition" instruction or a "branch" instruction.

2. *Application logic must be understood:*

- The computer can only process jobs which can be expressed in a finite steps leading to a specify goal. Each step must be clearly defined.
- If the steps in the solution cannot be precisely stated, the job cannot be done. That is why the computer may not be helpful to people in areas where subjective evaluations are important.
- An algorithm is *a set of steps that always lead to a solution*. There are cases when no algorithm exists to solve a problem, or the algorithm is so complex or time-consuming that it cannot be coded or run.
- In these cases, programmers rely on heuristics to help solve problems or perform tasks. Heuristics are like algorithms; they are *a set of steps for finding the solution* to a problem.
- But unlike an algorithm, a heuristic does not come with a guarantee of finding the best possible solution. Heuristics offer a good chance of finding a solution, although not necessarily the best one.
- *Combinatorial explosion* is used when a finite number of program steps generate an impossible large number of computer operations.

1.5: Data Representation

Human languages are represented in automated language in very many ways. Human languages are many. It is represented (in various) using various alphabets and numbers. But machine languages are represented in numerical terms. Human languages are alphabetical i.e., both alphabets and numbers are represented alphabetically. Machine languages are numerical i.e., both alphabets and numbers are represented numerically. Machine languages are many viz.

Binary language – only 2 characters 0 &1 (Base 2)
Octal language-only 8 characters as the name suggests i.e., 0, 1, 2, 3, 4, 5, 6 & 7(Base 8)
Hexadecimal language – Yes, you are right. It has 16 characters (Hexa-6; Decimal-10) – 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E & F (Base 16)
{Note here that alphabets refers to numbers i.e., A-10; B-11; C-12; D-13; E-14; F-15}
Commonly used Human Numeric Language is Decimal system. (Deci means 10)
Decimal System = 10 (0, 1, 2, 3, 4, 5, 6, 7, 8 & 9) also called Arabic System
Roman System =I V X L C M D (Alphabets represent numbers devised by Romans)
Binary System= 2 (0 &1)
Octal System = 8 (0, 1, 2, 3, 4, 5, 6 & 7)
Duo Decimal System = 12 (used for some purposes by the Romans)
Hexadecimal System= 16 (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E & F)
Vigesimal System = 20 (used by the Mayans)
Sexagesimal System = 60 (used by the Babylonians)

Relationship between Decimal system and Binary system:

Base 10 Decimal System and Base 2 Binary System has a unique relationship. This is represented in the following table.

1.1 Table showing equivalents of Decimal & Binary

Prefix	*Symbol*	*Power of 10 Multipliers*	*Equivalent power of 2 Multipliers*
Kilo	K	10^3	2^{10}
Mega	M	10^6	2^{20}
Giga	G	10^9	2^{30}
Tera	T	10^{12}	2^{40}
Peta	P	10^{15}	2^{50}
Exa	E	10^{18}	2^{60}
Zetta	Z	10^{21}	2^{70}
Yotta	Y	10^{24}	2^{80}

The powers of 10 multipliers and the power of 2 multipliers for a given word prefix are almost, but not quite, the same.

Remember:
- Multiples of bits are always expressed in powers of 10.
- Multiples of bytes are always expressed in powers of 2.
- Data speed is expressed in bits and data storage is expressed in bytes.
- Lower case alphabets for data speeds and upper case alphabets for data storage.

In subjects like telecommunications, electronics and physics multipliers are defined in powers of 10, from 10^{-24} to 10^{24}, proceeding in increments of three orders of magnitude (10^3 or 1,000)

In Information Technology and Data Storage, multipliers are defined in powers of 2 from 2^{10} to 2^{80}, proceeding in increments of ten orders of magnitude (2^{10} or 1,024). These multipliers are denoted in the following table:

1.2 Table showing power 10 & power 2 multipliers

S. No.	*Prefix*	*Symbol*	*Power of 10*	*Equivalent (not equal) Power of 2*
1	Yocto	y	10^{-24}	-
2	Zepto	z	10^{-21}	-
3	Alto	a	10^{-18}	-
4	Femto	f	10^{-15}	-
5	Pico	p	10^{-12}	-
6	Nano	n	10^{-9}	-
7	Micro	μ	10^{-6}	-
8	Milli	m	10^{-3}	-
9	Centi	c	10^{-2}	-
10	Deci	d	10^{-1}	-
11	(N.A)	-	10^{0}	2^{0}
12	Deka	D	10^{1}	-
13	Hecto	H	10^{2}	-
14	Kilo	K	10^{3}	2^{10}
15	Mega	M	10^{6}	2^{20}
16	Giga	G	10^{9}	2^{30}
17	Tera	T	10^{12}	2^{40}
18	Peta	P	10^{15}	2^{50}
19	Exa	E	10^{18}	2^{60}
20	Zetta	Z	10^{21}	2^{70}
21	Yotta	Y	10^{24}	2^{80}

Note: S.No. 1-13 and 19-21 are not generally used to express data spread. S.No. 1-10 is expressed to represent fractions of a second. Capital letter symbols for positive power and small letter symbols for negative power.

Clarification

Is 10^3 and 2^{10} are both same? The power of 10 definition of kilo (k) refers to 1,000, while the power of 2 definition of Kibi (Ki) refers to 1,024.

As if this is not confusing enough, when referring to a data speed of one kilobit per second (1 kbps), analysts generally mean 1,000 bits per second (10^3 bps), but when talking about one kilobyte (1 KB) of data storage, they usually mean 1,024 bytes (2^{10} bytes). Some computer scientists believe adopting special prefixes could eliminate this prevailing confusion. Therefore a standard was derived.

Binary Standard:
Kibi, Mebi, Gibi, Tebi, Pebi, and Exbi are binary prefix multipliers that, in 1998, were approved as a standard by the International Electro-technical Commission (IEC) in an effort to eliminate the uncertainty that sometimes occurs between decimal (power-of-10) and binary (power-of-2) numeration terms.

1.3 Table Showing the Latest Standardised Symbol

S.No.	*Full technical name*	*Proposed prefix*	*Proposed symbol*	*Numeric multiplier*
1	Kilobinary	Kibi	Ki	2^{10}
2	Megabinary	Mebi	Mi	2^{20}
3	Gigabinary	Gibi	Gi	2^{30}
4	Terabinary	Tebi	Ti	2^{40}
5	Petabinary	Pebi	Pi	2^{50}
6	Exabinary	Exbi	Ei	2^{60}

Binary digit:

0 or 1	= a BIT
8 Bits	= 1 Byte
4 Bits or Half byte	= 1 Nibble

NUMBER SYSTEM

History:

Mankind through the ages has used signs or symbols to represent numbers. The early forms were straight lines or groups of lines, much like as depicted in the film "Robinson Crusoe", where a group of six vertical lines with a diagonal line across represented one week.

It is difficult to represent large or very small numbers using such a graphical (straight line) approach.

As early as 3400 B.C., in Egypt and 3000 B.C., in Mesopotamia, they developed a symbol to represent the unit 10. This was a major advance, because it reduced the number of symbols required. For example, 13 could be represented as 10 and 3 units (Four Symbols instead of 13 that was required previously).

The Romans:

The Romans devised a number system (using alphabets) which could represent all the numbers from 1 to 1,000,000 using ONLY seven symbols (alphabets). I-1; V-5; X-10; L-50; C-100 (That's why it is Centum!); D-500; M-1,000. A small bar placed above a symbol indicates the number is multiplied by 1,000.

The Arabians:

The number system in most common use today is Arabic System (i.e., Decimal System). It was first developed by the Hindus and was used as early as the 3rd century B.C. The number '0' is an Indian discovery by world renowned mathematician Aryabhatta.

The introduction of the symbol '0' has made the positional value of digits very important. Thus, the concept of groups of units, tens of units, hundreds of units, thousands of units and so on became familiar.

Recurring sets:

In number systems, it's often helpful to think of recurring sets, where a set of values is repeated over and over again. Considering the decimal number system, it has a set of values which range from 0 to 9. This basic set is repeated over and over, creating large numbers. Note how the set of values 0 to 9 is repeated. Sets repeated both vertically and horizontally.

Base Values:

The base value of a number system is the number of different values the set has, before repeating itself. (For example, decimal has a base of ten values, 0 to 9)

(Observe the repetition pattern of number for each base value) Recurring sets

1.4 Comparative Table showing values for different number systems

Decimal	*Octal*	*Hexa - decimal*	*Binary*	*Short cut for Binary (sum the*					
				32	**16**	**8**	**4**	**2**	**1**
00	0	0	0						0
01	1	1	1						1
02	2	2	10					2	0
03	3	3	11					2	1
04	4	4	100				4	0	0
05	5	5	101				4	0	1
06	6	6	110				4	2	0
07	7	7	111				4	2	1

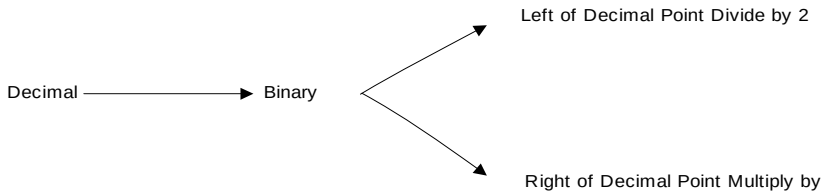
08	10	8	1000			8	0	0	0
09	11	9	1001			8	0	0	1
10	12	A	1010			8	0	2	0
11	13	B	1011			8	0	2	1
12	14	C	1100			8	4	0	0
13	15	D	1101			8	4	0	1
14	16	E	1110			8	4	2	0
15	17	F	1111			8	4	2	1
16	20	10	10000		16	0	0	0	0
17	21	11	10001		16	0	0	0	1
18	22	12	10010		16	0	0	2	0
19	23	13	10011		16	0	0	2	1
20	24	14	10100		16	0	4	0	0
21	25	15	10101		16	0	4	0	1
22	26	16	10110		16	0	4	2	0
23	27	17	10111		16	0	4	2	1
24	30	18	11000		16	8	0	0	0
25	31	19	10001		16	8	0	0	1
26	32	1A	11010		16	8	0	2	0
27	33	1B	11011		16	8	0	2	1
28	34	1C	11100		16	8	4	0	0
29	35	1D	11101		16	8	4	0	1
30	36	1E	11110		16	8	4	2	0
31	37	1F	11111		16	8	4	2	1
32	40	20	100000	32	0	0	0	0	0
0 - 9	0 - 7	0 - F	0&1						

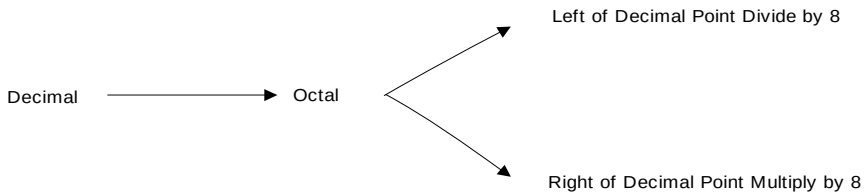
(Observe the repetition pattern of number for each base value)-Recurring sets

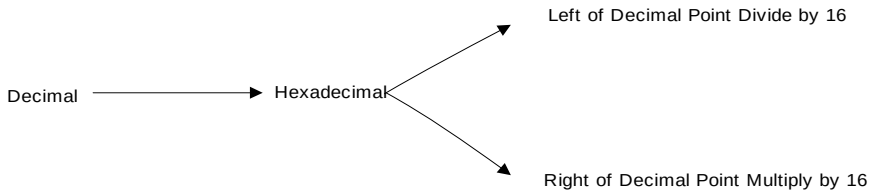
Number System conversion:

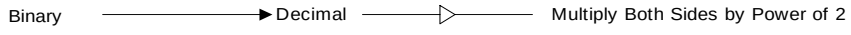
1. Decimal to Binary and Vice versa
2. Decimal to Octal and Vice versa
3. Decimal to Hexadecimal and vice versa
4. Binary to Octal and Vice versa
5. Binary to Hexadecimal and vice versa
6. Octal to Hexadecimal and vice versa - in total 12 conversions for 4 number systems

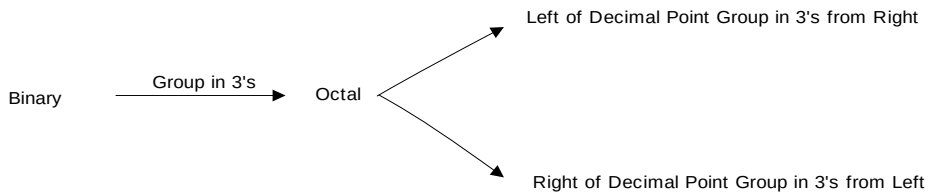
Rules for Conversion from One number system base to another number system base

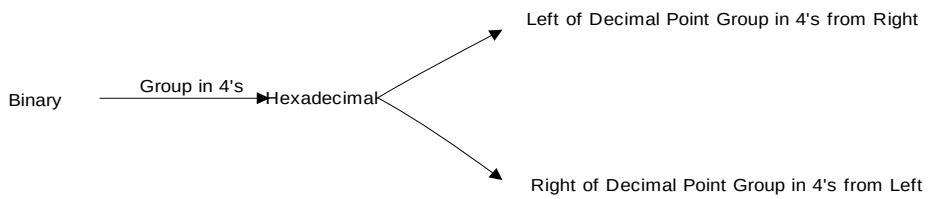


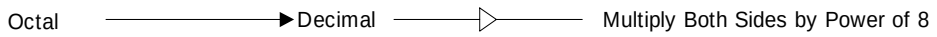


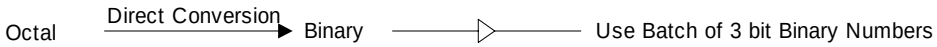






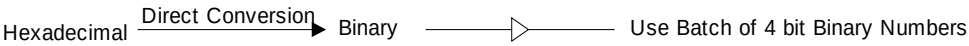


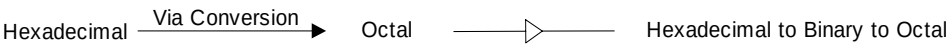

Octal
Decimal
Multiply Both Sides by Power of 8


Octal
Direct Conversion
Binary
Use Batch of 3 bit Binary Numbers


Octal
Via Conversion
Hexadecimal
Octal to Binary to Hexadecimal


Hexadecimal
Decimal
Multiply Both Sides by Power of 16


Hexadecimal
Direct Conversion
Binary
Use Batch of 4 bit Binary Numbers


Hexadecimal
Via Conversion
Octal
Hexadecimal to Binary to Octal

Decimal Number System

1. In this number system, there are ten distinct symbols that are used to form numbers. They are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. These ten symbols are called digits. A combination of these symbols gives rise to a number.

2. Decimal has a weighting factor of 10, in that each column move left indicates a multiplication value increase of 10 over the next/previous on the right (i.e., each column move to the left increases by a multiplying factor of 10)

3. The weight of a digit of a number is calculated from its relative position. In decimal number system, the weight of each digit is some power of 10. This is called (base or radix) of this number system. Such a number system is often called positional number system, since the weight depends upon its relative position.

4. When a number equals the radix (base), it cannot be represented by one digit and hence another digit may be added and so on. For example, the digits in the number 789 have the following decimal weights:

Concept 1: Decimal to Decimal (Left to Right) 789_{10}

Number	*Position*	*Weight*	*Position value*	*Product*
9	units	10^1	1	9
8	tens	10^2	10	80
7	hundreds	10^3	100	700
			SUM	789

Remember: To have clarity on base value to a given number we often add a suffix (subscript) to indicate the number base.

Example:

256_h	h means hexadecimal	:	256_{16}	16 means base 16
256_d	d means decimal	:	256_{10}	10 means base 10
256_o	o means octal	:	256_8	8 means base 8
101_b	b means binary	:	101_2	2 means base 2

Concept 2: Decimal to Binary conversion

The integer part of a decimal number can be converted to its equivalent binary by dividing it by repeatedly, until the number is exhausted and also by recording the remainders during each division. The remainders give raise the binary equivalent.

Example: Convert 789.3125_d to binary

Denominator	Numerator	Remainder
2	789	1
2	394	0
2	197	1
2	98	0
2	49	1
2	24	0
2	12	0
2	6	0
2	3	1
	1	

Integer	Fraction	Multiplicand
	0.3125	2
0	.6250	2
1	.2500	2
0	.5000	2
1	.0000	

$789.3125_{d} = 1100010101.0101_{b}$

Concept 3: Decimal to Octal conversion

The octal number system has a base 8. The symbols in this system are 0, 1, 2, 3, 4, 5, 6 and 7 (there is no 8 and 9). These digits, 0 through 7, have exactly same physical meaning as decimal symbols.

Example: Convert 789.3125_{d} to Octal

Denominator	Numerator	Remainder
8	789	5
8	98	2
8	12	4
	1	

Integer	Fraction	Multiplicand
	0.3125	8
2	.5000	8
4	.0000	

$789.3125_{d} = 1425.24_{o}$

Concept 4: Decimal to Hexadecimal conversion

Example: Convert 789.3125_{d} to Hexadecimal

Denominator	Numerator	Remainder
16	789	5
16	49	1
	3	

Integer	Fraction	Multiplicand
	0.3125	16
5	.0000	

$789.3125_{d} = 315.5_{h}$

Concept 5: Binary to Decimal conversion

In order to form a number in this system, it uses two digits 0 and 1. They are known as bits (binary digits). The weights in this system for a digit, in a number, are power of 2 rather that 10 as in the case of decimal number system. Binary has a weighting factor of 2, in that each column move to the left indicates a multiplication value increase of 2 over the previous(next) column to the right(i.e., each column move to the left increases by a multiplying factor of 2)

Binary	1	1	0	0	0	1	0	1	0	1	.	0	1	0	1
Base Power	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		2^{-1}	2^{-2}	2^{-3}	2^{-4}
Value	512	256	128	64	32	16	8	4	2	1		0.5	0.25	0.125	0.0625
Product	512	256	0	0	0	16	0	4	0	1		0	0.25	0	0.0625

512 + 256 + 16 + 4 + 1 + 0.25+ 0.0625 = 789.3125_d

Here the fourth row is the product of first row and third row.

Thumb Rule

We can also have the following steps to get a decimal number for a given binary number.

1) Write the binary number.
2) Directly under the binary number, write 1, 2, 4, 8, 16 ……..... from right to left
3) If a zero, appears in a digit position then omit the decimal weight for that position
4) Add the remaining weights to obtain the decimal equivalent

e.g: 1 0 1 0 1
16 8 4 2 1
16+4+1 = 21
Hence $(10101)^2 = (21)^{10}$

Concept 6: Octal to Decimal conversion

Octal has a weighting factor of 8, in that each column move to the left indicates a multiplication value increase of 8 over the previous (next) column on the right (i.e., each column move to the left increases by a multiplying factor of 8)

Octal	1	4	2	5	.	2	4
Base Power	8^3	8^2	8^1	8^0		8^{-1}	8^{-2}
Value	512	64	8	1		0.125	0.015625
Product	512	256	16	5		0.25	0.0625

512 + 256 + 16 + 5 + 0.25 + 0.0625 = 789.3125_d

Concept 7: Hexadecimal to decimal conversion

Hexadecimal has a weighting factor of 16, in that each column move to the left indicates a multiplication value increase of 16 over the previous(next) column to the right(i.e., each column move to the left increases by a multiplying factor of 16). 315.5_{h}

Hexadecimal	3	1	5	.	5
Base Power	16^2	16^1	16^0		16^{-1}
Value	256	16	1		0.0625
Product	768	16	5		0.3125

$768 + 16 + 5 + 0.3125 \quad = \quad 789.3125_{d}$

Concept 8: Binary to Octal conversion
Binary to octal conversion can be carried out if the binary number is grouped in 3 bits. Left side of decimal point grouping 3 bits from right side; and right side of decimal point grouping 3 bits from left side.

1100010101.0101_{b}

0	**0**	1	1	0	0	0	1	0	1	0	1	.	0	1	0	1	**0**	**0**
4	**2**	1	4	2	1	4	2	1	4	2	1		4	2	1	4	2	1
-	-	1	4	-	-	-	2	-	4	-	1		-	2	-	4	-	-
	1			4			2			5		.		2			4	

$1100010101.0101_{b} \quad = \quad 1425.24_{o}$

Concept 9: Octal to Binary conversion

Table showing Octal and Binary Equivalent

BINARY			Octal		Binary			Octal
4	*2*	*1*			*4*	*2*	*1*	
0	0	0	0		1	0	0	4
0	0	1	1		1	0	1	5
0	1	0	2		1	1	0	6
0	1	1	3		1	1	1	7

	1			4			2			5		.		2			4	
0	**0**	1	1	0	0	0	1	0	1	0	1	.	0	1	0	1	**0**	**0**

Concept 10: Binary to Hexadecimal conversion
Binary to Hexadecimal conversion can be carried out if the binary number is grouped in 4 bits. Left side of decimal point grouping 4 bits from right side; and right side of decimal point grouping 4 bits from left side.

1100010101.0101_{b}

0	0	1	1	0	0	0	1	0	1	0	1	.	0	1	0	1
8	**4**	2	1	8	4	2	1	8	4	2	1		8	4	2	1
-	-	2	1	-	-	-	1	-	4	-	1		-	4	-	1
		3				1				5		.			5	

1100010101.0101_{b} = 315.5_{h}

Concept 11: Hexadecimal to Binary conversion

Table showing Hexadecimal and Binary Equivalent

BINARY				Hexadecimal	Binary				Hexadecimal
8	*4*	2	*1*		*8*	*4*	2	*1*	
0	0	0	0	0	1	0	0	0	8
0	0	0	1	1	1	0	0	1	9
0	0	1	0	2	1	0	1	0	A
0	0	1	1	3	1	0	1	1	B
0	1	0	0	4	1	1	0	0	C
0	1	0	1	5	1	1	0	1	D
0	1	1	0	6	1	1	1	0	E
0	1	1	1	7	1	1	1	1	F

3				1				5				.	5			
0	0	1	1	0	0	0	1	0	1	0	1	.	0	1	0	1

Concept 12: Octal to Hexadecimal conversion & Hexadecimal to Octal conversion
To convert octal to hexadecimal we use the binary route. First we covert the octal number to binary number then binary number to hexadecimal number. Similarly we convert the hexadecimal number to binary number then binary number to octal number.

Binary Arithmetic

The next step in number system is to learn the basic arithmetic operations viz. addition, subtraction, multiplication and division. Binary numbers can do basic arithmetic operations following a procedure.

Addition

Binary addition is a very simple operation. The following are the basic rules of binary addition

													Hint
0	+	0									=	0	0
0	+	1									=	1	1
1	+	0									=	1	1
1	+	1									=	0 carry 1	2
1	+	1	+	1							=	1 carry 1	3
1	+	1	+	1	+	1					=	0 carry 10	4
1	+	1	+	1	+	1	+	1			=	1 carry 10	5
1	+	1	+	1	+	1	+	1	+	1	=	0 carry 11	6

Note that if addition of numbers in a column exceeds then the number 1 is carried over to the next column.

Concept Problem 13: Binary Addition

Add the decimal numbers in Binary form: $628_d + 212_d = 840_d$

			carry		*1*	*1*	*1*	*1*		*1*				
6	2	8		1	0	0	1	1	1	0	1	0	0	
2	1	2				1	1	0	1	0	1	0	0	
8	4	0		1	1	0	1	0	0	1	0	0	0	

Subtraction

Binary subtraction is carried out in two ways. First one is direct method using subtraction rules. Second one is one's complement method. (Complement method is not covered in our syllabus)

1	-	1		=	0
0	-	0		=	0
1	-	0		=	1
0	-	1		=	Borrow from left then subtract

Binary to Binary Coded Decimal (BCD)

Steps in Converting a Binary number to BCD number:

1. Convert the Binary to Decimal
2. Convert each decimal digit to its equivalent 4 bit binary number
3. The result is the BCD equivalent of the given binary.

Table for BCD equivalent of Decimal

4 Bit BCD				Decimal	4 Bit BCD				Decimal
0	0	0	0	0	0	1	0	1	5
0	0	0	1	1	0	1	1	0	6
0	0	1	0	2	0	1	1	1	7
0	0	1	1	3	1	0	0	0	8
0	1	0	0	4	1	0	0	1	9

Concept Problem 14: 1010110_b = 10000110_{bcd} M 95
Step 1: Converting Binary to Decimal $1010110_b = 86_d$
Step 2: Converting each decimal digit to its equivalent 4 bit binary 86 = 10000110
Step 3: BCD equivalent = 10000110

PARITY BIT

In computers, parity (from the Latin *paritas*: equal or equivalent) refers to a technique of checking whether data has been lost or written over when it's moved from one place in storage to another or when transmitted between computers.

Here's how it works: An additional binary digit, the *parity bit*, is added to a group of bits that are moved together. This bit is used only for the purpose of identifying whether the bits being moved arrived successfully. Before the bits are sent, they are counted and if the total number of data bits is even, the parity bit is set to one so that the total number of bits transmitted will form an odd number. If the total number of data bits is already an odd number, the parity bit remains or is set to 0. At the receiving end, each group of incoming bits is checked to see if the group totals to an odd number. If the total is even, a transmission error has occurred and either the transmission is retried or the system halts and an error message is sent to the user.

The description above describes how parity checking works within a computer. Specifically, the Peripheral Component Interconnect bus and the I/O bus controller use the odd parity method of error checking. Parity bit checking is not an infallible error-checking method since it's possible that two bits could be in error in a transmission, offsetting each other. For transmissions within a personal computer, this possibility is considered extremely remote. In some large computer systems where data integrity is seen as extremely important, three bits are allocated for parity checking.

Parity checking is also used in communication between modems. Here, parity checking can be selected to be even (a successful transmission will form an even number) or odd. Users may also select *no parity*, meaning that the modems will not transmit or check a parity bit. When no parity is selected (or defaulted), it's assumed that there are other forms of checking that will detect any errors in transmission. No parity also usually means that the parity bit can be used for data, speeding up transmission. In modem-to-modem communication, the type of parity is coordinated by the sending and receiving modems before the transmission takes place.

1.6: Data Processing

Data processing is the restructuring or reordering of data by people or machines, to increase their usefulness and values for some particular purpose. Data processing can be performed manually with the aid of such simple tools as paper, pencil and filing cabinets or electro-mechanically with the aid of such simple tools as paper, pencil and filing cabinets or electro-mechanically with the aid of unit record machines or electronically with the aid of a computer which is the major concern of this and following study papers.

Regardless of whether the system used to process the data is manual, mechanical or electronic, certain fundamental operations must be performed. These operations are:

1. Recording, 2. Classifying, 3. Sorting, 4. Calculating, 5. Summarizing, 6. Reporting

1. **Recording** - Recording is the transcribing of data into a permanent from e.g., writing the quantities of goods received on manual ledgers or kardex cards. As we shall see later, in electro-mechanical or electronic data processing, writing by clerks on ledgers is replaced by codification on machine readable file media.

2. **Classifying** – Classifying involves grouping of like items or transactions. Data are generally classified according to a code in the form of an alphabetic or numeric abbreviation. In charting accounts, for example, one may assign numeric codes to the various classes: 1. Asset account 2. Liability account, 3. Proprietorship account 4. Income account, 5. Cost account, 6. Expense account, There could be further sub-classes within each class. For example, the asset account may have a sub-class of CASH which may be assigned the code 11 to signify that it is the first sub-class. Thus classification may be carried down to the lowest level sub-classification.

3. **Sorting** - Sorting is the arranging of data of transactions in ascending or descending sequential manner. Sorting may be by numeric or alphabetic code. For example, the Indian states may be arranged in the descending order of population. Like-wise, the sales vouchers may be sorted by voucher number. The data field by which the transactions are arranged in a sequential order is known as the key; thus voucher number constitutes the language are arranged alphabetically provides another example. At times, sorting may involve more than one field. For example, you may want to have all the cities in Andhra Pradesh in alphabetic order, than all the cities in Assam, and so on. This allows case in reading a report. Arranging data or transactions in this type of order is known as major and minor sort. The category that is the sub-division is known as the minor field, while the other field is known as the major field. In the above example, the cities are the minor field, and the states are the major field. Sometimes, you may have to sort three fields to produce desired results. You may want voucher number within date within account head. Or you may want villages within districts within states. Thus, there are three sorting fields: minor, intermediate and major. The procedure for this type of sorting is to sort with

the minor field first followed by; sorting with intermediate field and finally sorting with the major field.

4. **Calculating** - A calculating is adding, subtracting, multiplying or dividing data to produce usable results. Updating of stock balances or computing interests on amount provide examples. Advanced calculations (viz., square roots) are also included.

5. **Summarizing** - Summarizing involves the consolidating of data emphasizing main points and tendencies. It usually involves deriving totals, results percentage etc.

6. **Reporting** - The summarized data, which would have been derived after recording, classifying, sorting, calculating etc. constitutes information and is presented to the management in the form of reports, reporting being the ultimate of all data processing activities.

All the steps can be performed manually as well as electro-mechanically or electronically.

1.7: Computer Files

Types of Files: Program Files, Data Files, & Others
The file is the collection of data or information that is treated as a unit by the computer. Files are given name—*filenames.* For instance, you might give your word processing file containing a paper you're writing for a psychology course the filename PSYCHREP or PSYCHREPORT.

Filenames used for the PC---but not for the Macintosh—also have *extension names,* or three-letter tags, which are usually inserted automatically by the applications software. These extensions are added on after a period following the filename—for example, .DOC in PSYCHREPORT.DOC, where the .DOC stands for "document". When you look in the directory of the files stored on your hard disk, you will notice a number of extensions, such as .DOC and .EXE.

There are many kinds of files, but perhaps the two principal ones are program files and data files.

- **Program files: Program files are files containing software instructions.** Examples are word processing or spreadsheet programs, which are made up of several different program files. The two most important are source program files and executable files.

  Source program files contain high-level computer instructions in the original form written by the programmer. Source program filenames may have the extension .COM.

For the processor to use source program instructions, they must be translated into machine language. The files that contain the machine-language instructions are called *executable files.* The filenames of executable files may have the extension .EXE. (Certain system support files containing machine-language instruction may use .DLL and .DRV).

- **Data files**: *Data files* are files that contain data—content such as a report you've created using word processing applications software. On PC systems, data files, too, take extensions after the filenames.

  The extension .DOC appears in filenames used for data files created with work processing or desktop publishing programs. Data files created with database software take the extensions .DAT, .DBF, and .MDB. Common spreadsheet extensions are .XLS and .WKS.

Other common types of files are ASCII (Text) files, Database files, Image files, Audio (Sound) files, Motion Video files, Animation files.

- **ASCII files:** ASCII is a common binary coding scheme used to represent data in a computer. *ASCII ("as-key") files* are text-only files that contain no graphics and no formatting, such as boldface or italics. This format is used to transfer documents between incompatible computers, such as PC and Macintosh. (Such files may use the .TXT extension).

- **Image files:** If ASCII files are for text, image files are for digitized graphics, such as art or photographs. (They are indicated by such extensions as .TIF, .EPS, .JPG, .GIF, and .BMP).

- **Audio files:** *Audio files* contain digitized sound and are used for conveying sound in CD-ROM multimedia and over the Internet. (They have extension such as .WAV and .MID).

- **Video files:** *Video files* contain digitized video images and are used for such purposes as to convey moving images over the Internet.

Two Types of Data Files: Master File & Transaction File

Among the several types of data files, two are commonly used to update data: a master file and a transaction file.

- **Master file:** *The master file is a data file containing relatively permanent records that are generally updated periodically***.** An example of a master file would be the address-label file for all students currently enrolled at your college.

- **Transaction file:** *The transaction file is a temporary holding file that holds all changes to be made to the master file: additions, deletions, revisions*. For

example, in the case of the address labels for your college, a transaction file would hold new names and addresses to be added (because over time new students enroll) and names and addresses to be deleted (because students leave). It would also hold revised names and addresses (because students change their names or move). Each month or so, the master file would be updated with the changes called for in the transaction file.

- **Reference files**: These files contain keys of records in other files. In order to retrieve record from a file, the reference file is first searched to find out in which file a record can be located.
- **Table files**: These are in the nature of catalogues or price lists.
- **Report files**: A report file is created from records in other files in a meaningful and concise form. A sales performance report and a report on materials rejected are examples of report files.
- **Historical files**: These contain statistical information past periods. These files are used to analyze trends or make comparisons of one period with another and so on.
- **Back-up-files:** These are copies of currently used master files kept in the computer library (i.e., collection of all computer files) as a measure of security.

Answers to Self-Examination Questions

Q.No.1: Discuss the relationship among characters, data items, records, and data files?

1. A *character* is a single letter, number, or special symbol (Ex: A, 2, &, #, @, etc.,)
2. A *data item (field)* is a set of characters which are used together to represent a specific data element viz. name or number (Ex: India, 123, etc.,)
3. A *record* consists of a group of data items related to an object of data processing (Ex: Ms. Aishwarya, 43, Juhu Beach, Mumbai – 400 002: Mobile: 98400 63269)
4. A *data file* is a complication of related data records maintained in pre-arranged order. (Ex: Address collection of SIRC CA Students)

Q.No.2: Define the term data processing. What are the fundamental operations carried out in any data processing department?

1. Data Processing is the restructuring of data by people or by machines, to increase their (data) usefulness and value for particular purpose
2. Regardless of whether the system used to process the data is manual, mechanical or electronic, certain fundamental operations must be performed, they are:
   - ✓ Recording
   - ✓ Classifying
   - ✓ Sorting
   - ✓ Calculating
   - ✓ Summarizing
   - ✓ Reporting

Q.No.3: Explain the term 'Stored program concept'?

1. Computers can perform a variety of mathematical calculations
2. Computers can repeat a complicated calculation million of times without error
3. Computers can print out whole paragraphs of text, write letters, draw pictures or plot curves and draw graphs
4. Computers can sort data, merge lists, search files and make logical decisions and comparisons
5. However they are devoid of any original thinking!
6. It does nothing what it is not told to do
7. It is provided with a set of instructions by persons professionally known as *programmer*
8. These instructions are stored in memory and executed under the command of control unit of CPU
9. This is known as stored program concept

Q.No.4: Describe the different ways in which data files can be classified?

1. Data Files are computer Files which can be read and written mechanically
2. Data files used in business can be divided into seven (7) types, such as:
   - Master Files – *permanent records viz. Telephone Directory*
   - Transaction Files – *operating records viz. Bank Book*
   - Reference Files – *key for other files viz. Library Directory*
   - Table Files – *viz. manual, catalogue, price list, fee details*
   - Report Files – *viz. Final meaningful and concise form*
   - Historical Files – *viz. statistical information of past periods*
   - Back up Files – *viz. copies of all files for safety & security*

Q.No.5: Describe in detail various generations of computers

Zero Generation:

- Cambridge – England – 1830 – *Charles Babbage* attempted to build an automatic mechanical calculator
- 1930 – *Punched Cards* were in wide use in large businesses and various types of punched card handling machines were available
- 1937 – Howard Aiken – Harvard- *Proposed* to IBM that a machine could be constructed which would automatically sequence the operation

First Generation:

- UNIVAC was the first general purpose electrical computer
- These electrical computers employed *vacuum tubes*
- Large in size – Required Air-Conditioning
- Input Punched Card Reader, Output Card Punches
- Popular among them is IBM-650 with magnetic drum memory & punched cards for input & output – Used both for Business and Scientific applications

Second Generation:

- IBM 1401 was the most popular electrical computer
- These machines employed transistors
- Required Less Power, Were Faster and More Reliable
- Distinct Categories for Business and Scientific Applications
- Used Magnetic Tape as the input / output media

Third Generation:

- These employed integrated circuits in which all the elements of an electronic circuit are contained in a tiny silicon wafer
- They are based on principles of standardisation & compatibility
- Modular Development of Hardware
- Permits multi-programming of software
- Permit use of high-level languages as FORTRAN and COBOL
- Offered communication capabilities and the use of remote terminals

Fourth Generation:

- Major Invention – LSIC – is a small 'chip', which contains thousands of small electronic components which functions as a complete system
- July 1977 – Commodore Limited – Dallas – National Computer Conference – announced a fully assembled microcomputer called PET
- IBM – 1981 announced Personal Computers
- Apple – 1984 introduced Macintosh with a friendly GUI – proof that computers can be easy and fun to use
- In 1995 – the most popular CPUs were Pentium, Power PC etc.
- RISC microprocessors are preferred in powerful servers for numeric computing and file services
- The computer networks came of age and are one of the most popular ways of interacting with computer chains of millions of users
- The computers are being applied in various areas like simulation, visualization, parallel computing, virtual reality, multimedia, etc.,

Fifth Generation:

- This is in its infancy stage
- Using recent engineering advances, computers are able to accept spoken word instructions (voice recognition) and imitate human reasoning
- Has to ability to translate a foreign language
- Artificial Intelligence – could reason well enough to hold conversations with its human operators, use visual input, and learn from its own experience
- Expert systems – allows non-experts to make decisions comparable to those of an expert
- Two engineering advances in the science of computer design & technology are coming together to enable the creation of 5^{th} generation computers

Parallel Processing – The technology where multiple micro-processors are used for computing. The concept of using multiple processors in the same computer is known as

parallel processing. In parallel processing, one main processor examines the programming problem and determines what portions, if any, of the problem can be solved in pieces.

Massive Parallel Processing – Computer designers are creating mainframes and super computers with thousands of integrated microprocessors. Parallel processing on such a large scale is referred to as **massively parallel processing**. These super-fast supercomputers will have sufficient computing capacity to attack applications that have been beyond that of computers with traditional computer designs. For example, researchers hope to simulate global warming with these computers.

Q.No.6: What are the main components of a computer system? What role do they play?

A complete computer system consists of four parts: hardware, software, one or more users and data

Hardware:

1. The physical devices that make up the computer are called **hardware**.
2. Hardware is any part of the computer that can be physically touched.
3. A computer's hardware consists of interconnected electronic devices that you can use to control the computer's operation, input and output.
4. The generic term **device** refers to any piece of hardware

Software:

1. Software is a set of instructions that makes the computer perform tasks.
2. In other words, software tells the computer what to do.
3. Some programs exist primarily for the computer's use, helping it perform tasks and manage its own resources.
4. Other types of programs exist for the user, enabling him or her to perform tasks such as creating documents.
5. The term **program** refers to any piece of software.

Users:

1. People are the computer operators, also known as **users**
2. It can be argued that some computer systems are complete without a person's involvement; however, no computer is totally autonomous.

Data:

1. **Data** consists of individual facts or bits of information, which by themselves may not make much sense to a person.
2. Computerized data is **digital**, meaning that it has been reduced to digits, or numbers.
3. Within the computer, data is organized into **files**.

A file that a user can open and use is often called a **document**.

Q.No.7: Explain the difference between the following terms relating to computer system:

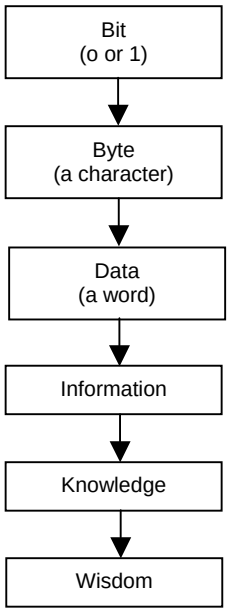
Analog computers and Digital Computers

PROS ▪ Process data input in a continuous form ▪ Voltage, Temperature, Pressure are represented in the computer as a continuous ▪ Offers low cost & ease in programming CONS ▪ Accuracy Factor and limited storage capacity ▪ Not suitable for processing business data	PROS ▪ Storing data for processing ▪ Performing logical operations ▪ Editing or deleting input data ▪ Printing the result at high speed ▪ Any desired level of accuracy can be achieved by considering as many places of decimal as is necessary ▪ Most suitable for business applications CONS ▪ High Cost ▪ Complexity in programming

Special-purpose computer and General-purpose computer

▪ Ex: Super Computer for unique scientific applications ▪ Defense, Aircraft design, computer generated movies, whether research, etc., ▪ Complex algorithms are used ▪ It is not amenable to any change ▪ High degree of parallelism (ability to perform a large number of operations simultaneously) ▪ Can support 10,000 terminals at a time	▪ Ex: For Scientific & Business Applications ▪ Mainframe are big general purpose computers capable of handling all kinds of scientific & business applications ▪ They have large on-line secondary storage capacity ▪ Airline or Railway reservation system ▪ Major suppliers are IBM, Honey Well, Burroughs, etc., ▪ Simple algorithms are used ▪ It is amenable to any change in business

Data processing and Data processing system

Data Processing	Data Processing System
1. Data Processing is the restructuring or reordering of data by people or by machines, to increase their (data) usefulness and value for particular purpose 2. Data Processing can be performed manually with the aid of simple tools viz. paper, pencil, pen, files and filing cabinet 3. Data Processing can be performed electro-mechanically with the aid of unit record machines 4. Data Processing can be performed electronically with the aid of a computer system 5. Regardless of whether the system used to process the data is manual, mechanical or electronic, certain fundamental operations must be performed, they are: ✓ Recording ✓ Classifying ✓ Sorting ✓ Calculating ✓ Summarizing ✓ Reporting	1. Data Processing System accepts data as **input** and **processes** it into information as **output** 2. Data Processing System includes Data Processing (process) 3. Data Processing System identifies input in raw form (bits, bytes & data) processes it into information (file) and the user is supposed to use this information (knowledge) into wisdom oriented activities. 

Q.No.8: Write short notes on the following types of computers?

Super Computer

1. Supercomputers are the most powerful computers made, and physically, they are some of the largest.
2. These systems can process huge amounts of data, and the fastest supercomputers can perform more than 1 trillion (1,000,000,000,000) calculations per second.
3. Some supercomputers such as Cray T3E system – can house thousands of processors.
4. Supercomputers are used in the mapping of the human gene, forecasting weather, and modeling complex processors like nuclear fission.
5. Typically prices from 225,000 to over 30 million (in US dollars), supercomputers are high-capacity machines that require special air-conditioned rooms and are the fastest calculating devices ever invented.

Main Frame Computer

1. Mainframe computers are used in large organizations where many people need access to the same data.
2. In a traditional mainframe environment, each user accesses the mainframe's resources through a device called a terminal.
3. There are two kinds of terminals. A dumb terminal and an intelligent terminal.
4. A dumb terminal does not have its own CPU or storage devices. It is simply an input/output (I/O) device that functions as a window into a computer located somewhere else.
5. An intelligent terminal can perform some processing operations, but it usually does not have any storage.
6. The word "mainframe" probably comes from the metal frames, housed in cabinets, on which manufacturers mounted the computer's electronic circuits.

Mini Computer

1. First released in 1960s, minicomputers got their name because of their small size compared to other computers of the day.
2. The capabilities of a minicomputer are somewhere between mainframes and personal computers. (*For this reason, minicomputers increasingly are being called midrange computers*)
3. Although some "minis" are designed for a single user, the most powerful minicomputers can serve the input and output needs of hundreds of users at a time. This is the HP 3000 minicomputer.

Micro Computer

1. The term microcomputer and personal computer (PC) are interchangeable, and refer to a type of computer system that was designed for use by a single person.
2. Two common designs for PCs are Horizontal Base Model and Vertical Tower Model.
3. The more traditional desktop model features a horizontally oriented system unit, on top of which many users place the monitor.
4. Vertically oriented tower models have become the more popular style of desktop system.

Workstations

1. Workstations differ significantly from microcomputer in two areas.
2. Internally, workstations are constructed differently than microcomputers. They are based on different architecture of CPU called *reduced instruction set computing* (RISC), which results in faster processing of instructions.
3. Externally, the other difference between workstations and microcomputers in that most microcomputers can run any of the four major operating systems – DOS, UNIX,

OS/2 and Microsoft Windows NT, but workstations generally run the UNIX operating systems or a variation of it.

4. The biggest manufacturer of workstations is Sun Microsystems. Workstations like the Sun Blade 100 – are specialized, single-user computers with many of the features of a personal computer but with the processing power of a minicomputer
5. These powerful machines are popular among scientists, engineers, and animators who need a great deal of number-crunching power.

Q.No.9: Explain the following terms related to computer systems:

Bit

1. In a computer, all data is represented by the state of the computer's electronic switches.
2. A switch has only two possible states – on and off – so it can represent only two numeric values.
3. To a computer, when a switch is off, it represents a 0; when a switch is on, it represents a 1.
4. When referring to computerized data, the value represented by each switch's state – whether the switch is turned on or off – is called a **bit** (*a combination of binary digit*)
5. Because there are only two values, computers are said to function in base 2, which also is known as the binary number system (*bi means "2" in Latin*)

Word

1. To represent anything meaningful (*in other words, to convey information*), the computer uses bits in groups.
2. A group of eight bits is called a byte.
3. A group of bytes is a word.

BCD System

1. The pure binary system is more appropriate for scientific applications where the bulk of work consists of arithmetic computations.
2. Business applications entail reading and writing of voluminous amount of plain English and less comparatively less arithmetic.
3. BCD system is a hybrid of the pure binary system and the decimal system.
4. In this system, the decimal weighing is maintained, but the digit is represented by a combination of the binary digits 0 and 1.

Hexadecimal System

1. The hexadecimal (hex) system, using base 16, incorporates the convenience of the BCD system with the full storage capabilities.
2. It is base 16 that uses the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
3. Each hex place value is expressed in binary by one group of four bits.

ASCII system

1. ASCII (*pronounced AS-key*) stands for the American Standard Code for Information Interchange.
2. Today, the ASCII character set is by far the most commonly used in computer in computers of all types.
3. ASCII is an 8-bit code that specifies characters up to only 127; there are many variations that specify different character sets for codes 128 through 255.

Parity Bit

1. Parity means Equality.
2. Dust, electrical disturbance, weather conditions and other factors can cause interference in a circuit or communications line that is transmitting a byte. (*Does a computer know if an error has occurred*?)
3. Detection is accomplished by use of a parity bit.
4. A parity bit is an extra bit attached to the end of a byte for purposes of checking for accuracy. (A parity bit also called as check bit).
5. The ninth bit is the parity bit. (It is usually appended to the left, can also be to the right).
6. The parity checking is part of Operating System. It has to be enabled
7. The parity bit enables a computer system to check for errors during transmission.
8. A system can adopt either of the two schemes. Parity schemes may be even parity or odd parity
9. The system software in the computer automatically and continually checks the parity scheme for accuracy
10. If the message "Parity Error" appears on the screen, a technician has to look at the computer to see, what is the cause of the problem.

Byte

1. To represent letters, numbers or special characters (w, 3, ! or *), bits are combined into groups.
2. A group of 8 bits is called a byte, and a byte represents one character, digit or other value.
3. The capacity of a computer's memory or a diskette is expressed in numbers of bytes or multiples of kilobytes and megabytes.

EBCDIC System

1. EBCDIC (Pronounced EB-si-dic) stands for Extended Binary Coded Decimal Interchange Code.
2. EBCDIC is an 8-bit code that defines 256 symbols.
3. EBCDIC is still used in IBM mainframe and midrange systems, but it is rarely encountered in personal computers.

Octal System

1. Octal is a number system that has 8 (eight) bases (0, 1, 2, 3, 4, 5, 6, 7)
2. As its radix 8 is a power of 2, namely 2^3, it is fairly simple to convert binary to octal and *vice-versa.*

3. To convert binary to octal, the rule is group in 3s
4. In the binary number; to the left of decimal point group in 3s starting from right, similarly, to the right of the decimal point group in 3s starting from left.

Past Examination Questions:

Q.No.1: How man codes can be generated using 9 bits? (M 95)
Ans: 2^9 = 512 codes can be generated using 9 bits
Reason: Base is 2 since a bit is either 1 or 0; and the power is 9 is given

Q.No.2: What is the name given to the time at which the computer is not available for processing? (M 95)
Ans: Down time.

Q.No.3: Define the following terms with reference to computer technology:

1. **Analog Computer (N 95)**
   a. Analog means continuous wave format.
   b. Analog computers process data in continuous form.
   c. Nonstop data such as voltage, temperature, pressure etc., are represented in the continuous, unbroken flow of information.
   d. In engineering and scientific applications where quantities to be processed exist on waveforms or continually rising and falling voltages, pressure and so on, analog computers are very useful.

2. **Workstation (N 01)**
   a. Workstations differ significantly from microcomputer in two areas.
   b. Internally, workstations are constructed differently than microcomputers. They are based on different architecture of CPU called reduced instruction set computing (RISC), which results in faster processing of instructions.
   c. Externally, the other difference between workstations and microcomputers in that most microcomputers can run any of the four major operating systems – DOS, UNIX, OS/2 and Microsoft Windows NT, but workstations generally run the UNIX operating systems or a variation of it.
   d. The biggest manufacturer of workstations is Sun Microsystems. Workstations like the Sun Blade 100 – are specialized, single-user computers with many of the features of a personal computer but with the processing power of a minicomputer
   e. These powerful machines are popular among scientists, engineers, and animators who need a great deal of number-crunching power.

3. **Backup files (N 99)**
   a. Backup files mean making copy of data, separate from the original version on computer's hard disk.
   b. We can backup the entire disk, programs and all, or our data files.

c. If our original data is lost, we can restore the backup copy, and then resume our work with no more than minor inconvenience.
d. Medium: The most popular backup medium is the tape drive, removable hard disk, disk cartridge, CR-RW or DVD-RW.
e. For backing up or entire hard disk to a high capacity device, we use the file transfer software which is built-in operating system utilities.

Q.No.4: Briefly describe four basic operations performed by a computer. (N 97)

A computer system performs four fundamental operations, they are: input operations, processing operations, output operations and storage operations.

Input Operation: In the *input* operation, data is entered or otherwise captured electronically and is converted to a form that can be processed by the computer. The means for "capturing" data (the raw unsorted facts) is input-hardware, such as a keyboard.

Processing Operation: In the *processing* operation, the data is manipulated to process or transform it into information (such as summaries or totals). For example arithmetic operations, mathematical operations, trigonometric operations, statistical operations etc.

Output Operation: In the *output* operation, the information obtained from the data is produced in a form usable by people. Examples of output are printed text, sound and charts displayed on a computer screen.

Secondary-storage Operation: In the *storage* operation, data, information and programs are permanently stored in computer processable form. Diskettes, CDs, DVDs, DATs, etc..,

Q.No.5: What is the meaning of 'Field' and 'Record' in respect of a computer data file? Also describe the various types of data files. (N 97, N 00, N 95)

Field:
1. The field is the lowest level in the data hierarchy at which we can derive any meaning from the data.
2. For example, a single character (such as A) has little meaning out of context.
3. But when characters are combined to form a name (for example: Aishwarya or Alexander), they from a logical unit.
4. A field is best described by example: PAN, First Name, Address, Marital Status)
5. These are fields, the basic subdivisions of a record.
6. An address is often represented as four fields: Door No, Street name, Area, City, State and Pin code.
7. If we treated the entire address as one field, it would be cumbersome to print because the street address is normally placed on a separate line from the city, state, and pin code. Since name and address files are often sorted by Pin code, it is also a good idea to store Pin code as a separate field.

Record:

1. A record is a description of an event (for example: a sale, a hotel reservation) or an item (for example: a student, a semester).
2. Related fields describing an event or an item are logically grouped to from a record.
3. For example, the following example shows some of the fields that might be found in a typical CA student record.
4. It consists of a group of data items related to an object of data processing.

Fields	*Registration No*	*Last Name*	*First Name*	*Middle Name*	*PE I-Cleared*
Record 1	SNF 25493	Gopal	Krishna	Raju	MAY 2004
Record 2	SNF 25494	Gopal	Madan	Narayanan	NOV 2004

File:

1. A file is a collection of related records. The students file contains a record for each student. A results file contains a record for each candidate's score.
2. A *file* is a *secondary storage* as a *vehicle* is to a *parking lot*. A variety of vehicles, cars, buses, trucks, motorcycles and so on are put in parking places to be picked up later.
3. Just as single vehicles enter and exit; files are stored and retrieved as a unit. To help you find your vehicle, large parking lots are organized with numbered parking places for each category of vehicles. The same is true with files and secondary storage.
4. Files are stored in numbered "parking places" on disk for retrieval. Fortunately, we do not have to remember the exact location of the file. The operating system does that for us.
5. What to do with files? Create files, Name files, Save files, Copy files, Move files, Delete files, Retrieve files, Update files, Display files, Print files, Play files, Execute files, Download files, Upload files, Export files, Import files, Compress files and Protect files.

Q.No.6: Distinguish between

1. Master files and Transaction files (M 95, M 01, N 03)

Master Files	Transaction Files
1. A master file contains relatively permanent records for identification and summarizing statistical information. 2. A product file, customer file and employee file are examples of master files. 3. The descriptive information in a master file may include such items as product code, descriptions, specifications, etc., 4. Statistical information, in a customer master file, contains amount outstanding, age of outstanding etc.,	1. Transaction files are created from source documents used for recording events or transactions. 2. These are details files, and the information is used for updating the master files. 3. If the processing is of batch type, the transactions are accumulated for a period and a transaction file is created at the end of the period. 4. The typical source documents, from which transaction files are created are purchase orders, job-cards, invoices, etc.,

2. Data processing and Data processing system (N 95, N 97)

Data processing	Data processing system
1. Accepts data as input and processes it into information as output 2. Non- Automatic & Automatic 3. Non- Automatic means Manual and Mechanical 4. Automatic data processing implies the use of machines for data processing.	1. A system that accepts data as input and processes it into information as output 2. Restructuring of data by people or machines to increase their usefulness and value for some particular purpose 3. Fundamental operations are performed regardless whether it is

3. Data and Information (M 98)

Data	Information
1. Data is any fact, observation, assumption or occurrence 2. They are useful knowledge or information of value to an individual or business 3. They are factual material used as a basis for discussion, decision, calculation or measurement 4. Data are compiled to form reports, figures or documents etc.	1. Information is organized or classified data 2. Information has value 3. From information we get knowledge 4. Knowledge is wisdom oriented

4. Third generation and Fourth generation of computers (M 97)

Third Generation	Fourth Generation
1. These employed integrated circuits in which all the elements of an electronic circuit are contained in a tiny silicon wafer 2. They are based on principles of standardization & compatibility 3. Modular Development of Hardware 4. Permits multi-programming of software 5. Permit use of high-level languages as FORTRAN and COBOL 6. Offered communication capabilities and the use of remote terminals	1. Major Invention – LSIC – is a small 'chip', which contains thousands of small electronic components which functions as a complete system 2. July 1977 – Commodore Limited – Dallas – National Computer Conference – announced a fully assembled microcomputer called PET 3. IBM – 1981 announced Personal Computers 4. Apple – 1984 introduced Macintosh with a friendly GUI – proof that computers can be easy and fun to use 5. In 1995 – the most popular CPUs were Pentium, Power PC etc. 6. RISC microprocessors are preferred in powerful servers for numeric computing and file services 7. The computer networks came of age

	and are one of the most popular ways of interacting with computer chains of millions of users **8.** The computers are being applied in various areas like simulation, visualization, parallel computing, virtual reality, multimedia, etc.,

5. Analog and Digital computers (N 98)

Analog computers	Digital Computers
PROS ▪ Process data input in a continuous form ▪ Voltage, Temperature, Pressure are represented in the computer as a continuous, unbroken flow of information ▪ In engineering and scientific applications where quantities to be processed exist on waveforms (continually rising and falling) ▪ Offers low cost & ease in programming	PROS ▪ Storing data for processing ▪ Performing logical operations ▪ Editing or deleting input data ▪ Printing the result at high speed ▪ Any desired level of accuracy can be achieved by considering as many places of decimal as is necessary ▪ Most suitable for business applications
CONS ▪ Accuracy Factor and limited storage capacity ▪ Not suitable for processing business data	CONS ▪ High Cost ▪ Complexity in programming

6. Mainframe and Super Computers (M 00)

Main Frame Computer	Super Computer
1. Mainframe computers are used in large organizations where many people need access to the same data. 2. In a traditional mainframe environment, each user accesses the mainframe's resources through a device called a terminal. 3. There are two kinds of terminals. A dumb terminal and an intelligent terminal. 4. A dumb terminal does not have its own CPU or storage devices. It is simply an input/output (I/O) device that functions as a window into a computer located somewhere else.	1. Supercomputers are the most powerful computers made, and physically, they are some of the largest. 2. These systems can process huge amounts of data, and the fastest supercomputers can perform more than 1 trillion (1,000,000,000,000) calculations per second. 3. Some supercomputers such as Cray T3E system – can house thousands of processors. 4. Supercomputers are used in the mapping of the human gene, forecasting weather, and modeling complex processors like nuclear fission.

5. An intelligent terminal can perform some processing operations, but it usually does not have any storage. 6. The word "mainframe" probably comes from the metal frames, housed in cabinets, on which manufacturers mounted the computer's electronic circuits.	5. Typically prices from 225,000 to over 30 million (in US dollars), supercomputers are high-capacity machines that require special air-conditioned rooms and are the fastest calculating devices ever invented.

Q.No.7: Convert from one number system to another number system:

i.	1100001_b	=	97_d	N 94
ii.	2315_o	=	1229_d	N 94
iii.	$121B_h$	=	4634_d	N 94
iv.	110101_b	=	01010011_{bcd}	M 95
v.	10111_b	=	00100011_{bcd}	M 95
vi.	1010110_b	=	10000110_{bcd}	M 95
vii.	10101010_b	=	170_d	M 96
viii.	765_o	=	501_d	M 96
ix.	$125F_h$	=	4703_d	M 96
x.	123_d	=	1111011_b	N 96
xi.	1011010_b	=	90_d	N 96
xii.	4567_o	=	2423_d	N 96
xiii.	$BABA_h$	=	47802_d	N 96
xiv.	1357_o	=	$2EF_h$	N 96
xv.	423.25_d	=	110100111.01_b	M 97
xvi.	786.5_d	=	1422.4_o	M 97
xvii.	$ABCD_h$	=	43981_d	M 97
xviii.	10110.101_b	=	22.625_d	M 97
xix.	1234_o	=	$29C_h$	M 97
xx.	344.25_d	=	101011000.01_b	N 97
xxi.	1001110.01_b	=	78.25_d	N 97
xxii.	$CDEF_h$	=	1100110111101111_b	N 97
xxiii.	572_o	=	$17A_h$	N 97
xxiv.	1489_d	=	2721_d	N 97
xxv.	572_d	=	1074_o	M 98
xxvi.	$A029_h$	=	41001_d	M 98

xxvii.	101101.01_{b}	=	45.25_{d}	M 98
xxviii.	3572_{o}	=	$77A_{h}$	M 98
xxix.	256_{o}	=	10101110_{b}	M 98
xxx.	101.011_{b}	=	5.375_{d}	N 98
xxxi.	27.625_{d}	=	11011.101_{b}	N 98
xxxii.	$3B8.D6_{h}$	=	1110111000.1101011_{b}	N 98
xxxiii.	1357_{o}	=	$2EF_{h}$	N 98
xxxiv.	2315_{o}	=	1229_{d}	N 98
xxxv.	11011.101_{b}	=	27.625_{d}	M 99
xxxvi.	$EF92_{h}$	=	1110111110010010_{b}	M 99
xxxvii.	605_{o}	=	185_{h}	M 99
xxxviii.	2562_{d}	=	5002_{o}	M 99
xxxix.	462.5625_{d}	=	111001110.1001_{b}	M 99
xl.	101101.1101_{b}	=	45.8125_{d}	N 99
xli.	$A29B_{h}$	=	1010001010011011_{b}	N 99
xlii.	725_{o}	=	$1D5_{h}$	N 99
xliii.	1029_{d}	=	2005_{o}	N 99
xliv.	25.3125_{d}	=	11001.0101_{b}	N 99
xlv.	657_{o}	=	$1AF_{h}$	M 00
xlvi.	$A2B.9C_{h}$	=	$101000101011.10011100_{b}$	M 00
xlvii.	1101.101_{b}	=	13.625_{d}	M 00
xlviii.	2508_{d}	=	4714_{o}	M 00
xlix.	48.1875_{d}	=	110000.0011_{b}	M 00
l.	0.1011_{b}	=	0.6875_{d}	N 00
li.	0.625_{d}	=	0.101_{b}	N 00
lii.	0.34_{o}	=	0.4375_{d}	N 00
liii.	28.125_{d}	=	34.1_{o}	N 00
liv.	$A9F8_{h}$	=	1010100111111000_{b}	N 00
lv.	101101.1101_{b}	=	55.64_{o}	M 01
lvi.	$A029_{h}$	=	41001_{d}	M 01
lvii.	10110.101_{b}	=	22.625_{d}	M 01
lviii.	525.5_{d}	=	$20D.8_{h}$	M 01
lix.	7375.71_{o}	=	$EFD.E4_{h}$	M 01
lx.	56.35_{o}	=	101110.011101_{b}	N 01

lxi.	1011.1011_b	=	13.58_o	N 01
lxii.	$6B.3A_h$	=	153.164_o	N 01
lxiii.	56.57_o	=	$2E.BC_h$	N 01
lxiv.	$A028_h$	=	41000_d	N 01
lxv.	10101.10101_b	=	21.65625_d	M 02
lxvi.	123.625_d	=	1111011.101_b	M 02
lxvii.	2345.25_d	=	4451.2_o	M 02
lxviii.	43.21_o	=	100011.010001_b	M 02
lxix.	$AB.FED_h$	=	253.7755_o	M 02
lxx.	334.625_d	=	101001110.101_b	N 02
lxxi.	1101101.0101_b	=	109.3125_d	N 02
lxxii.	7523_o	=	$F53_h$	N 02
lxxiii.	$15AE_h$	=	5550_d	N 02
lxxiv.	238.5_d	=	356.4_o	N 02
lxxv.	295.5625_d	=	100100111.1001_b	M 03
lxxvi.	1011.1011_b	=	11.6875_d	M 03
lxxvii.	$592F_h$	=	22831_d	M 03
lxxviii.	436.625_d	=	664.5_o	M 03
lxxix.	6437_o	=	$D1F_h$	M 03
lxxx.	101101.011_b	=	45.375_d	N 03
lxxxi.	99.8125_d	=	1100011.1101_b	N 03
lxxxii.	$B2C_h$	=	2860_d	N 03
lxxxiii.	$2E7_h$	=	1347_o	N 03
lxxxiv.	2508_d	=	4714_o	N 03
lxxxv.	246.125_d	=	11110110.001_b	M 04
lxxxvi.	101101.1011_b	=	45.6875_d	M 04
lxxxvii.	426.5_d	=	652.4_o	M 04
lxxxviii.	$A2B4_h$	=	41652_d	M 04
lxxxix.	7654_o	=	FAC_h	M 04
xc.	765.625_d	=	1011111101.101_b	N 04
xci.	11011010.1101_b	=	218.8125_d	N 04
xcii.	9876_d	=	21254_o	N 04
xciii.	7654_o	=	FAC_h	N 04
xciv.	$AD5_h$	=	2773_d	N 04

xcv.	1267.3125_{d}	=	10011110011.0101_{b}	M 05
xcvi.	10110.101_{b}	=	22.625_{d}	M 05
xcvii.	1234_{o}	=	$29C_{h}$	M 05
xcviii.	$B2C_{h}$	=	101100101100_{b}	M 05
xcix.	10110111.1_{b}	=	267.4_{o}	M 05

Q.No.8: Arrange the following four measure of time from smallest to largest. Microsecond, Millisecond, Picosecond, Nanosecond (N 94)

Answer: Picosecond, Nanosecond, Microsecond and Millisecond – Ascending Order