Characteristics of Memory:

An important characteristic of a memory is whether it is volatile or non volatile. The contents of volatile memory are lost if the power is turned off. On the other hand, a non volatile memory retains its contents after the power is switched off. The best known non volatile memory is magnetic core.

In the broad sense, a µC’s memory system can be logically divided into three groups:

1) Processor memory
2) Primary or main memory
3) Secondary memory

Processor memory refers to a set of µP registers. These registers hold temporary results when a computation is progress. There is no speed disparity between these registers and the µP because they are fabricated on the same chip using the same technology.

Primary memory is the external memory to store both program and data. The µP can access their memories directly. In earlier days, the primary memory was designed using magnetic cores. In modern µPs, MOS technology is employed in the primary memory design. Usually, the size of primary memory is much larger than the processor memory and its operating speed is slower than that the processor registers by a factor of 25 or 30.

Secondary memory refers to the storage medium compositing slow devices such as hard disks and floppies. These devices are used to hold large data and huge program that are not needed by the
processor frequently. Sometimes, secondary memories are also referred to as auxiliary or back up storage.

In order to design an efficient memory system, the following characteristics of memory must be known. The most important factor of a memory system is its cost, expressed in dollars per bit. A good design implies a very low cost per bit.

There are two parameters that will indicate the speed with which information can be transferred in and out of a memory.

1) Access time, \( t_A \)
2) Cycle time, \( t_C \)

The access time \( t_A \) is defined as the average time taken to read a unit of information from the memory. Sometimes the access time is also referred to as read access time. Similarly, one can define write access time. Usually, the write access time will be equal to read access time. The cycle time \( t_C \) of a memory unit is defined as the average time lapse between two successive read operations.

The reciprocal of access time is called the access rate \( (r_A=1/t_A) \), which is expressed in bits per second. Similarly, the reciprocal of cycle time is referred to as data transfer rate or bandwidth also expressed in bits per second.

The third important characteristic of memory unit is its access mode. The access mode refers to the manner in which information can be accessed from the memory. There are two major access modes. They are the random access mode and sequential access modes. In random access mode, any memory location access time is independent of the location from which the data is read. In sequential...
access mode, the memory is accessed strictly in a sequential manner. In this mode, the access time depends on the location in which data is stored. They are also referred as serial access memories. A bipolar memory and magnetic tape are typical example for random & serial –access memories.

Random access memories than its sequential access memory 2nd order to active a compromise. Some memories combine both access modes and called semi-random memories. A typical example is magnetic access whit one read/write head for each track. This arrangement permits any track to be accessed. At random however. Access within a track must be made in a serial fashion.

**Classification of Memory:**

In general, semiconductor memories can be clarified in two main groups’ random access memories (RAM) and sequential access memories (SAM).

RAM can be classified in three main groups as shown below.

![Memory Classification Diagram]

**ROMS:**

The type of memory means the content of an address location can only be read and cannot be written into. The contents of the
memory location are not destroyed whether the power is ON or OFF. Such a memory is known as non volatile memory. ROMs are used to store data on permanent basis. They are random access memories and this makes them very useful for the storage of computer operating systems, software language computers, look-up tables and programs for dedicated microprocessor applications. ROMs can only be read are not written into.

**MASK ROMs:**

Mask ROMs are programmed by a masking operation performed on the chip during the manufacturing process. The contents of a ROM are decided by the manufacture. These contents are permanently stored in a ROM at the time of manufacturing. The contents of MROMs cannot be changed by the user. Most desktop computers use MROMs to contain there operating system and for execution fixed procedures, such as decoding the keyboard and the generation of characters for the CRT.

**PROMs:**

If user needs relatively few ROMs, there is a variation, which cost more per devices but allows the user to in rest the information. To avoid the high one-time cost of producing custom mask ROMs, IC manufacturing provides user programmable ROMs. This device is called programmable Read only memory. Using special equipments, called PROM programmers, user can program a PROM- once. Subsequently one can read the information out of PROM as often as one wish, but one can never write into it again. Therefore once the
PROM is programmed with correct information it can be used as a ROM only in microcomputer. If one needs to change or correct the information stored in the PROM, one must pull it out, throw it away and replace it with a fresh unused PROM, writing the new on corrected information into this in used devices. The PROM will hold its contents indefinitely.

These PROMs are provided with fusible links which are burned during the programming. Once the data are permanently stored in the PROMs, it can be read again and again by just accessing the correct memory location.

**EPROMs:**

If a mistake is done in programming ROM and PROMs, the correction cannot be made. The solution of this problem is erasable PROM (EPROM). An EPROM is an erasable PROM. The contents are erased by ultra violet light. Therefore, they are also called UVEPROM. The user can not erase the content of a single memory location, the entire contents are erased.

EPROMs can be reprogrammed using EPROM programmer. Once programmed, it can be used as ROM in microcomputer. Later, if one needs to correct the information stored, it is taken out from the system, erase the program written, write new program into it and use it.

The EPROM is erased by exposing an open window in the IC to an ultraviolet light source for a specified length of time, typical erase
time vary between two and 30 minutes, the EPROM programmed and providing proper addresses.

An EPROM also holds the information indefinitely once it has been programmed. One can read the contents of an EPROM as often as one like.

**RMMs:**

They are read mostly memories, since they have much slower write time then read time, there memories are usually suited for operation where mostly reading rather than, sorting will be performed.

**E²PROMs:**

E²PROM are electrically erasable PROM. They need not to be removed from a microcomputer board for erasing. Erasing & programming E²PROM is much easier as the ultraviolet sources are not required. The stored information can be erased by applying a high voltage of about 21V, a singly byte or the entire chip can be erased in10 mille sec. This is faster than UV erasing and it can be done easily while the chip is still in circuit, It is also known as EAPROM (electrically alterable PROM). One can write into at any time without erasing prior contents. The problems with EAROM are that electronically they are relatively difficult to use also, they slowly lose their information.

One application of the E²PROM is in the tuner of a morden TV set. The E²PROM remember (i) the channel, you were watching when your tuned off the set (2) the volume setting of the audio amplifier.
RWMS:

In this type of memory one can either read the contents of an addressed location in a MEMORY READ operation or one can write a m bit of data in the addressed memory location in a MEMORY WRITE operation. It is a volatile memory. It is normally known as RANDOM ACCESS MEMORY (RAM). The content of RWM shall be destroyed when the power is OFF. During of MEMORY READ operation the content of the addressed location is not destroyed. It is only read onto the external data bus. During a MEMORY WRITE operation, however, the original content of the addressed location is destroyed and the new content takes it placed which is just now written.

Read/write memories are used for temporary storage of data and program instruction in a up based septum there are also RAMs, RWMs are generally called RAMs, RAMMs a specific terms it tells that the data can be read on written to any memory location,

RAM is classified as either static on dynamic, static RAMs (SRAMs) flip flops as basic storage elements; whereas the dynamic RAMs (DRAMs) use internal capacitor as basic storage elements, additional refresh circuitry is needed to maintain the charge on the internal capacitor of a dynamic RAM; they have more packing density, there it has more storage capacity per unit area team a static RAM, the cast per bit of dynamic RAMs is also much less than that of the static RAMs.
Non-volatile RAM:

A Non-volatile RAM combines a static RAM and E²PROM into the same chip. Such a device operates as a normal RAM. If power supply fails the entire content of RAM are stored in E²PROM by a single signal. A signal can transfer data from E²PROM back into the RAM. E.g. x2201 is a non-volatile RAM of 1K bit. The transfer time is 4msec.