UNIT-4

1) Memory System
2) a) Semiconductor
   b) Internal organisation of memory chips
   c) Static Memory
   d) Asynchronous DRAMs
   e) Synchronous DRAMs
   f) Structure of large memories
   g) Memory system consideration
   h) RAMBUS memory
2) Read only memories
   a) ROM, PROM, EPROM, EEPROM, Flash memory, Speed, Size and Cost of memory.
3) Secondary storage
   a) Magnetic Hard disks,
   b) Optical Disk
   c) Magnetic tab systems.

Memory System :-

→ To store the data mechanism available in the computer system is the memory system.
→ Data can be stored in many way like primary memory and secondary memory.

Characteristics of Memory system :-

1) **Location** – i) CPU
ii) Internal
iii) External

i) **CPU** :- Data is stored in CPU registers and in its cache memory, Approximately 16 KB.

ii) **Internal Memory or Main Memory** :- It can be accessed the system Directly.

iii) **External Memory** :- It is in the form of secondary to which the CPU can access with the help of I/O controllers.
e.g → Magnetic disk, magnetic tab etc.

ii) **Capacity** – It is expressed using two terms :-
i) word size ii) Number of words

i) **Word size** :- It is expressed in byte (8 bits). Word size can be 8 bit, 16 bit, 32 bit.

ii) **Number of words** :- The number of words that can be in a particular device.
e.g → If memory capacity is 4K x 8. Here the word size & 4K means 4 x 1 KB = 4096

iii) **Unit of transfer** :- It specifies the maximum number of bits that can be read or written into the memory at a time. In main memory it is in the form of word size.
→ In secondary memory it is in the form of block (large set of data).

iv) **Access Method** :- There methods.
i) sequencial
ii) Random
iii) Direct
i) Memory is organised data retrival of phy 1, 2, ... n refers
e.g → Magnetic tap
ii) In digital syste in memory has by any location as random acce
iii) Directly any data is refer
e.g → Hard

v) **Performance** :- can be measured
i) Access time
i) In RAM the time to be performed it is referred to be position
ii) In RAM it sp -al time requi
iii) It is define transferred

vi) **Physical ty** It is of 2
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vii) **Physica**
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methods. i) sequencial access
ii) Random access
iii) Direct access

i) Memory is organised into units of data i.e records. Data retrival of physical records inorder from 1, 2, ---, n refers to sequencial access.
e.g → Magnetic taps.

ii) In digital systems each addressable location in memory has an unique address, when random. ly any location choosen to store data is refered as random access.

iii) Directly any address location choosen to store data is referred as direct access.
e.g → Harddisk

v) Performance :- performance of a memory system can be measured using 3 parameters.
i) Access time ii) Memory cycle time iii) Transfer rate

i) In RAM the time taken by read or write operations to be performed is refererred as access time. In non-RAM it is refered as the time taken by read, write, head to be positioned at the desired location.

ii) In RAM it specifies the sum of access time and addition. -al time required before a second access is performed.

iii) It is defined as the rate at which data can be transferred into or out of a memory unit.

vi) Physical type of a Memory System :-

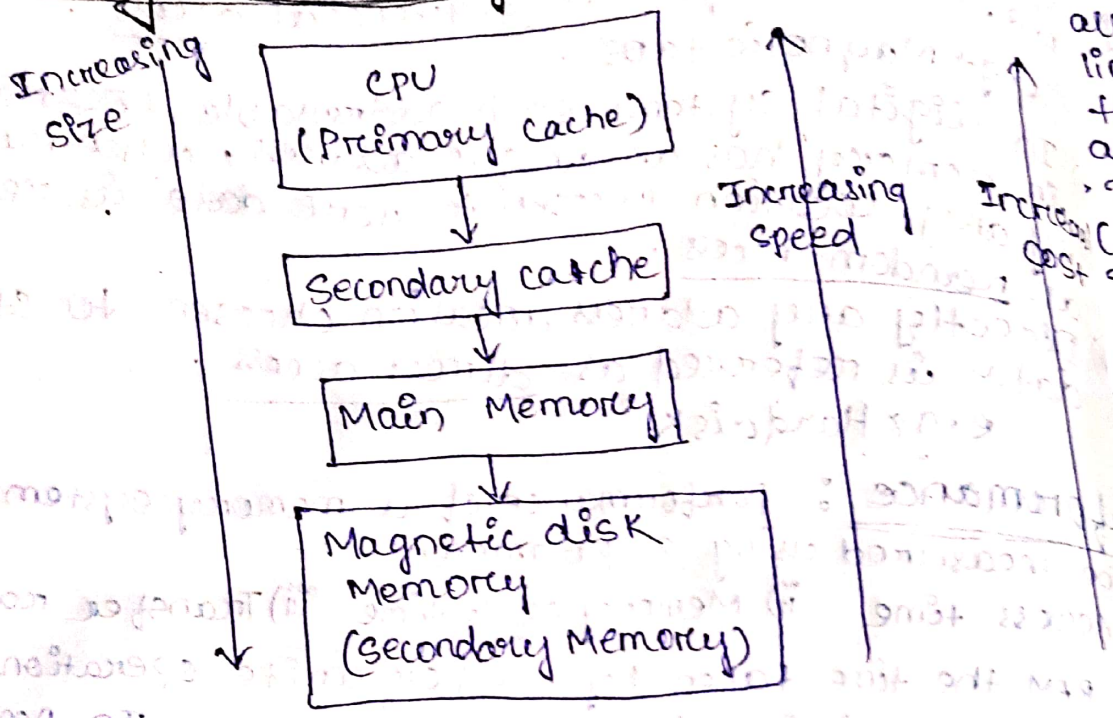
It is of 2 types.
i) semiconductor memory
ii) Magnetic surface memory

vii) Physical Characteristics :-

i) volatile or Non-volatile - If memory can hold data if power is off then it is called as non-volatile else volatile.

ii) Erasable / Non-erasable :- If the data is once programmed can't be erased then it is called as non-erasable memory otherwise if data in the memory is erasable then it is called as erasable memory.

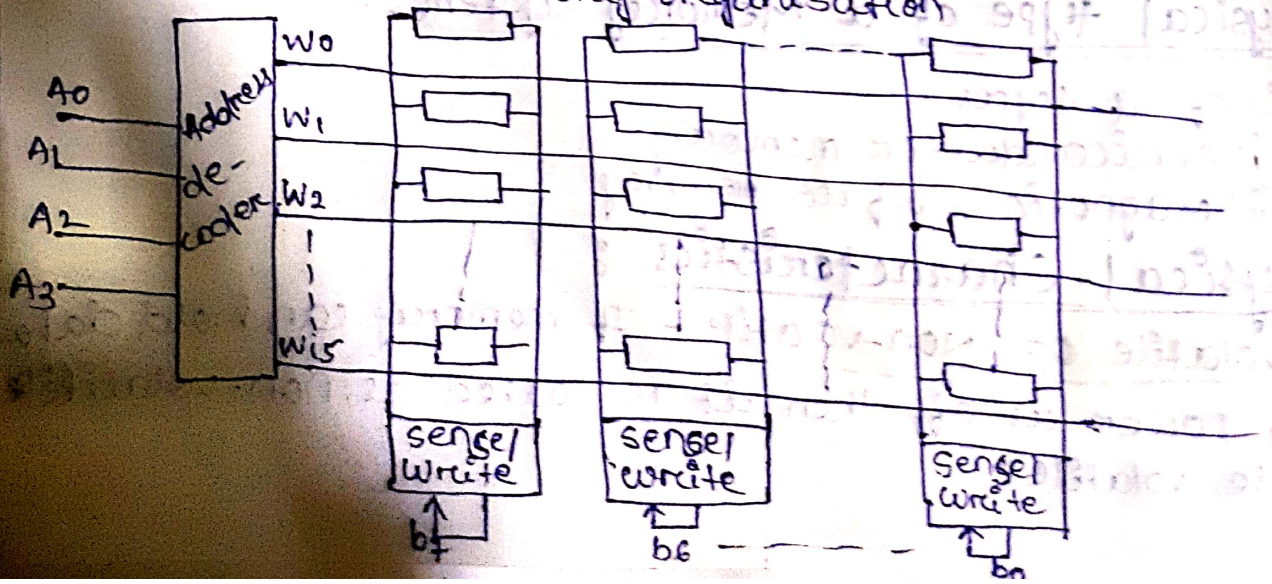
Memory Hierarchy :-



Internal organisation of memory system :-

The memory cell is capable of storing 1 bit of information at a time, so a number of memory cells are organised in the form of matrix to create a memory chip for storing large amount of information.

16 × 8 Memory organisation



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16 memory location are available from (w_0 ... w_{15})
8 bits in each memory location (b_0 ... b_7)

→ Each row of cells constitute a memory word and all cell of a row are connected to a common line (word line) and address decoder is used to drive the word line which is depending on the address present in the address bus.
→ The cells in each column are connected by a lines (bit line).
→ These bit lines are connected to data input line and data output line through a "Sense / write" circuit.
→ During a read operation the sense/write circuit helps to ~~send transmit to the output dataline~~ sense or read the information stored in the cell and transmit to the output dataline.
→ During write it receives the information and store in the cell of the selected word.

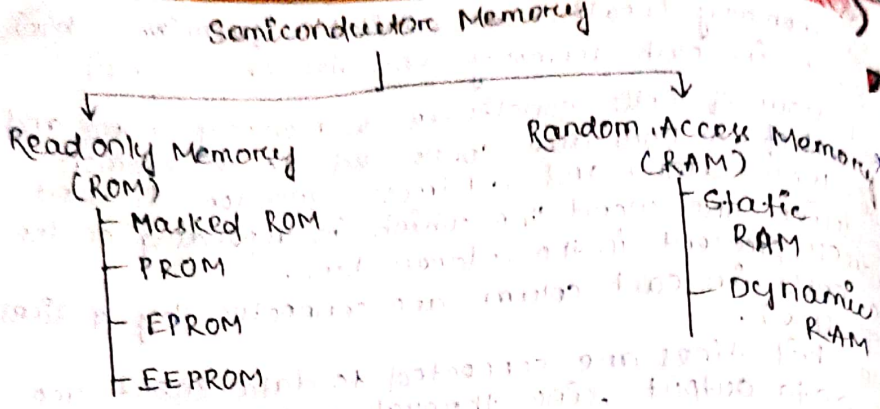
Semiconductor Memory :-

→ For storing digital information the integrated circuit device utilised is known as semiconductor memory, it can be also refered as integrated circuit memory or large scale integrated memory or memory chip or semiconductor storage or transfor memory.

Defination :-

A semiconductor memory is a main memory element of a micro computer based system which is used to store program and data.

→ It stores code and information parmanently.
→ It is directly accessable by the microprocessor.



ROM :-

→ ROM is the semiconductor memory where data once written doesn't change.
→ It is used where data is to be stored permanently even if the power is removed.
→ It is used for the semiconductor memory type where the data & programs are still needed after the power is down.
e.g→ BIOS data of a computer are stored in ROM.
→ Writing data in ROM is not easy it requires special technology and social hardware.
→ If required the data in the ROM may be erased and re-written using some specific technology only.

PROM :- (Programmable Read Only Memory)

→ PROM is the semiconductor memory where data once written can't be erased and stored permanently.
→ It is programmed using special PROM Programmer.
→ PROM stores data as a charge on a capacitor with charge storage capacitor.
→ Here data can be written rapidly.
→ Data can be leak away and lost after some year when the charge is discharged.
→ It stores data of small quantity and in systems that has low capacity and durability.

EPROM : (Erasable Programmable ROM)

→ Here data in a ROM can be written or program rapidly and can be erased later on when need
→ The data can be erased from the device through an ultraviolet light by uncovering the by a label.

EEPROM :- (Electrically Erasable programmable

→ In EEPROM data can be written to it and er from it using electrical voltage in order to the durability of the device.
→ It contains an erase pin on it to erase using the electrical signal.
→ EEPROM is a better ROM but not faster

RAM :- (Random Access Memory)

→ RAM is used for reading and writing d order as required by the processor.
→ It may be used as the computer or p where variables and other storage required on a random basis.
→ Data is stored and read several ti from RAM for several years.
→ RAM memory is temporary in nature
→ It is more durable.
→ It has 2 types - DRAM & SRAM

DRAM :- (Dynamic RAM)

→ It uses a capacitor to store e and the level of charge on each determines of its 1 or 0.
→ But these capacitors donot h indefinitely, hence data need periodically. Hence it is refer RAM.
→ DRAM is used in personal com computers as the main RAM.

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Random Access Memory (RAM)
- Static RAM
- Dynamic RAM

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EEPROM: (Electrically Erasable programmable ROM)
→ In EEPROM data can be written in to and erased from it using electrical voltage in order to maintain the durability of the device.
→ It contains an erase pin on it to erase data using the electrical signal.
→ EEPROM is a better ROM but not faster as RAM.

RAM :- (Random Access Memory)
→ RAM is used for reading and writing data in any order as required by the processor.
→ It may be used as the computer or processor memory where variables and other storage data are required on a random basis.
→ Data is stored and read several times to and from RAM for several years.
→ RAM memory is temporary in nature.
→ It is more durable.
→ It has 2 types - DRAM & SRAM

DRAM :- (Dynamic RAM)
→ It uses a capacitor to store each bit of data and the level of charge on each capacitor determines of it is 1 or 0.
→ But these capacitors donot hold their charge indefinitely, hence data needs to be refreshed periodically. Hence it is refered as dynamic RAM.
→ DRAM is used in personal computers, work station computers as the main RAM.

disadvantage :-

→ Its manufacturing process is complex.
→ Data requires frequent refreshing.
→ More complex external circuitary is required, t
of it is high cost.
→ It is a volatile memory.
→ It is costly in nature.
→ Works in a relatively slow operational speed.

S-RAM : (Static RAM)

→ It is static in nature and doesn't require freq
refreshing.
→ It allows faster read and write of item than D-RAM
→ Its cycle time is more shorter as it doesn't requ
pause between accesses.

disadvantage :-

→ It consumes more power.
→ They are more expensive than D-RAM.
* S-RAM is used for cache memory where as D-RAM is used for main semi conductor memory.

Types of D-RAM :-

1) Synchronous D-RAM 2) Asynchronous D-RAM

Synchronous D-RAM (SDRAM)

→ It is a semiconductor memory that runs at furth
speed than normal D-RAM.
→ It is synchronised to the clock of the processor.
→ It is capable of keeping 2 sets of memory addresses
simultaneously opened.
→ It transfers data from one set of addresses to the othe
basing upon the clock pulse.
→ SD-RAM cuts down on the delays associated with non-synch
-nous RAM which closes the address bank before opening
the next address.
→ Several types of SDRAM memory technologies are availa
→ The most recently used in the DDR-4 (Double Data Rat
SDRAM.
→ With some latest improvements DDR5 is going to
replace DDR4.

Types of SDRAM :-

1) Single Data Rate SDRAM (SDR-SDRAM): It makes a single transfer of data per clock cycle.
2) Double Data Rate SDRAM (DDR SDRAM): It almost doubles the bandwidth of data rate of SDRAM by using double pinning process. This process allows for data to transfer on rising and falling edges of a clock signal.
3) RAMBUS SD RAM (RD RAM) :- These were most widely used in early 2000 for graphics cards. It provides a very high speed data transfer rate over a narrow CPU memory bus. It uses various speed of mechanisms like a synchronous memory interface, catching inside the D-RAM chips and very fast signal time.

Asynchronous DRAM (ADRAM) :-

→ The memory access was not synchronised with the system.
→ Hence, it is called asynchronous.
→ It was the older version of D-RAM, which became replaced by SD-RAM.

Types of AD-RAM :-

1) RAS only Refresh (ROR) ADERAM - It is a classic AD RAM which is refreshed while opening each row. It uses external counters to refresh the rows.
2) CAS before RAS Refresh (CBR) - It is used to reduce the external circuitary. Here the counter is used inside the memory chip for refresh without using the external counter. It is also beneficial for development of SDRAM.
3) Fast page Mode D-RAM (FPM D-RAM) - It was designed to work faster than other AD RAMS. It is used in personal computers.

Memory :

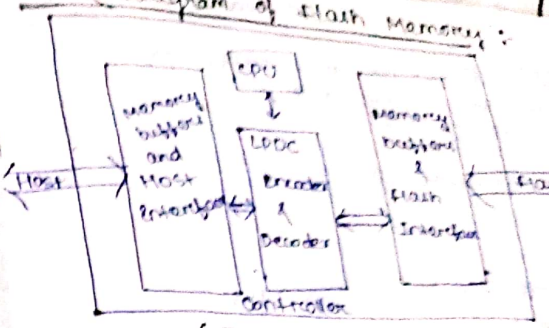
→ Flash memory is a long life and non-volatile storage chip which is widely used in embeded systems.
→ It can help to store data even when power is off.
→ It can be electrically erased and reprogrammed.
→ Flash memory developed from EEPROM.
→ It must be erased before it can be re written with new data.
→ The erase is performed in blocks (256 KB to 20 MB block size).
→ It is of 2 types. i) NOR Flash
ii) NAND Flash

i) **NOR Flash :** It allows quick random access to any location in the memory array.
It stores boot code and executable information as a replacement of EPROM.
It performs the roll of ROM applications in different embedded systems.

ii) **NAND FLASH :** It allows a long initial read access to the memory array as compared to NOR flash.
NAND costs less per bit than the NOR flash.
It is used in memory cards, USB flash drives, Solid state Drives SDD(SSD).

Both of the types of flash memory are used in personal computers and all types of embeded systems like digital audio-players, digital camera, mobile phones, video games, scientific instrument, industrial robotics etc.

Block diagram of flash memory :



(Flash Memory Device

Flash Memory cards :-

→ Flash memory cards and sticks are for storing and transfering different
→ It has the capacity from 8 MB to 1
→ USB drives, solid state drives, are examples of it.
→ It can store photos, programs, do pocket pcs and palm os devices.

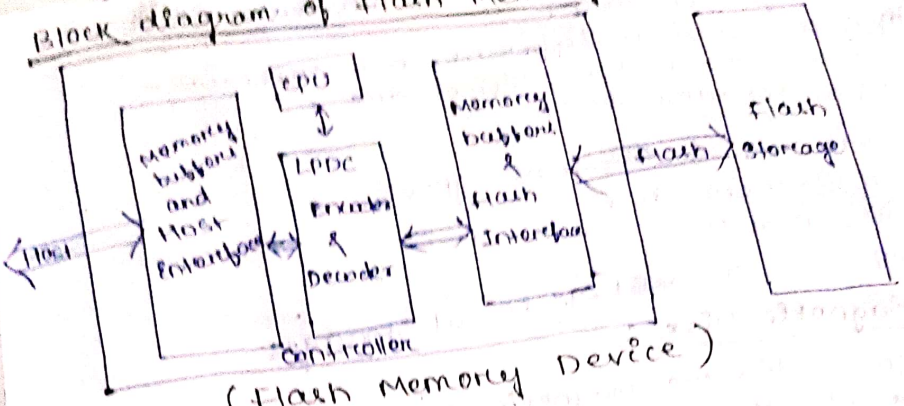
Types of flash memory cards

i) Secured Digital Memory Car
ii) Compact Flash (CF) Memory C
iii) Memory Stick (MS) Memory
iv) Multimedia Memory card :
v) Smart media (SM) memory
vi) XD Picture card

Secondary storage :-

→ Secondary storage refers amount of data.
→ It is a non-volatile mem
→ These devices are of high transfer data from one

Block diagram of Flash Memory :-



(Flash Memory Device)

Flash Memory Cards :-

→ Flash memory cards and sticks are a popular medium for storing and transfering different amount of data.
→ It has the capacity from 8 MB to 1 TB.
→ USB drives, solid state drives, camera memory cards are examples of it.
→ It can store photos, programs, data etc in different pocket pcs and palm os devices.

Types of flash memory cards :-

i) Secured Digital Memory Card (SD memory card)
ii) Compact Flash (CF) Memory card
iii) Memory Stick (MS) Memory card
iv) Multimedia Memory card
v) Smart media (SM) memory card
vi) XD picture card

Secondary storage :-

→ secondary storage refers to any device bulk/large amount of data.
→ It is a non-volatile memory.
→ These devices are of high capacity and also able to transfer data from one location to other.

- Secondary storage devices can deal with those quickly access data.
- ii) It comes with different cost criterias.
- iii) How durable the devices are.
- iv) How portable is it.

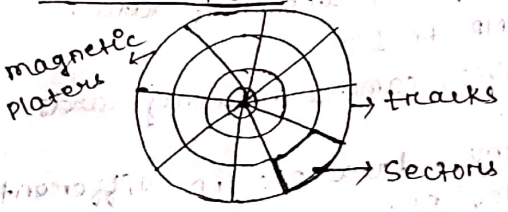
→ These are of different types :-

i) Magnetic disk
ii) Optical Disk
iii) SSD or solid electrical storages

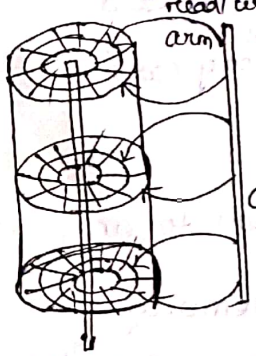
i) Magnetic Disk :-

→ Magnetic disk use magnetisation process to store data into it.
→ We can read, write, re-write, access data in it

Architecture :-



i) The magnetic disk is a collection of platters.
ii) Each plater has several tracks.
iii) Each track is further devided into sectors.
iv) A cylinder is formed by combining the tracks at a given radius of disk pack.



→ The read-write arm of the read write allows to read and write data on the
ii) The head reaches at a particular track write data with the rotation of the plat
iii) Each platter has two surface areas to to store data with individual read-w time.
iv) To complete an I/O request the disk ha
v) The parameters that effect its perfor
→ Seek time
→ Rotation Latency
→ Data
→ Data transfer rate
→ controller arch head
→ Executing delay

→ The storage capacity of magnetic d the bits located per unit area of
→ The capacity can be measured as
Storage capacity = no. of recording s

no. of sectors
no. of bytes

→ The highest capacity of SS device is measured in yotal
1 Yotabyte = 1024 TB
→ It is the main storage device
→ It is cheap per unit of stor
→ It provides faster access to

ii) Optical Disk :-

→ An optical disk is a flat circular objects.
→ It stores information in th variations on its surface the aid of a beam of
→ Optical disk can be a blue more data than a standard

v) The read-write arm of the read write head allows to read and write data on the disk.
vi) The hard reaches at a particular track and read write data with the rotation of the platen.
vii) Each platen has two surface areas top and bottom. to store data with individual read write heads.
viii) To complete an I/O request the disk has disk access time.
ix) The parameters that effect its performances are
- Seek time
- Rotation Latency
- Data transfer rate
- controller arch head
- Executing delay

x) Data

→ The storage capacity of magnetic disk is based on the bits located per unit area of the disk surface.
→ The capacity can be measured as:

Storage capacity = no. of recording surfaces * number of tracks per surface * no. of sectors per track * no. of bytes per sector

→ The highest capacity of SS (secondary storage) device is measured in Yotabytes.
1 Yotabyte = 1024 TB
→ It is the main storage device in computers.
→ It is cheap per unit of storage.
→ It provides faster access too.

vi) Optical Disk :-
→ An optical disk is a flat and usual disk shaped circular objects.
→ It stores information in the form of physical variations on its surface that can be read with the aid of a beam of light or laser light.
→ Optical disk can be a blue ray disk which can hold more data than a standard DVD.

→ It can store movies with better sound quality.
→ It is more expensive than DVDs.
→ It requires a blue ray player.
→ It allows to store HD movies and other HD recordings with the help of laser.

iii) Solid state Drive :-

→ It is an electrical storage device.
→ It is used in computers to store data.
→ It is also a non-volatile storage media.
→ SSD is faster than traditional HDDs (Hard Disk Drive).
→ With SSD the operating system also boot up more rapidely, programs will load quicker and files can be saved faster.
→ As it is compact in size, it is very portable, data transfer speed becomes higher, consumes low power.
→ It is more expensive than magnetic storage mediums.
→ Now a days the impact of flash memory drives, SSDs are more useful & convenient storage media with portable and removable characteristics.

D-RAM	S-RAM
i) Dynamic RAM.	i) Static RAM.
ii) D-RAM can do byte level writing and multiple byte level reading.	ii) S-RAM can do byte level read and write.
iii) D-RAM needs refreshing as it operates on the principle of charging the capacitor.	iii) Here there is no need for refreshing, as it operates on switching the current.
iv) It is less expensive than S-RAM.	iv) It is more expensive.
v) D-RAM is slower	v) It is faster.
vi) It is used in main memory.	vi) It is used in cache memory.
vii) The structure of DRAM module needs a transistor and a capacitor for storing every bit of data.	vii) The structure of SRAM chip needs a lot of transistors.