**MICRO-PROGRAMMING** :🡺It can execute any instruction. The CPU should divide it down into a set of sequential operations. This set of operations are called microinstruction. The sequential micro-operations need the control signals to execute. 🡺 Control signals saved in the ROM are created to execute the instructions on the data direction. 🡺 These control signals can control the micro-operations concerned with a microinstruction that is to be performed at any time step The address of the microinstruction is executed next is generated.The previous 2 steps are copied until all the microinstructions associated with the instruction in the set are executed. **ADV** :- It can more systematic design of the control unit. 🡺It is simpler to debug and change. 🡺It can retain the underlying structure of the control function. 🡺It can make the design of the control unit much simpler. Hence, it is inexpensive and less error-prone. 🡺It can orderly and systematic design process. 🡺It is used to control functions implemented in software and not hardware 🡺 It is more flexible. 🡺It is used to complex function is carried out easily. **DIS : 🡺**Adaptability is obtained at more cost. 🡺It is slower than a hardwired control unit. **CLASSIFICATION OF MEMORY :-**  Primary or Main Memory : - Primary memory is also known as the computer system's main memory that communicates directly within the CPU, Auxiliary memory and the Cache memory. Main memory is used to kept programs or data when the processor is active to use them. 🡺 RAM (Random Access Memory) 🡺ROM (Read Only Memory) **RAM :**Random Access Memory (RAM) is one of the faster types of main memory accessed directly by the CPU. It is the hardware in a computer device to temporarily store data, programs or program results. It is used to read/write data in memory until the machine is working. It is volatile, which means if a power failure occurs or the computer is turned off, the information stored in RAM will be lost. DRAM : 🡺It requires continuously refreshed to retain the data. 🡺It is slower than SRAM 🡺It holds a large amount of data 🡺It is the combination of capacitor and transistor 🡺 It is less expensive as compared to SRAM 🡺Less power consumption **CHARACTERISTICS OF STATIC RAM** 🡺 It does not require to refresh.🡺It is faster than DRAM🡺It is expensive.🡺High power consumption🡺Longer life🡺Large size🡺Uses as a cache memory 🡺**ADV RAM** :-🡺It is a faster type of memory in a computer🡺It requires less power to operate.🡺Program loads much faster🡺More RAM increases the performance of a system and can multitask.🡺Perform read and write operations.🡺The processor can read information faster than a hard disc, floppy, USB, etc. **DIS RAM :-** 🡺Less RAM reduces the speed and performance of a computer.🡺Due to volatile, it requires electricity to preserve the data.🡺It is expensive than ROM🡺It is unreliable as compared to ROM🡺The Size of RAM is limited. 🡺**ROM** :- is a memory device or storage medium that is used to permanently store information inside a chip. It is a read-only memory that can only read stored information, data or programs, but we cannot write or modify anything. **🡺MROM (Masked Read Only Memory):** - MROM is the oldest type of read-only memory whose program or data is pre-configured by the integrated circuit manufacture at the time of manufacturing. Therefore, a program or instruction stored within the MROM chip cannot be changed by the user. 🡺PROM (Programmable Read Only Memory)🡺EPROM (Erasable and Programmable Read Only Memory): 🡺EEPROM (Electrically Erasable and Programmable Read Only Memory):🡺 Flash ROM: 🡺 **ROM ADV** :- 🡺 It is a non-volatile memory in which stored information can be lost even power is turned off.🡺 It is static, so it does not require refreshing the content every time.🡺Data can be stored permanently.🡺 It is easy to test and store large data as compared to RAM🡺 These cannot be changed accidently🡺It is cheaper than RAM.🡺 It is simple and reliable as compared to RAM.🡺It helps to start the computer and loads the OS. ROM 🡺Store data cannot be updated or modify except to read the existing data.🡺It is a slower memory than RAM to access the stored data.🡺It takes around 40 minutes to destroy the existing data using the high charge of ultraviolet light. **REQUIREMENTS OF MEMORY MANAGEMENT** :- 1**) Sharing of memory** :- During a multi-process environment, all the processes access the same part of the main memory. Here protection measures are required during this sharing process which is taken care of by memory management. This approach of sharing has been an advantageous one because each process does not need a separate copy to be created as they access the shared copy already available in the memory. Shared memory is considered an efficient approach during inter-process communication methods. **2) Memory protection** :- Protection mechanisms have to be satisfied by the processor which is in the execution state, to avoid interference of other unauthorized to perform write operations to the same file located in the shared memory space. This has to be in control by the processor of the system rather than the installed operating system, as OS has a function to control the process which occupies them, thereby checking the reference of the valid memory. In simple terms, protection is the method of securing the memory from unauthorized processes. **3) Mapping of Address /Relocation** − During the time of process execution, the user may not know about other programs that are residing in the main memory, here swapping happens to the disk and it gets returned to the main memory but with a different location. Relocation happens after swapping because the previous memory location where the process already resided will now be used by another process. Once the process gets loaded to the memory, translation must happen from the logical address to the physical address, which is done by the associated process and the operating system. A physical address contains a combination of logical addresses and contents related to the relocation register.

**4) Logical addressing** − Programs that are stored inside the memory units are organized into modules and these modules are modifiable with read and execute permission but a few do not have permission to modify. The sequence of bytes or otherwise as words is the representation form of main memory which is linear and has a one-dimensional address area in nature. As said above, logical addresses are generated by the CPU during the run time of the process. The user programs which are given as input is divided into modules compiled independently and their references are addressed during the run time of the system. Protection can vary on each level of logical spaces where different modules reside. **5) Physical space** − As it’s known that the memory of the system has two divisions such as main memory and secondary memory. Main memory (volatile) is capable to store and handle the current programs which are in execution with better performance whereas secondary memory (which acts as nonvolatile) supports storing the data for a long time but provides less performance when compared to main memory. The flow of information and swapping process seems to be a difficult task for the user to understand.

**SECONDARY MEMORY :-**Secondary memory is a permanent storage space to hold a large amount of data. Secondary memory is also known as external memory that representing the various storage media (hard drives, USB, CDs, flash drives and DVDs) on which the computer data and program can be saved on a long term basis. 🡺Features : a) Its speed is slower than the primary/ main memory.b)Store data cannot be lost due to non-volatile nature.c)t can store large collections of different types, such as audio, video, pictures, text, software, etc.d)All the stored data in a secondary memory cannot be lost because it is a permanent storage area; even the power is turned off.e)It has various optical and magnetic memories to store data.🡺 **DMA :-** DMA represents Direct Memory Access. It is a hardware-controlled data transfer technique. An external device is used to control data transfer. The external device generates address and control signals that are required to control data transfer. External devices also allow peripheral devices to directly access memory. The external device which controls the data transfer is called the DMA controller. 🡺I/O device asserts DRQ line when it is ready to transfer data. 🡺 The DMAC asserts the HLDA line to request the use of the buses from the processor. 🡺 The processor asserts HLDA, granting them control of buses to the DMAC. 🡺The DMAC asserts DACK to the requesting I/O device and executes the DMA bus cycle, resulting in data transfer. 🡺 I/O device deasserts its DRQ after data transfer of one byte or word. 🡺DMA deasserts DACK line. 🡺The word/byte transfer count is decremented and the memory address is incremented. 🡺The HOLD line is deasserted to give control of all buses back to the processor. 🡺HOLD signal is reasserted to request the use of buses when the I/O device is ready to transfer another byte or word. The same process is then repeated until the last transfer. 🡺When the transfer count is exhausted, the terminal count is generated to indicate the end of the transfer.**CACHE MEMORY :-** 🡺When the CPU needs to access memory, the cache is examined. If the word is found in the cache, it is read from the fast memory.🡺If the word addressed by the CPU is not found in the cache, the main memory is accessed to read the word. 🡺A block of words one just accessed is then transferred from main memory to cache memory. The block size may vary from one word (the one just accessed) to about 16 words adjacent to the one just accessed.🡺 The performance of the cache memory is frequently measured in terms of a quantity called hit ratio.🡺 When the CPU refers to memory and finds the word in cache, it is said to produce a hit.🡺If the word is not found in the cache, it is in main memory and it counts as a miss.🡺The ratio of the number of hits divided by the total CPU references to memory (hits plus misses) is the hit ratio. **MULTICORE SYSTEM** :- A single computing component with multiple cores (independent processing units) is known as a multicore processor. It denotes the presence of a single CPU with several cores in the system. Individually, these cores may read and run computer instructions. They work in such a way that the computer system appears to have several processors, although they are cores, not processors. These cores may execute normal processors instructions, including add, move data, and branch. **SUPERSCALAR PROCESSOR** :- A superscalar processor is created to produce an implementation rate of more than one instruction per clock cycle for a single sequential program. Superscalar processor design defines as a set of methods that enable the central processing unit (CPU) of a computer to manage the throughput of more than one instruction per cycle while performing a single sequential program.While there is not a global agreement on the interpretation, superscalar design techniques involve parallel instruction decoding, parallel register renaming, speculative execution, and out-of-order execution. These techniques are usually employed along with complementing design techniques including pipelining, caching, branch prediction, and multi-core in current microprocessor designs. **LAW OF BA :** 1) complement law : (A’)’ = A 2) AND : (A.B)’ = A’+B’ 3) Commutative : A+B+C = B+C+A = C+A+B = B+A+C 4) Associative : (A+B)+C = A+(B+C) Distributive : (A+B)+C = A+(B+C) 5) Idempotent Law : A.A = A ; A+A = A 6) Absorption : A+A.B = A ; A(A+B) = A 7) Demorgons : (A+B)’ = A’.B’ ; (A.B)’ = A’ + B’