Memory Management

Date
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* Basic Memory Management :
- Memory is a collection of data stored in binary format.
- To manage the memory we need some kind of mechanism which is memory management.

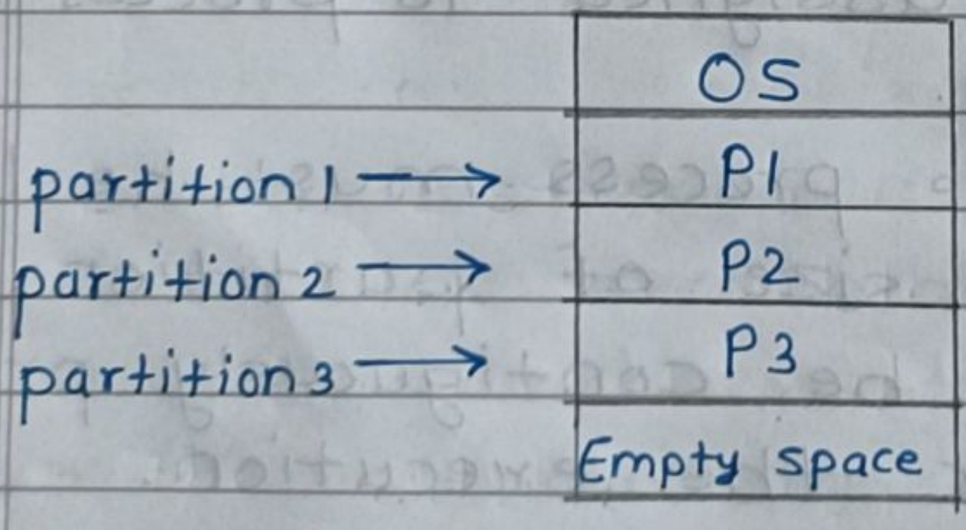
* Partitioning :

i) Fixed Partitiong :
- It is one of the oldest and simplest techique to load more than one process into the main memory.
- It is contiguous Memory Allocation.
- The main memory is divided into partitions of equal or different sizes.
- The OS always resides in the first partition and other partitions can be used to store user processes.
- The memory is assigned to process in a contiguous way.
- The size of the process must be less than or equal to size of partition.
- A process must be contiguously present in a partition for the execution.
- Advantages :
i) Easy to implement.
ii) Less overhead.

- pisadvantages :
i) Internal Fragmentation.

ii) External Fragmentation.
iii) Limitation of degree of multiprogramming.
iv) Memory is not fully utilized.

ii) Variable Partitioning:
- It is a part of contiguous memory Allocation.
- It is used to overcome the problems occured in fixed partitioning.
- Initially, RAM is empty and partitions are made during the run time as per process's needs.
- The size of the partition will be equal to the size of process.
- Then the partition is allocated to the process.
- Number of partitions are not fixed and it depends on the number of processes and Memory size.



(process size = partition size)

- Advantages:
i) Internal Fragmentation.
ii) No limitation of the size of process.
iii) No limitation on degree of multiprogramming.

- disadvantages :
i) External Fragmentation.
ii) Complex Memory Allocation.

* Free space management techniques :
i) to keep track of free space or blocks.
ii) to reuse the space after deletion of files.
iii) System maintains a free space list to keep track of deallocated disk blocks.
- There are two techqiues to manage Free space :
    i) Bit Vector.
    ii) Linked List.

i) Bit Vector :
- Frequently, the free space list is implemented as a bit map or bit vector.
- A bitmap contains the number of ~~blocks~~ bits and each bit represents each block.
- Each block is represented by 1 bit.
- If the block is free, the bit is 1.
- If the block is allocated, the bit is 0.
- For example :
    Consider a disk where blocks 2, 3, 4, 5, 8, 9, 10, 13, 15 are free and rest of the blocks are allocated. The free space bit map would be ;
    0011110011100100

- Advantage:
i) Simple and easy to understand.
ii) Consumes less Memory.
iii) It is efficient to find free space.

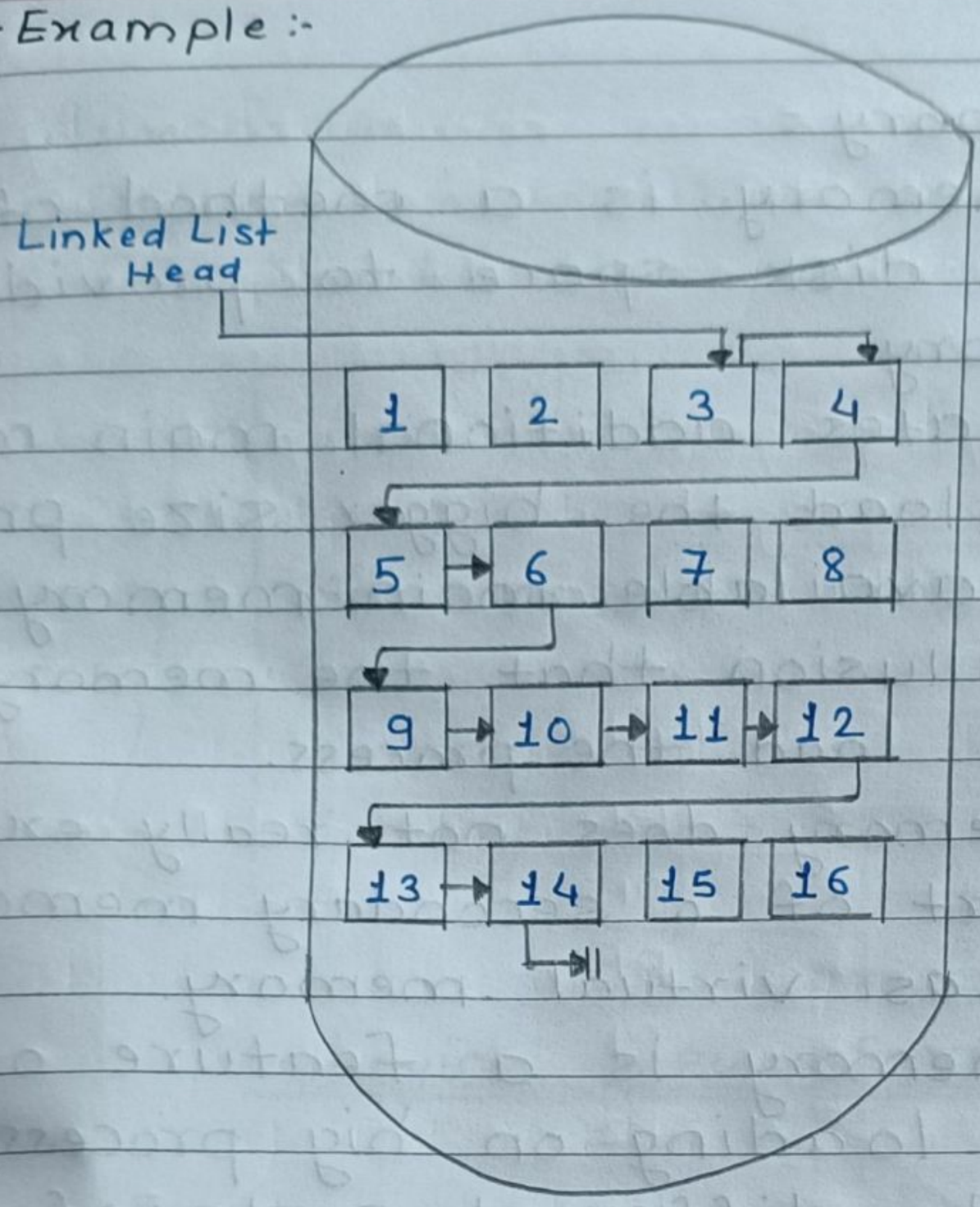
- Disadvantages:
i) The OS goes through all the blocks until it finds a free block.
ii) It is not efficient when disk size is large.

- The formula to find a free block number is:

block number = (number of bits per word) * (number of 0-value word) + (offset of first 1 bit)
= 8 * 0 + 3
= 0 + 3
= 3

ii) Linked List:
- All the free blocks existing in the disk are linked together in a linked list.
- The address of the first free block is stored somewhere in the memory.
- Each free block contains a pointer that contains the address to the next free block.
- The last free block points to null, indicating the end of linked List.

- Example :-



- Advantage :

i) Prevented External Fragmentation.

ii) Simple to understand.

iii) Available space is used efficiently.

- Disadvantages :

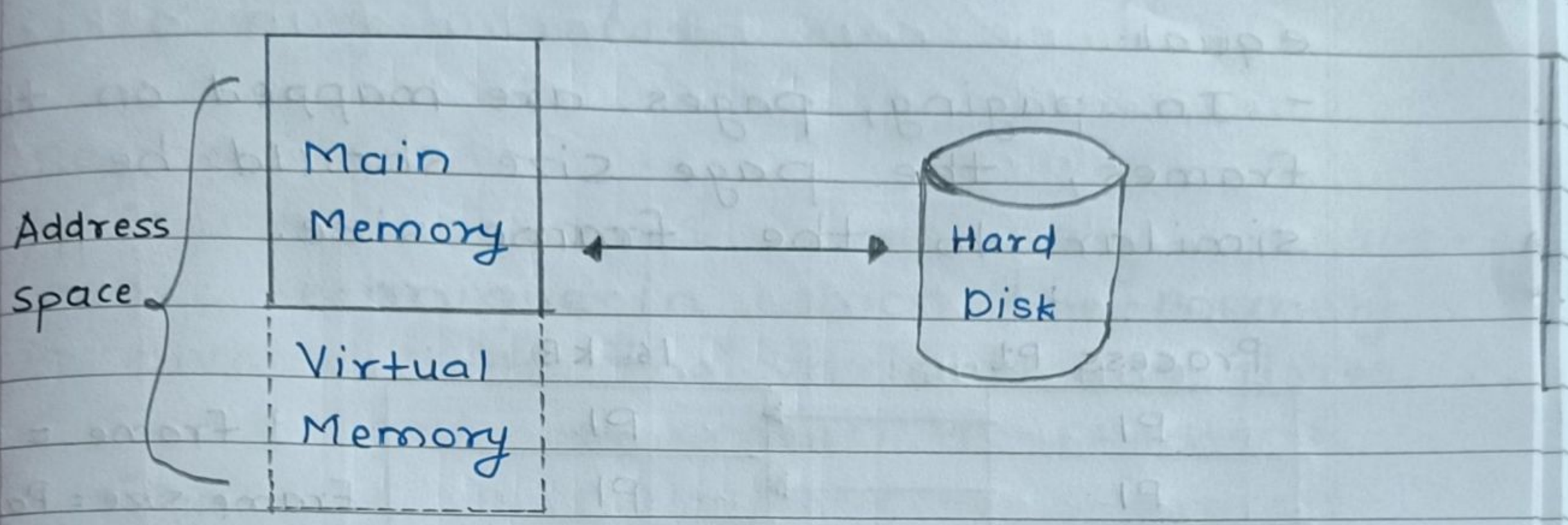
i) Overhead of pointers.

ii) Not efficient to reach every block of memory.

* Virtual Memory :
- Virtual memory is a method of using hard disk space to provide extra memory.
- It simulates additional main memory.
- User can load the bigger size processes than the available main memory by having the illusion that the memory is available to load the process.
- Virtual memory does not really exists but the part of a secondary memory are made as virtual memory.
- Virtual memory is a feature of OS, instead of loading on big process, the OS loads the different parts of more than one process in the form of pages while they are executing.
- Only required page will be loaded in memory.
- Virtual memory can be implemented using →
    i) Paging
    ii) Segmentation.

- Virtual memory use two types of addresses :
    i) Virtual address
    ii) Physical address

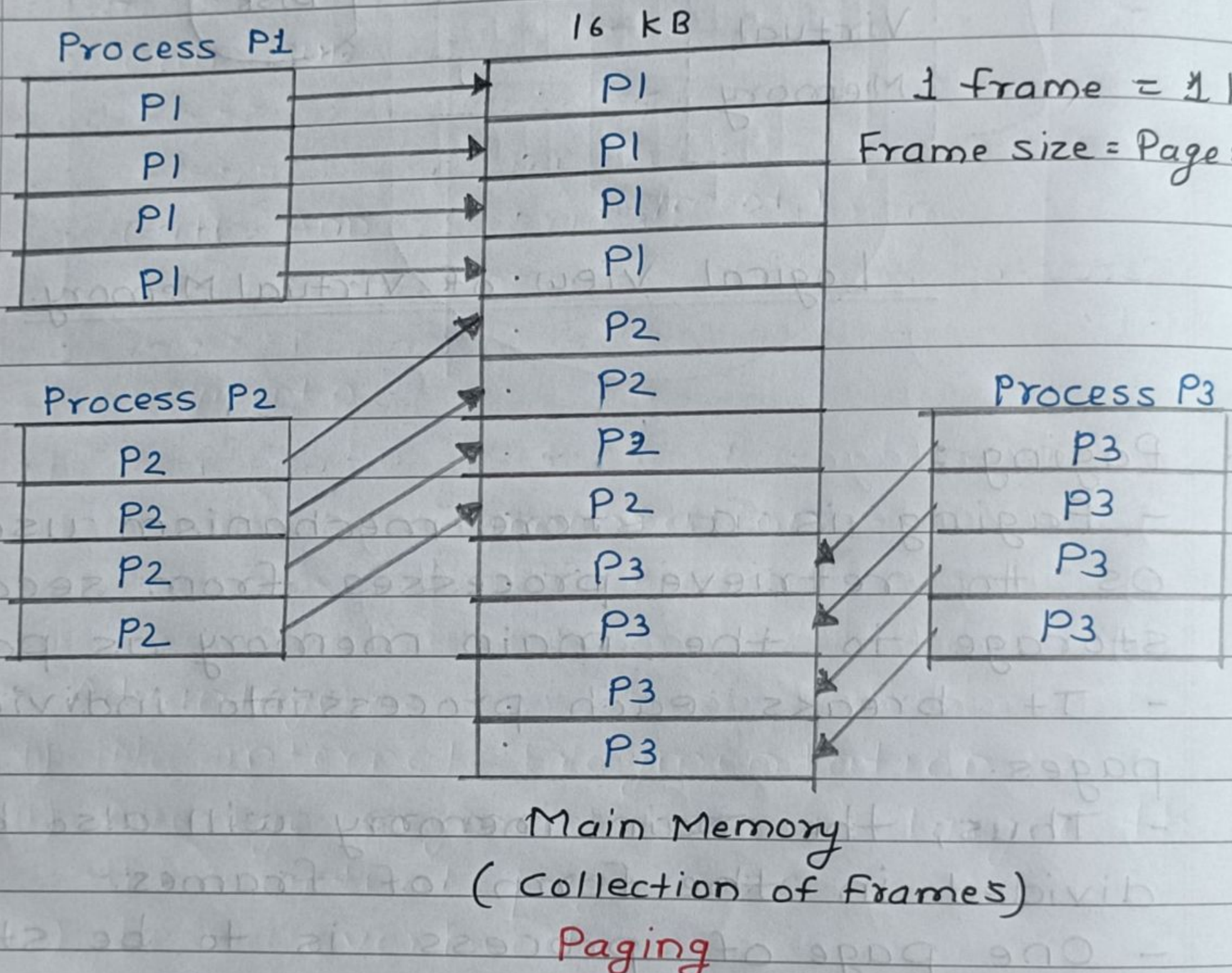
- Advantages :
i) Degree of multiprogramming increased.
ii) CPU utilization will be increased.



Logical View of Virtual Memory.

* Paging :
- Paging is a store mechanism used in OS to retrieve processes from secondary storage to the main memory as pages.
- It breaks each process into individual pages.
- Thus, the main memory will also be divided in the form of frames.
- One page of process is to be stored in one of the frames of the memory.
- The pages can be stored at the different locations of the memory but the main goal is to find always the contiguous frames.
- Process pages are brought into the main memory whenever required, else

they are stored in main memory.
- OS defines the size of the frames.
+ The sizes of each frame must be equal.
- In paging, pages are mapped on the frames, the page size should be similar to the frame size.



Paging

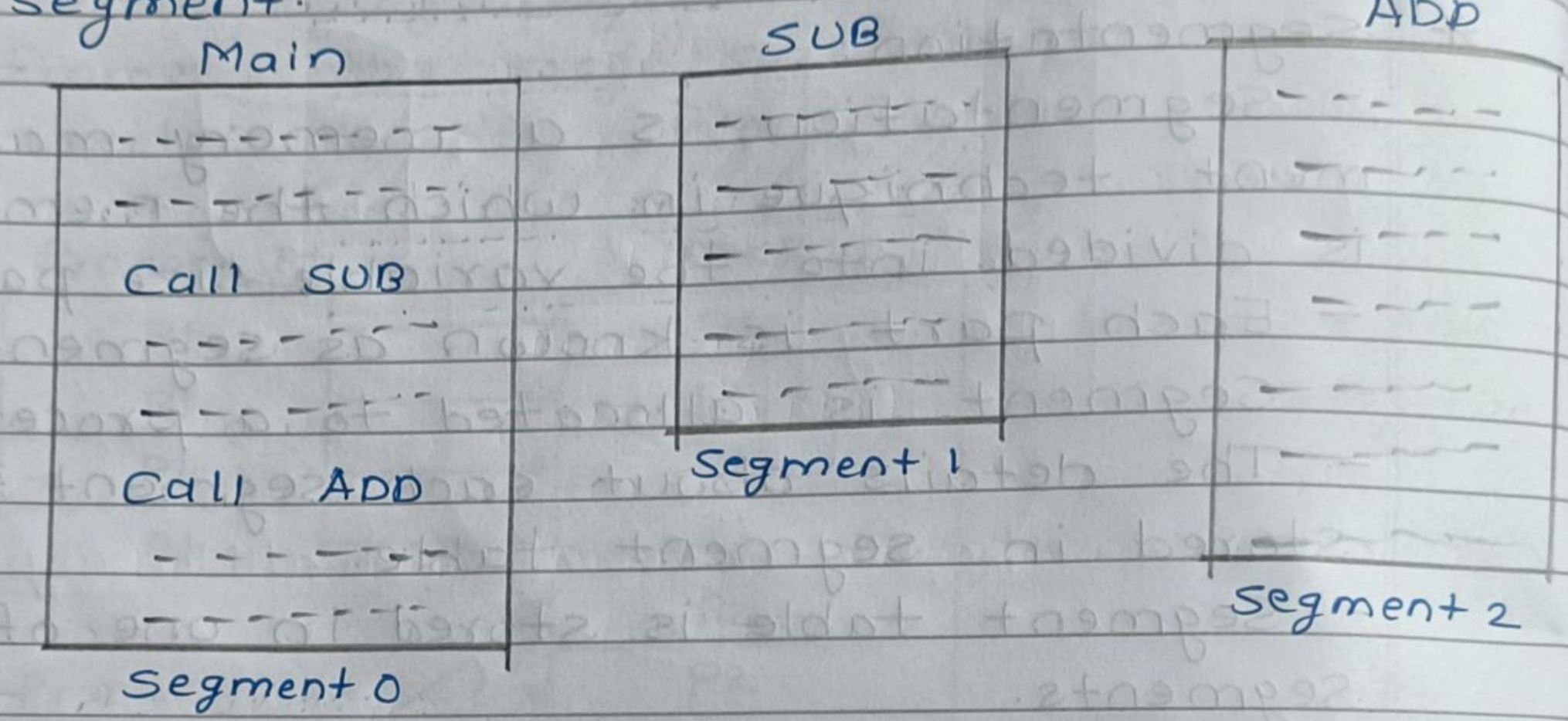
- Advantages:
i) Easy to use.
ii) No need for External Fragmentation.
iii) Swapping is easy between equal size pages & Frames.

- Disadvantages:
i) Internal Fragmentation.
ii) Page table consume additional memory.
iii) Memory overhead.

* Segmentation:
- Segmentation is a memory management technique in which the memory is divided into the variable size parts.
- Each part is known as segment.
- Segment is allocated to a process.
- The details about each segment ~~is~~ are stored in segment table.
- Segment table is stored in one of the segments.
- Segment table contains two information: about segment:
  i) Base: It is the base address of segment.
  ii) Length: It is the length of the segment.

- Paging is more close to OS.
- OS doesn't care about the user's view of the process.
- It may divide same function into different pages and those pages may or may not be loaded at the same time into the memory. which decrease efficiency.
- It is better to have segmentation which divides the process into the segments.

- Each segment contains the same type of functions.
- For example, main function can be included in one segment and the library functions can be included in other segment.



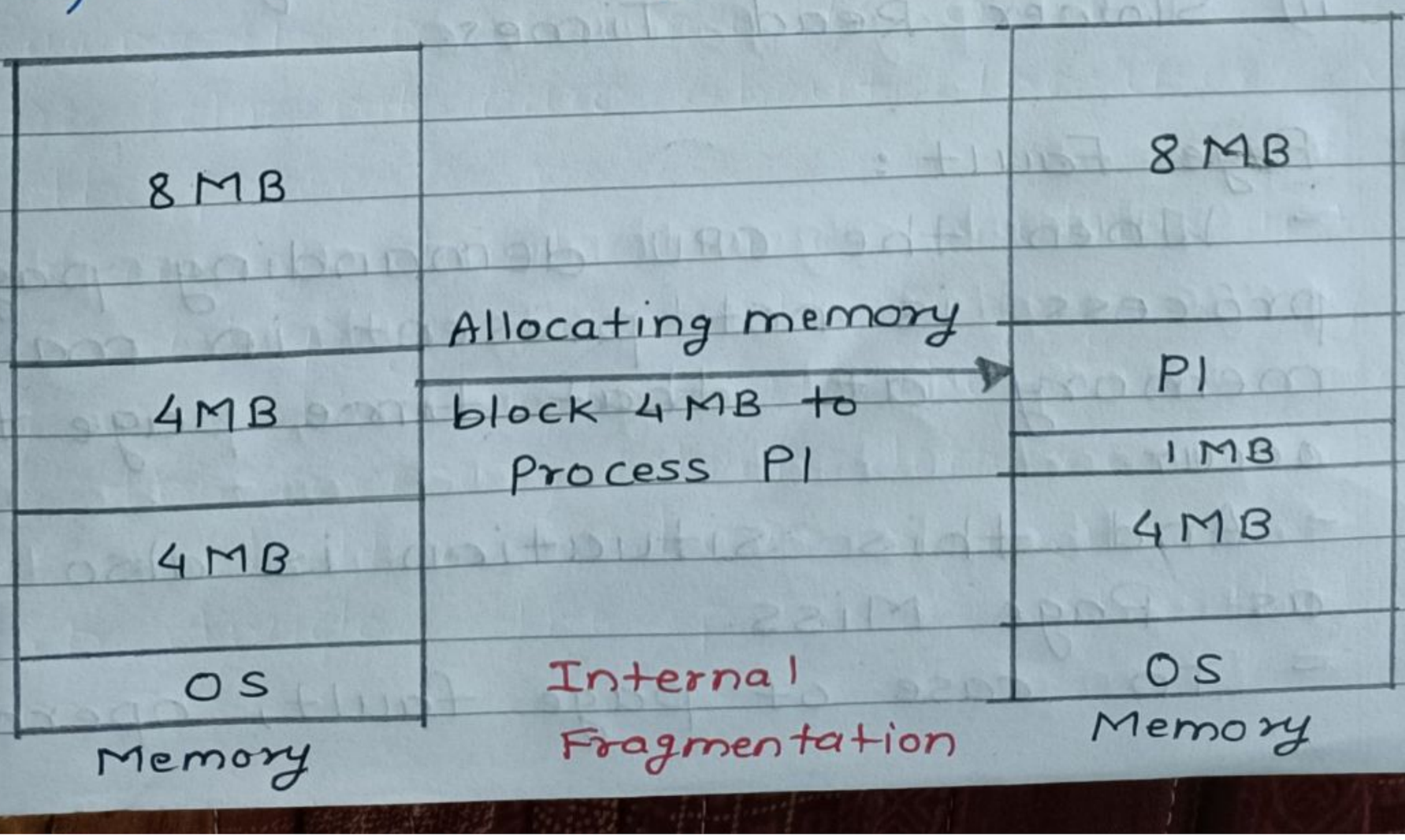
Segmentation

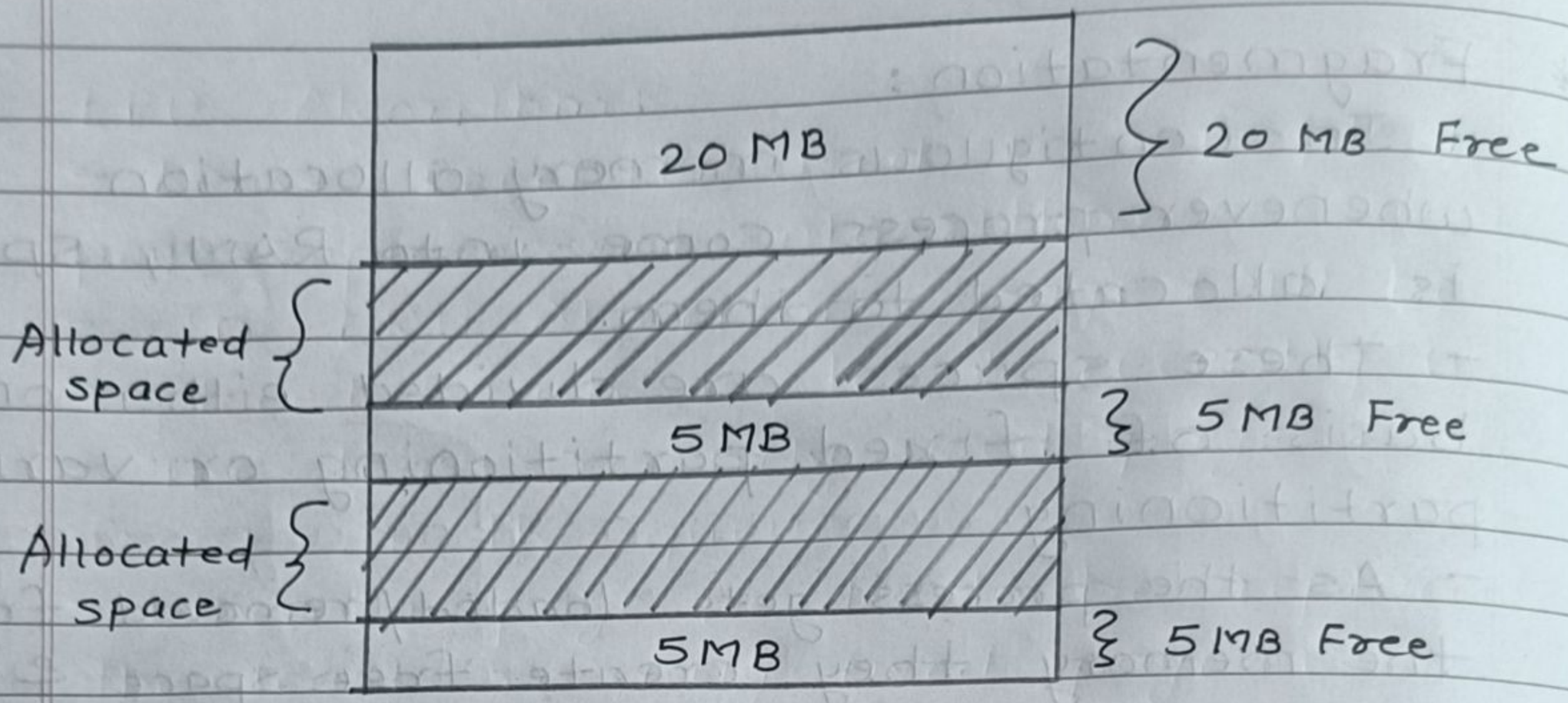
- Advantage :-
  i) No internal Fragmentation.
  ii) Average segment size is larger than the actual page size.
  iii) Less overhead.

- Disadvantage :-
  i) It can have External segmentation.
  ii) It is difficult to allocate contiguous memory to variable sized partition.
  iii) Costly memory management algorithms

* Fragmentation:

- In contiguous memory allocation whenever process come into RAM, space is allocated to them.
- These spaces are divided either on basis of fixed partitioning or variable partitioning.
- As the process gets loaded/removed from the memory they create free space & these spaces gets broken into small pieces that it can't be allocated to the coming processes due to its small size.
- When the processes loaded or removed from the memory they create free space or hole in the memory and these blocks cannot be allocated to new process & the space remains unused.
- There are two types of fragmentation:
  i) Internal Fragmentation.
  ii) External Fragmentation.





Process P2 needs 25 kb memory space.

- Advantages :
  i) Fast Data Writes
  ii) Fewer Failures
  iii) Storage optimization

- Disadvantages :-
  i) Need for regular defragmentation
  ii) Slower Read Times.

* Page Fault :
  - When the CPU demanding page of process is not present in main memory at that time page fault occur.
  - And this situation is also known as Page Miss.
  - In case of page fault, operating

system have to replace one of the existing page with the CPU needed page.
- Different page replacement algorithm is used to decide which page have to replace.
- The main purpose is to reduce the number of page faults.

* Page Replacement Algorithms :

i) FIFO Algorithm :

- First in First out is simplest page replacement algorithm.
- In FIFO algorithm, the operating system keeps track of all pages in the memory in a queue.
- The oldest page is in front of the queue.
- When a page needs to be replaced the firstly come page or the front of the queue is selected for removal.
- Example :

Consider page reference string 3, 8, 2, 3, 9, 1, 6, 3, 8 with 3 page frames find the number of page faults.

	3	8	2	3	9	1	6	3	8
Frame 3			2	2	2	2	6	6	6
Frame 2		8	8	8	8	1	1	1	8
Frame 1	3	3	3	3	9	9	9	3	3
	F	F	F	Hit	F	F	F	F	F

Total Page Faults : 8

ii) LRU Algorithm:

- Least Recently used is simplest page replacement algorithm.
- In LRU Algorithm, page will be replaced which is least recently used.
- The least recently used page is in front of the queue.
- When a page needs to be replaced the least recently used page is selected for removal.
- Example:

Consider a reference string: 4,7,6,1,7,6,1,2,7,2 with 3 page frames. Find out number of page faults.

	4	7	6	1	7	6	1	2	7	2
Frame 3			6	6	6	6	6	6	7	7
Frame 2		7	7	7	7	7	7	2	2	2
Frame 1	4	4	4	1	1	1	1	1	1	1
	F	F	F	F	H	H	H	F	F	H

Total page faults: 6

iii) Optimal:

- Optimal algorithm is a simplest page replacement algorithm.
- In optimal algorithm, pages are replaced which would not be used for the longest duration of time in future.
- Example:

Consider page references 7, 0, 1, 2, 0, 3, 0 4, 2, 3, 0, 3, 2, 3 with 4 page frame. Find number of page faults.

	7	0	1	2	0	3	0	4	2	3	0	3	2	3
Frame 4				2	2	2	2	2	2	2	2	2	2	2
Frame 3			1	1	1	1	1	4	4	4	4	4	4	4
Frame 2		0	0	0	0	0	0	0	0	0	0	0	0	0
Frame 1	7	7	7	7	7	3	3	3	3	3	3	3	3	3
	F	F	F	F	H	F	H	F	H	H	H	H	H	H

Total page faults : 6

* Questions:

1) Distinguish between Monoprogramming & Multiprogramming?

2) Write difference between Paging & segmentation?

3) Difference between Internal Fragmentation & External Fragmentation.

4) Solve at least 3 examples of each algorithm:
   i) FIFO
   ii) LRU
   iii) Optimal.