PART-I

UNIT-3

CPU SCHEDULING

CPU Scheduling:- CPU scheduling is a Process of determining which Process will own CPU for execution while another Process is own Hold.

Purpose of scheduling Algorithm:-

(1) maximum CPU utilization.
(2) fare-allocation of CPU
(3) maximum throughput
(4) minimum waiting time.

Types of CPU Scheduling Algorithm:-

(1) Preemptive Algorithm
(2) Non Preemptive Algorithm.

Preemptiv Algorithm:-

(1) Shortest Remaining time first (SRTF) (SJF) Shortest Job first.
(2) Round Robin (RR)
(3) Priority scheduling.

Non-Preemptive Algorithm:-

(1) First come first serve (FFFS)
(2) Shortest Job first (SJF)
(3) Priority scheduling.
(4) multilevel queue.
(5) Highest Reabose Ratio Next (HRRN)

Performance criteria for CPU scheduling!-

(1) Arrival time (A.T)
(2) Burst time (B.T)
(3) completion time (C.T)
(4) Turn around time (TAT)
(5) waiting time (WT)
(6) Response time

Arrival time (A.T)!- The time at which the Process enters into the ready queue is called arrival time.

Burst time (B.T)!- The amount of time required by the CPU to execute the Process is called Burst time. This does not include waiting time.

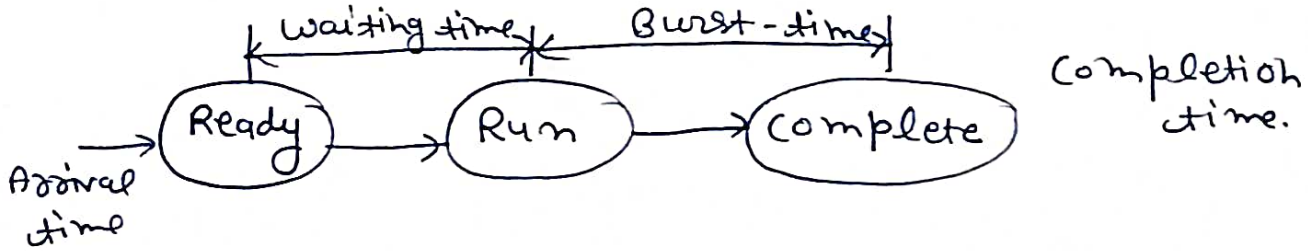
completion time!- The time at which the Process completes its execution is called completion time. (CT).

Turn-around time!- The amount of time spent by the Process from its arrival to its completion is called turnaround time. (TAT)

waiting time!- The amount of time for which the Process waits for the CPU to be assigned is called waiting time. (WT).

Response time!- Response time is the time spent when the Process is in the ready queue and gets the CPU the first time.

Various time Related to a Process:-

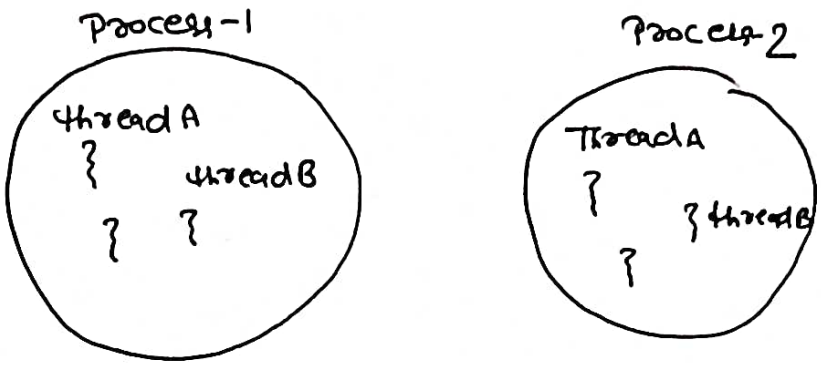


Process States:-

Process:- A Process is the instance of a computer Program that is being executed by one or many threads.

In the operating system, a Process is something that is currently under execution. So an active Program can be called a Process.

Ex When you want to search something on web then you start a browser, so this can be a Process.



Process Attributes:- A Process has various attributes associated with it. Some of the attributes are:-

Process ID:- Every Process will be given an id called Process ID to uniquely identify that Process from the other Processes.

Process State:- Each and every Process has some states associated with it at a particular instant of time. This is denoted by Process State. It can be new, ready, running etc.

CPU Scheduling information:- Each Process is executed by using some Process scheduling algorithm like FCFS, SJF, Round-Robin etc.

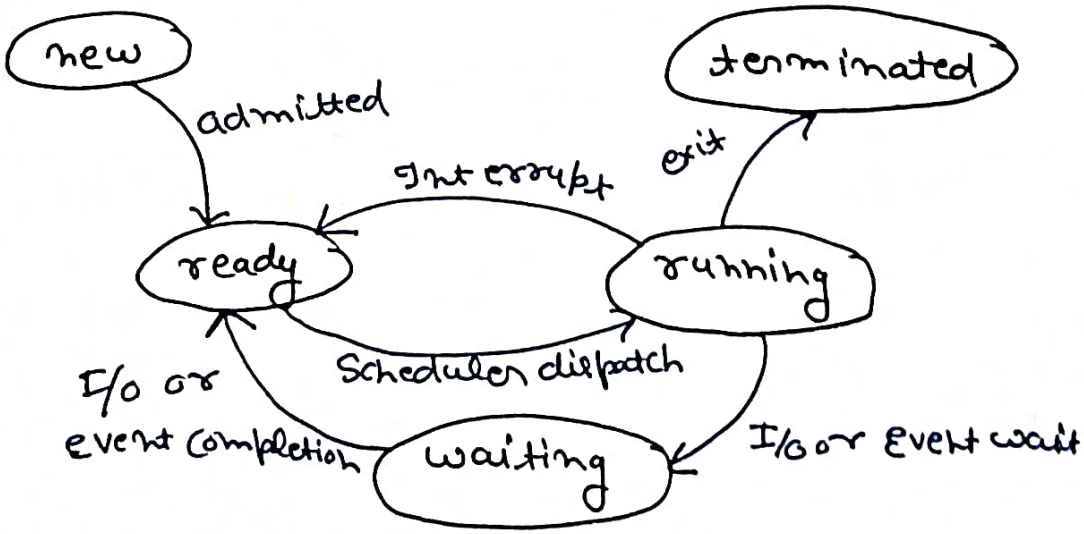
I/o Information!- Each Process needs some I/o devices for their execution. so the information about device allocated and device need is crucial.

Priority!- Every Process has its own priority. The Process with the heighest Priority among the Processes gets the CPU first.

Process Counter!- Process (Program) counter stores the address of the last introduction of the Process on which the Process was suspended.

STATES OF PROCESS / PROCESS LIFE CYCLE!-

During the execution of a Process, it undergoes a no of States. These stages may be differ in different operating System and the names of these States are also not Standarcelized.



New State!- This is the state when the process is just created - It is the first state of a process.

Ready State!- After the creation of the process, when the process is ready for its execution then it goes in the ready state. In a ready state, the process is ready for its execution by the CPU but it is waiting for its turn to come.

Running State!- The process present in the ready state, the CPU chooses one process amongst them by using some CPU scheduling algorithm. The process will now be executed by the CPU and is in the running state.

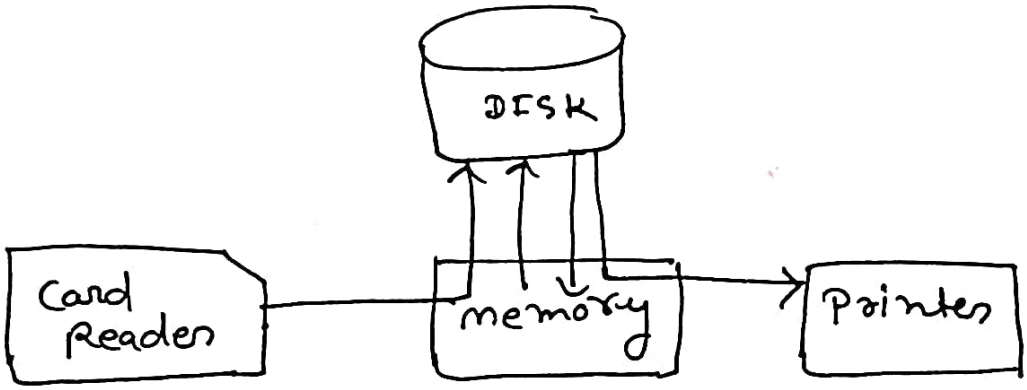
Waiting or Blocked State!- During the execution of the process. The process might require some I/O operation like writing on file, or some more priority process might come. on file in these situations the running process will have to go into the waiting or blocked state and the other process will come for its execution.

Terminated State!- After the complete execution of the process. The process comes into the terminated state and the information related to this process is deleted.

SPOOLING:- Spooling stands for simultaneous Peripheral operations online".

In Spooling more than on I/o operations can be performed simultaneously. Such as at the time when the CPU is executing some Process then more than one I/o operation can also be done at the same time.

⇒ Spooling refers to putting data of various I/o Jobs in a buffer. This buffer is a special area in memory or Hard disk which is accessible to I/o devices.



(Spooling Process)

Advantages of Spooling:-

⇒ Since there is no interaction of I/o devices with CPU. So the CPU need not wait for the I/o operation to take place. The I/o operation take a large amount of time.

⇒ The CPU is kept busy most of the time and hence it is note in the idle state which is good to have a situation.

⇒ more than one I/O devices can work simultaneously.

⇒ The spooling operation uses a disk as a very large buffer.

SCHEDULERS IN OPERATING SYSTEM!-

A Scheduler is a special type of system software that Handles Process Scheduling in numerous ways.

Process Scheduling Handles the selection of a Process for the Processor on the basis of a scheduling algorithm and also the removal of a Process from the Processor.

It mainly Selects the Jobs that are to be submitted into the system and decides whether the currently running Process should keep running or not. If not then which Process should be the next one to run.

It is an important Part of multiprogramming operating System.

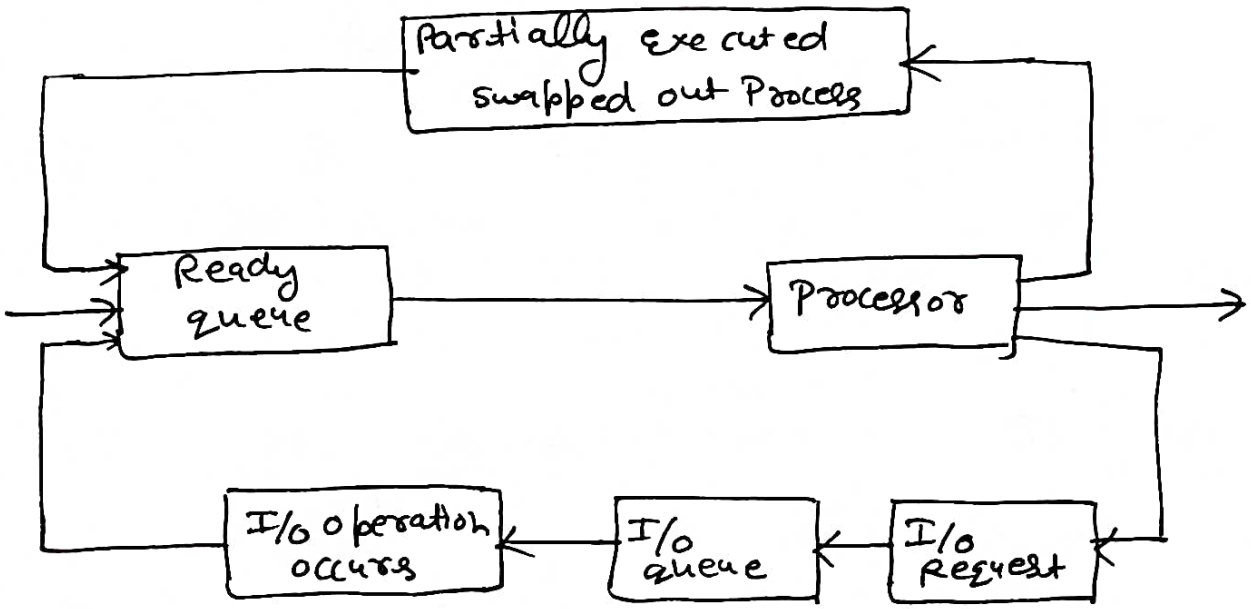
Types of Schedulers!-

(1) Long- term Scheduler
(2) Short- term Scheduler
(3) medium- term Scheduler

(1) Long term Scheduler:- Long term scheduler is also known as Job Scheduler

It chooses the Processes from the pool (secondary memory) and keeps them in the ready queue maintained in the Primary.

It selects and loads the Processes into the memory for execution with the help of CPU Scheduling. It Provides a balanced combo of Jobs, such as I/O bound and Processor bound and controls the degree of multiprogramming.



(CPU Scheduler)

(2) Short-term Scheduler:- A Short-term Scheduler also known as a CPU Scheduler increases system performance as per the chosen set of criteria. This is the change of ready & state to running state of the Process.

It selects a Process from the multiple Processes that are in ready state in order to execute it and also allocates the CPU to one of them. It is faster than long-term schedulers and is also called a dispatcher as it makes the decision on which Process will be executed next;

(3) Medium term Scheduler:-

Medium term Scheduler takes care of the swapped out Processes. if the running state Processes needs some Io time for the completion then there is a need to change its State from running to waiting

It is helpful in reducing the degree of multiprogramming. swapping is also ~~helpful~~ useful to improve the mix of I/O bound and CPU bound Processes in the memory.

Comparison of Schedulers:-

Long Term Scheduler	Short term Scheduler	medium term Scheduler
(1) A Job Scheduler	(1) A CPU Scheduler	(1) A Process Swapping Scheduler.
(2) Slowest Speed.	(2) Fastest Speed	(2) Speed is b/w the other two.
(3) Controls the degree of multiprogramming.	(3) Provides less control over the degree of multiprogramming.	(3) Reduces the degree of multiprogramming.
(4) Absent or minimal in the time-Sharing OS.	(4) minimal in time-Sharing OS.	(4) Part of time-Sharing OS.
(5) Selects a process from Pool and loads it into memory for execution.	(5) Selects a Process that is ready for execution.	(5) Re-introduces Processes into memory for continued execution.

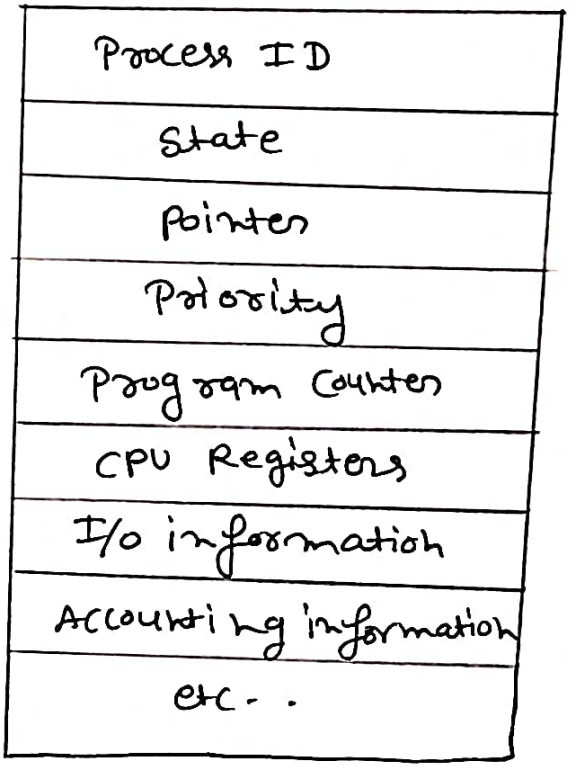
Process Control Block (PCB) / Task Control Block (TCB)

A Process Control Block (PCB) contains information about the Process.

A Process control block is a data structure maintained by the operating system (OS) for every Process.

The PCB is identified by an integer Process ID (PID).

A Process Control Block (PCB) keeps all the information needed to keep track on a Process.



Pointer:- It is stack Pointer which is required to saved when the Process is switched from one state to another to retain the current position of the Process.

Process State:- It stores the respective state of the Process.

Process Number:- Every Process is assigned with a unique id known as Process ID or PID which stores the Process identifier.

Process Counter:- It is stores the counter which contains the address of the next instruction that is to be executed for the Process.

Register:- There are the CPU registers which includes: accumulator, base registers and general Purpose register.

memory limits:- The field contains the information about memory management system used by operating system this may include the Page table. Segment tables etc.

open file list:- This information includes the List of files opened for a Process.

PROCESS SCHEDULING QUEUES:-

The operating system all PCB in Process scheduling queues.

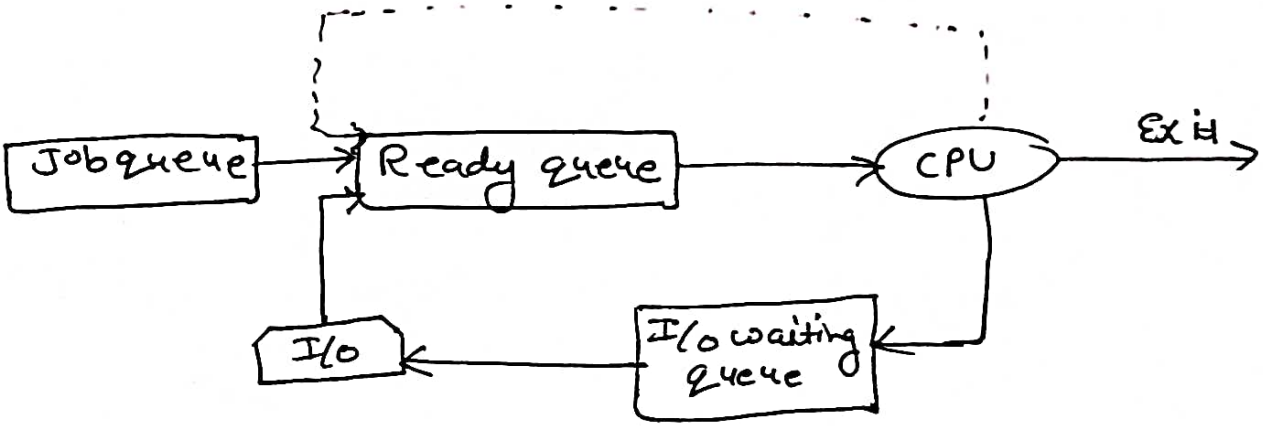
The operating system maintains a separate queue for each of the Process States and PCBs of all Processes in the same execution state are Placed in the same queue.

⇒ When the state of a process is Changed its PCB is unlinked from the current queue and moved to its new state queue.

Job queue:- This queue keeps all the Processes in the system.

Ready queue:- This queue keeps a set of all Processes residing in main memory ready and waiting to execute. A new Process is always put in this queue.

Device queue:- The Processes which are blocked due to unavailability of an I/O device constitute this queue.



Spooling:- Spooling is a process in which data is temporarily held to be used and executed by a device Programor system. Data is sent to and stored in memory or other volatile storage until the Program or computer requests it for execution.

VIRTUAL MACHINE:-

A virtual machine (VM) is a virtual environment which functions as a virtual computer system with its own CPU, memory, network interface, and storage, created on a Physical h/w system.

VMs are Isolated from the rest of the system, and multiple VMs can exist on a single piece of H/w like a server. That means, it as a simulated image of application S/w and OS which is executed on a Host computer or a server.
It has its own OS and S/w that will facilitate the resource to virtual computers.

Types of virtual machine:-

There are distinct types of VM available all with distinct functionalities.

(1) System virtual machines:-

These types of virtual machines are also termed as full virtualization VMs. It facilitates a replacement for an actual machine. These VMs offers the functionality required

for executing the whole OS. A hypervisor applies native execution for managing and sharing Hardware. It permits for more than one environment that is separated from each other while exists on a similar physical machine. Novel hypervisor applies virtualization specific H/w and h/w-assisted virtualization from various host CPUs primarily.

Process virtual machines:- These virtual machines are created for executing several programs of the computer within the Platform-independent environment.

Advantages of virtual machine:-

⇒ virtual machine facilitiates compatibility of the S/w which is executing on it. Hence, each S/w specified for a virtualized Host would also execute on the VM.

⇒ It offeres isolation among distinct types of Processors and OSes. Hence the Processor OS executing on a single virtual machine change the host of any other host systems and virtual machines.

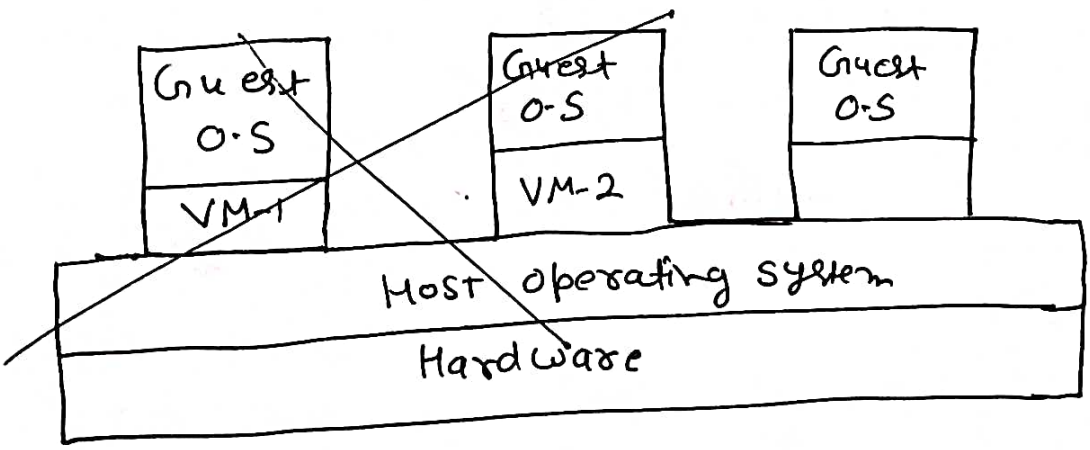
⇒ virtual machine facilitates encapsulation various S/w present over the VM could be controlled and modified.

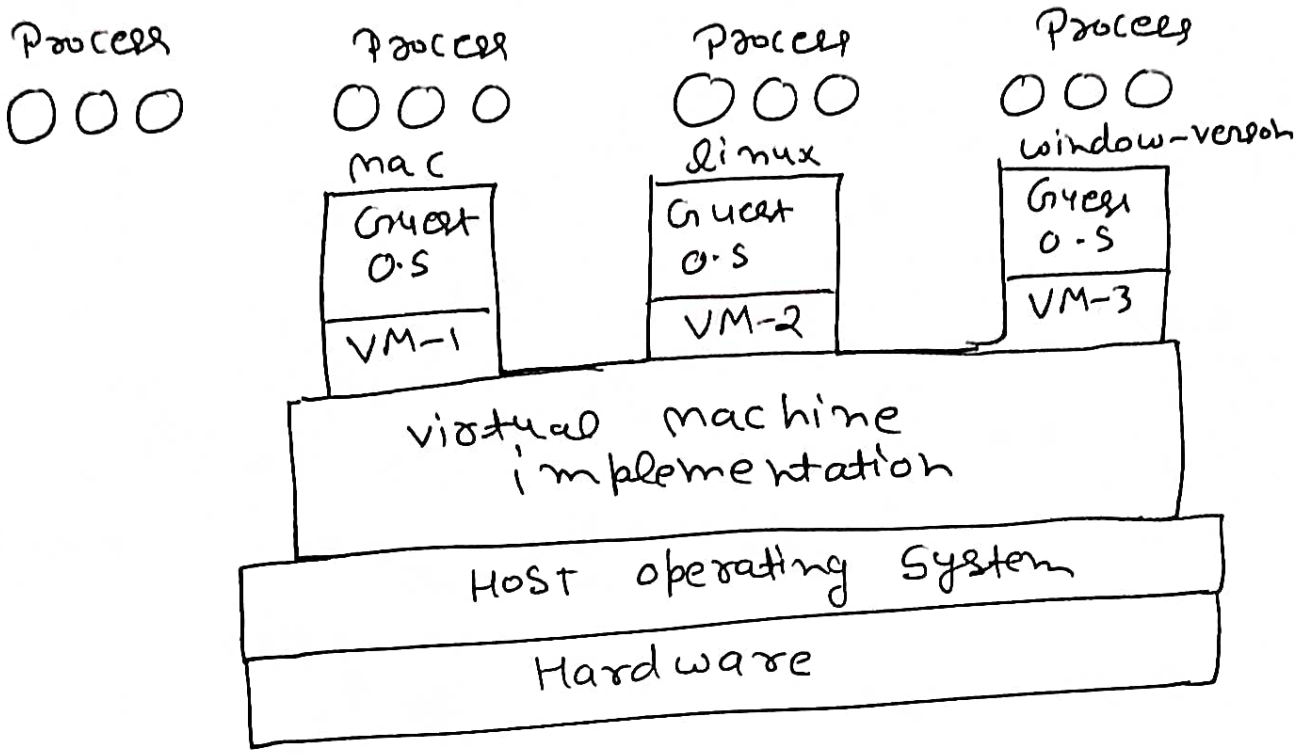
⇒ virtual machine give several features such as the addition of new operation System. An error in a single operating System will not affect any other operating system available on the host. It offers the transfer of many files b/w VMs and no dual booting for the multi- OS Host.

⇒ VM Provides better management of S/w because VM can execute a complete Stack of Software of the run legacy operating System host, machine etc.

⇒ It can be Possible to distribute h/w Resource to S/w stacks independently. The VM could be transferred to district computers for Balancing the Load.

Process Process Process Process





(virtual machine (VM))

PRIORITY SCHEDULING ALGORITHM:-

In Priority Scheduling, there is a Priority number assigned to each Process.

There are two types of Priority scheduling algorithm exists.

(1) Preemptive
(2) Non Preemptive.

* if the Priority number doesnot change it self throughout the Process, It is called Static Priority, while keeps Changing it self at regular intervals it is called dynamic Priority.

Example of Non-Preemptive Algorithm:-

Ex1 In the CPU Scheduling Policy is Preemptive Priority calculate the average waiting time & average turn around time. (Lesser the number Higher the Priority).

Process	Priority	Arrival time(AT)	Burst Time(BT)
P1	2	0	3
P2	6	2	5
P3	3	1	4
P4	5	4	2
P5	7	6	9
P6	4	5	4
P7	10	7	10

Eg

Non Preemptive Priority Scheduling

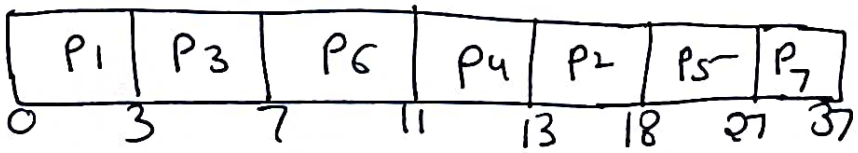
Process ID	Priority	Arrival time (AT)	Burst time (BT)	Completion time (CT)	Turn around time (TAT)	Waiting time (WT)	Response time (RT)
P_1	2	0	3	3	3	0	0
P_2	6	2	5	18	16	11	11
P_3	3	1	4	7	6	2	2
P_4	5	4	2	13	9	7	7
P_5	7	6	9	27	21	12	12
P_6	4	5	4	11	6	2	2
P_7	(0CL)	7	10	37	30	20	20

Criteria = "Priority"

mode = Non-Preemptive

Step 1

Gantt Chart



Turn around time (T.AT) = CT − AT

P_1 (TAT) = 3 − 0

$P_1 = 3$

P_2 (T.AT) = CT − AT

= 18 − 2

$P_2 = 16$

P_3 (T.AT) = CT − AT

= 7 − 1

$P_3 = 6$

T·AT (P_4) = CT − AT

= 13 − 4

$P_4 = 9$

T·AT (P_5) = CT − AT

= 27 − 6

$P_5 = 21$

T·AT (P_6) = CT − AT

= 11 − 5

$P_6 = 6$

T·A·T (P_7) = CT − AT

= 37 − 7

$P_7 = 30$

Average turn around time = $\frac{P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7}{7}$

$= \frac{3 + 16 + 6 + 9 + 21 + 6 + 30}{7}$

$= \frac{25 + 30 + 6 + 30}{7}$

$= \frac{25 + 66}{7}$

$= \frac{91}{7}$

Avg T·A·T = 13 units

Ex Consider the following Process:

Process	Burst Time
P_1	7
P_2	5
P_3	6
P_4	3

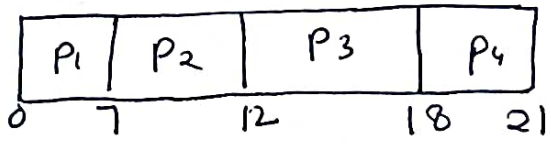
What is the average waiting time and turnaround time for these Process with FCFS scheduling.

Sol

Process	Burst time	Arrival time
P_1	7	0
P_2	5	0
P_3	6	0
P_4	3	0

Step 1:

Gantt Chart:



wai

turn around time of all Process

TAT (P_1) = Completion Time − Arrival time

P_1 = 7 − 0

P_1 = 7

TAT (P_2) = CT − AT

= 12 − 0

= 12

TAT (P_3) = CT − AT

$= 18-0$

$= 18$

$TAT(P_4) = 21-0$

$P_4 = 21$

Average Turn around time (TAT) $= \frac{P_1+P_2+P_3+P_4}{4}$

$= 0$

$= \frac{7+12+18+21}{4}$

$= \frac{58}{4}$

$= 14.5$ unit

waiting time = Turn around time - Burst time

$WT(P_1) = 7-7$

$WT(P_1) = 0$

$WT(P_2) = 12-5$

$= 7$

$WT(P_3) = 18-6$

$= 12$

$WT(P_4) = 21-3$

$= 18$

Average waiting time $= \frac{P_1+P_2+P_3+P_4}{4}$

$$= \frac{0+7+12+18}{4}$$

$$= \frac{37}{4}$$

$$= 9.25$$

Average waiting time = 9.25 Ans

Ex3 consider the following Process

Process	Burst time
P_1	2
P_2	5
P_3	3
P_4	9
P_5	4

what is the average waiting time and turn around time for these Process with FCFS scheduling.

Sol we consider all Process arrival time = 0

Process	Burst time	arrival time
P_1	2	0
P_2	5	0
P_3	3	0
P_4	9	0
P_5	4	0