

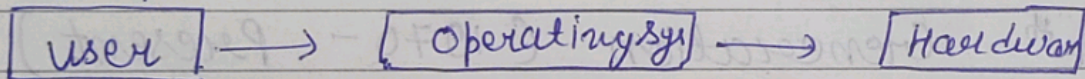
OPERATING SYSTEM

1- Basic of Operating system.

Definition - Generations of O.S - Types of operating system, Multi programming, Real time, Embedded and time sharing.

-: Operating system :-

An operating system can be defined as the interface between user and hardware. It manages hardware and software resources of a computer.



Generation of O.S :-

1st Generation :- (1940s - 1950s)

Early computer did not have operating system. they were operated manually with switches, punch cards, or paper tapes.

2 → 2nd Generation (1950 to 1960)

In this generation computers used batch programming processing system. When similar jobs were processed together without user interaction during execution.

3 → 3rd Generation (Mid 1960 - 1970)

Multiprogramming was introduced allowing multiple programs to run simultaneously. Time sharing system were also developed allowing multiple users to interact with the system at the same time.

4 → 4th Generation (1970 - Present)

The development of personal computers (PCs) led to the creation of user friendly O.S like MS DOS, windows, Mac OS, Linux. These OSes brought graphical user interfaces (GUIs) and multitasking capabilities.

5 → 5th Generation : (Present and Beyond)

Modern operating system support distributed computing, where resources are shared across multiple machines. Cloud-based OS and virtual machines allow system to run across remote servers.

Types of Operating system :-

1- Batch Operating System :-

In a batch OS, similar jobs are grouped together and processed without user interaction. The jobs are stored in queue, and the system process them one by one.

2- Time sharing operating system (Multi-tasking)

Time sharing OS allows multiple users to use the computer simultaneously. The CPU switches between tasks quickly, providing the illusion that all tasks are running at the same time.

3- Distributed Operating system :-

Distributed OS manage a group of independent computers and makes them appear as a single system. This allow resources sharing across machines.

4- RTOS (Real Time O.S)

RTOS is used in system where processing needs to be done in a fixed time constraint. It is common in system like embedded devices, robots and scientific research.

5- Multiprogramming Operating System:-

In a multiprogramming OS program are loaded into memory and the CPU switches between them to ensure efficient resource use.

6- Network Operating System:-

A network OS allows computers to communicate and share resources over a network.

Example :- windows server, Unix, Linux

7- Mobile Operating System:-

A mobile OS is specifically designed for smartphones, tablets and other handheld devices ex. Android and iOS

8- Embedded Operating System:-

An Embedded OS is designed to work on embedded systems, which are small scale systems that are part of larger devices like microwaves, washing machines.

9- Single user single task $\Rightarrow$ One task, one user

10- Multi user OS $\Rightarrow$ Multiple user access the system

Components of O.S:-

- 1) file management
- 2) security management
- 3) Process management
- 4) Secondary storage management
- 5) Network management
- 6) Input output management

There are 4 types

- 1) Real time Embedded OS $\Rightarrow$ System focus on meeting real time performance requirements, meaning tasks must be completed within specific time
- 2) Standalone Em OS $\Rightarrow$ These are simple, independent systems that perform a single dedicated task.
- 3) Network Em OS $\Rightarrow$ These system are designed to work over networks
- 4) Mobile Em OS $\Rightarrow$ These system are used in mobile devices.

Operating system is the system software which interface between computer user & Main OS.
 Main OS $\Rightarrow$ Linux, Windows, MacOS, Android, iOS, MS DOS, Symbian OS.

WORK OF O.S :- Function of O.S

- 1) Operating system is the main program of computer.
- 2) They complete many works.
- 3) They show the output on screen.
- 1) Memory Management :- Primary memory management called memory management.
- 2) Processor Management $\Rightarrow$ Multiprogramming Environment.
 मे OS यह करता है कि किस प्रक्रिया को उपयोग करने के लिए अब और कितने समय के लिए देना है, इसे process scheduling कहा है, OS के जिस प्रोग्राम उपयोग,
 3) Device management $\Rightarrow$ होता है उसे $\Rightarrow$ Traffic Controller.
- 3) Device Management :- device management involves tracking the status of all devices managing communication between the OS and devices.
- 4) File management :- that handles the creation storage, retrieval and organization of data files.

5) Security :- Computer security is critical to ensure that sensitive data remains confidential, intact and available to authorized user only.

Types of O.S :-

- 1) Multisuser O.S $\Rightarrow$ इस से ग्रहण user को एक साथ कार्य करने में permission provide करता है, ये computer network में प्रयोग किया जाता है।
- 2) Single user $\Rightarrow$ एक समय में एक केवल एक कार्य।
- 3) Multitasking $\Rightarrow$
- 4) Multiprocessing $\Rightarrow$
- 5) Network O.S
- 6) Distributed O.S
- 1) Real time O.S $\Rightarrow$
 $\rightarrow$ Hard $\Rightarrow$ These system have strict time constraints.
 $\rightarrow$ Soft $\Rightarrow$ less strict constraints.
 $\rightarrow$ Input $\rightarrow$ quick Response, $\rightarrow$ Limited time
 is a software that runs real-time application that must process data as soon as it comes and provides immediate response.
 यह विशेष प्रकार का OS जिसे data process करने के लिए decision time limit के according output देना।

OPERATING SYSTEM COMPONENTS

Real time OS

(RTOS) is an operating system that is designed to process data and events in real time, ensuring tasks are completed within a specific time, ensuring constraint. RTOS is used in systems that require immediate and deterministic responses to events. (निर्धारित प्रतिक्रिया)

उदाहरण → सड़क निर्माण समय सीमा के भीतर पूरा होना चाहिए
There are 3 types

1) Hard real time system :-

In hard real time system task must be completed within a strict deadline, and missing the deadline could lead to

(catastrophic) catastrophic failure.

Ex → Flight control system and industrial robot.

2) Soft real time system
Deadlines are important but not as strict as hard real-time system. Missing a deadline occasionally doesn't result in a total system failure. Ex → Video streaming, online game.

3) Firm real time OS
Missing the deadline may degrade the quality of the system's performance but it will not cause total failure. Ex → banking system.

Examples of Operating System :-

1) Windows :- Windows is the (GUI) graphical user interface based operating system. That developed by Microsoft. It allows perform many task like running application, file management, browsing the internet and playing games. It supports multitasking meaning you can run application simultaneously (एक साथ दो या दो से अधिक कार्य).

2) Mac OS → Mac OS developed by Apple, design is known for sleek (सुंदर) design and user friendly interface. It is the OS for Mac computers. They integrate with other apple devices.

3) Linux → Linux is open source OS widely used in server, embedded system and desktop environment. It is known for security, stability and flexibility. Linux can be customized according to the user's needs.

4) Unix → Unix is multiuser, multi-tasking OS. used mainly in servers, work station and large computing environments. It is known for these powerful command line interface and high stability.

OPERATING SYSTEM COMPONENTS

- Basic function of O.S
- * Process Management Component -
 - * Memory Management -
 - * I/O Management -
 - * File Management -
 - * Protection System -

Process Management Component :-

Process management involves overseeing the execution of process in a system to ensure efficient use of resources and smooth operation.

इसका उद्देश्य सिस्टम में चलने वाली प्रक्रियाओं का प्रबंधन करना, ताकि संसाधनों का प्रभावी उपयोग हो और system सुचारु रूप से चले,

- * The main components of Process Management

1) Process creation and Termination :-

Creation :- The operating system must be able to create new process as needed; for example when a user opens an application.

Termination :- Process are terminated either when they finish execution or if they need to be stopped manually.

(A task is killed)

▷ Fork ▷ Exec

▷ Exit

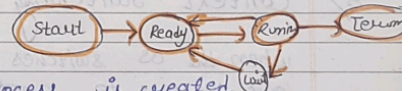
2) Process Scheduling :-

- **Scheduler :** Determine which process gets to use the CPU and for how long. It switches between processes to ensure that all active process get adequate CPU time; यह प्रक्रियाओं के बीच switch करता है ताकि सभी सक्रिय प्रक्रियाओं को CPU मिल सके,

- **Types of Scheduling :-** includes preemptive scheduling (where the OS can interrupt a process) and nonpreemptive scheduling (where a process runs until it finishes) जहाँ प्रक्रिया तब तक चलती है जब तक वह समाप्त न हो।

3) Process State and State Transition :-

State of Process



- **New :** when a process is created
- **Ready :** The process is ready to be executed
- **Running :** The process is currently being executed by the CPU.
- **Waiting :** The process waiting for an (I/O operation) event
- **Terminated :** The process has finished execution.

Components →

4) Process Control Block (PCB)

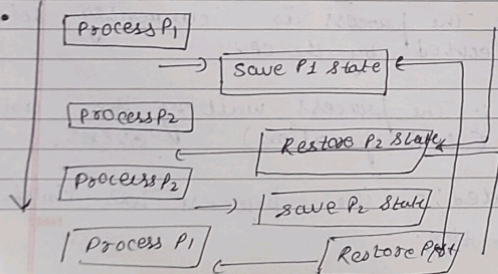
The PCB is a data structure used by the operating system to store information about a process. This includes

Process id	
State	✓
Pointer	✓
Priority	✓ <i>degree</i>
Program Counter	✓
CPU registers	✓
I/O inform	✓
Accounting info	✓
etc	

5) Context Switching

When the OS switches the CPU from executing one process to another, it must save the current process's state (context) and load the new context.

CPU

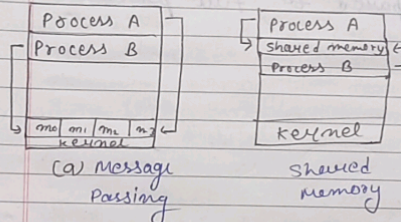


6) Inter Process Communication :- (IPC)

IPC mechanisms allow processes to communicate and synchronize with each other. This is critical when processes share data or need to coordinate their execution.

IPC can be achieved using techniques like

- Pipes
- Message Queues
- Shared memory
- Semaphores



⇒ Process Synchronization :-

When multiple process access shared resources (like file or memory) there needs to be coordinate to prevent conflicts or race conditions

8) Deadlock Handling:-

Deadlock occurs when two or more processes are stuck waiting for resources that are being held by other processes, leading to an impasse.

9) Threads:-

Threads are lightweight processes that share the same resources (like memory) but can run independently. Threads reduce overhead compared to full processes.

Memory:-

Memory is the faculty of the brain by which data or information is encoded, stored and retrieved when needed.

It is responsible for storing data and instructions that the CPU uses to perform operations.

Types of Memory:-

1) Primary Memory:- This is the memory directly accessed by the CPU to perform read and write operations. Primary memory is fast but limited in size.

There are 2 types

1) RAM $\Rightarrow$ Random Access Memory:- Temporarily store data and programs that are currently in use.

* data is lost when power is off.
 $\Rightarrow$ DRAM @ SRAM

2) ROM (Read-Only Memory):- Permanently stores important data/instructions.

Non-volatile (data is retained even when the power is off)

Type of ROM

1) PROM
2) EPROM

3) EEPROM

2) Secondary Memory:-

This memory is used for long term data storage. It is not directly accessed by the CPU.

- 1) HDD (Hard Disk Drive)
- 2) SSD (Solid State ")
- 3) USB Drives

3) Cache Memory:-

A high speed memory located between the CPU and RAM used to store frequently accessed data for quick retrieval.

- ▷ L1 Cache
- ▷ L2 "
- ▷ L3 "

4) Virtual Memory:-

A memory management technique where part of the hard drive is used as additional RAM. It allows to run larger programs.

MEMORY ORGANIZATION:-

Memory Organization refers to how memory is structured and managed in a computer system. It involves the arrangement of memory components, addressing schemes, and techniques for efficient access and management of data.

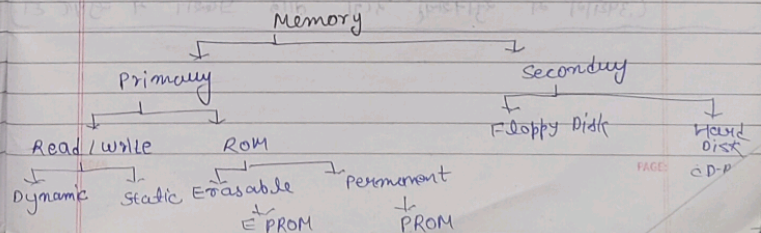
1) Registers:- small, high-speed storage locations within the CPU used to store data that is being processed.

2) Cache memory:- A small, fast memory located between the CPU and main memory.

3) Main memory (RAM) ⇒ volatile memory used to store programs and data that are currently in use.

4) Secondary Memory:- Non-volatile memory used for long-term storage.

5) Memory Addressing:- Each memory location has a unique address to access data.



* MEMORY MANAGEMENT :-

Memory management refers to the system approach to managing memory allocation, deallocation, and usage efficiently. It ensures that program or application can use memory resources without running into issue like memory leaks, fragmentation or insufficient memory errors.

- 1) Memory Allocation :- Assigning memory to a program or task
प्रोग्राम या कार्य को मेमोरी प्रदान करना
- 2) Memory Deallocation :- Releasing memory when it is no longer needed.
जब मेमोरी की आवश्यकता न हो उसे छोड़ना
- 3) Garbage Collection :- Automatically freeing unused memory to prevent usage of memory leaks.
अनावश्यक मेमोरी को स्वचालित रूप से मुक्त करना ताकि मेमोरी लीक से बचा जा सके
- 4) Memory Optimization :- Ensuring efficient usage of memory to maximize performance.
(उपयोग को सुनिश्चित करना ताकि प्रदर्शन में सुधार हो)

Input-Output Management :-

The operating system is in charge of handling various types of input, such as those from the keyboard, mouse and desktop. Regarding all types of inputs and outputs the OS handles all interfaces in the most appropriate manner (तरीके) (सबसे उपयुक्त)

O.S विभिन्न प्रकार के inputs को संचालित का काम करता है, है, O.S सभी interface को उपयुक्त तरीके से संचालित है।

Input output management refers to how a computer system handles the communication between its CPU and its peripherals, such as storage devices, printers, keyboards, monitor etc.

I/O प्रबंधन कंप्यूटर प्रणाली में CPU और उसके परिधीय उपकरणों के बीच संचार को संचालित करने का काम करता है।

- 1) I/O Devices :- Device send data to the computer (keyboard, mouse)
- 2) O/P Devices :- Device that receive data (monitor, printer)
- 3) Storage Device :- device that provides data storage and retrieval (hard devices, SSD's)

OS is responsible for the following activities with respect to I/O Device management.

1) Hide the detail of (H/W) Hardware work devices

2) Manage Main memory for the device using cache, buffer and spooling
use करके डिवाइस के लिए मुख्य मेमोरी प्रबंधित करते हैं,

I/O प्रबंधन के मुख्य घटक (Main Components)

1) I/O controllers

These are hardware components that control and manage the communications between the CPU and the I/O devices. (संचार नियंत्रित करते हैं)। They act like intermediary, managing signals and data transfer between the device and the system.

2) I/O Ports :-

Interface through which input and output devices connect to the computer system. Example: USB port, HDMI.

3) I/O channels :-

These are pathway to data transfer between the I/O devices and CPU. They ensure smooth data flow without overloading the CPU.

4) I/O Buffering :-

Buffering refers to temporarily storing data in a memory buffer while it is being transferred between the CPU and I/O devices. This helps improve performance.
बफरिंग प्रक्रिया में डेटा को अस्थायी रूप से स्टोर किया जाता है ताकि CPU और I/O devices के बीच डेटा transfer बिना रुकावट के हो।

5) I/O Scheduling

This is the process by which the OS decides the order in which I/O operations should be performed (I/O operation किस रूप में किए जाएंगे)

6) Device Drivers :-

Device drivers are specialized software. They are used to allow the OS to communicate with I/O devices (OS को I/O devices के साथ संवाद करने में मदद करते हैं)

7) Spooling :- error handling

I/O management errors also deal with errors that arise during data transmission. Common I/O errors include device not ready, out of space, or hardware failures.

8) Spooling :- (Simultaneous peripheral operations on line)

is a process where data is temporarily held in a queue or buffer in waiting for an I/O device (like a printer) to be ready.

(प्रक्रिया है जिसमें डेटा अस्थायी रूप से होता या बफर में संग्रहीत किया जाता है, जब तक I/O उपकरण)

File Management:-

file management refers to the process of organizing, storing and maintaining files on a computer or other storage devices as well as organizing them in a structured way to ensure easy access and retrieval.

File management main components:-

- 1) File creation :- The process of generating new files or document
- 2) File naming :- Assigning meaningful names to files or easy identification
- 3) File organization :-
- 4) File security
- 5) File sharing
- 6) File Deletion :- Permanently removing unnecessary files to free up space
- 7) File Backup and Recovery :- Ensuring important files are backed up and can be recovered in case of data loss.

Protection System:-

The protection system in an operating system is responsible for ensuring that resources, such as memory, files, CPU and devices are used properly and safely by different programs and users.

विभिन्न प्रोग्राम और उपयोगकर्ता सिस्टम संसाधनों जैसे memory, files, CPU and devices का सही और सुरक्षित रूप से उपयोग करे

It prevents unauthorized access.
(अनुमति के बिना)

They provide security by password similar other techniques. It prevents unauthorized access to programs and data.

UNIT-3

-i PROCESSES :-

- * Definition
- * Process Relationship
- * Process States
- * Process state transitions
- * Process control Block.
- * Context switching

Processes :-

(निर्दिष्ट) (निर्दिष्ट)
A process is essentially a program in execution. When a program runs, it becomes a process including the program code, current activity and the system resources it is using.
इसलिए जो प्रोग्राम चल रहा है, प्रोसेस कहलाता है जो निष्पादन में है, जो उस प्रोग्राम runs होता है और यह प्रोसेस कहलाता है।

Key components of the Process

- 1) Program Code :- The executable instruction.

1) PC (Program Counter) :- Tracks the next instruction to execute.

2) Memory :- Includes the process's code, data, and stack.

3) Process state :- Represents the current status (running, waiting).

4) Register :- Holds data for the current task which changes as the process executes.

5) Resources :- May include files, I/O devices or CPU time.

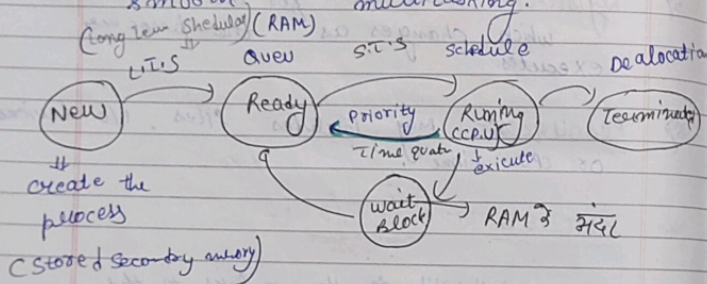
* PROCESS RELATIONSHIP :-

Process relationship refers to the interconnections and dependencies between different process or step within a system or workflow.

Process State :-

A process state represents the current condition or status of a process as it moves through various stages of execution within an O.S.

These state helps the operating system manage resources and ensure multitasking.



L.T.S ⇒ जहाँ से जहाँ program Ready Queue में लाना।

* Non Preemptive

Preemptive type of scheduling

↓
जहाँ से से running process को stop करना।

1) New ⇒ The process is being created. It hasn't yet entered the main memory and awaits admission to the ready state.
इसे अभी मुख्य मेमोरी में नहीं लाया गया है। और यह Ready अवस्था में प्रवेश करने में wait कर रही है।

2) Ready ⇒ The process has all the resources it needs (except the CPU) and is waiting to be assigned to a processor for execution.
और यह C.P.U. के द्वारा चलाने की प्रतीक्षा कर रही है।

3) Running :- The process is being executed on the CPU. Only one process per CPU can be in this state at any given time.

4) Waiting :- The process is unable to proceed because it's waiting for some event to occur, like I/O completion or a resource becoming available.

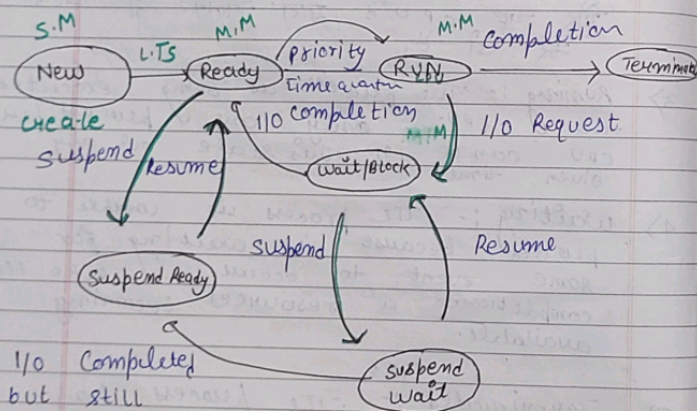
5) Terminated :- The process has completed execution and is ending. All resources are deallocated.

Process state transitions :-

(प्रयोग अवस्था परिवर्तन)

A process state transition is when a process changes state due to an event. These states and transition depend on CPU scheduling and resources availability.

Schedule/Dispatch



I/O Completed but still suspend state :-

* Read to suspend Ready

When the main memory is full and a higher priority process need to be executed, a lower priority process transition from the ready to the suspend ready state.

:- New to Ready

After being loaded into the main memory and ready for execution, a process transitions from a new to ready state.

Preempted :-

A process is preempted when it is removed from the running state by the scheduler. This can happen when higher priority becomes runnable, or when a process consumes its entire time slice. या जवाब और प्रयोग अपना पूरा समय slice से लेती है।

* Process Control Block :- *

A process control block (PCB) is a data structure that stores information about a process being managed by an O.S. A PCB is also called a process descriptor or task control block (TCB).

Process Control Block Diagram

Process ID
Process state
Program Counter
Register
Memory Limits
List of Open file
I/O Status Information

- 1) Process ID: It shows the unique No. or ID of a particular process.
- 2) Process state: Tells the particular state in which a process is at that particular moment.
- 3) Program Counter: Indicates the address of the next instruction.
- 4) Register: That has to be executed for that particular process.
- 5) Memory limits: Contains memory allocation data, like base and limit registers.
- 6) List of Open file: base and limit registers.

Register: It tells us the registers that are being used by a particular process.

I/O Status Information: Detail about I/O devices assigned to the process.

Context Switching :-

Context switching in an O.S. that allows multiple processes to share a single CPU.

* How it works

When a context switch occurs, the OS saves the state of the current process, loads the state of the new process, and then resumes execution of the new process.

* Context switching ensures that processes do not conflict and enables multiple processes to run simultaneously.

UNIT - 4

* service provide by :- O.S

1> File system Management :-

- managing access to file such as reading, writing and modifying data.
- creation, deletion and manipulation of file and directories

2> Memory management

Allocation and deallocation

- * managing virtual memory and swapping to maximize memory utilization

3> Process "

creation and termination

4> Device "

5> security

6> I/O operations

O.S

↓

* collection of application that acts as an interface between hardware and software

Controls all of the computer resources and activities

Characteristics of O.S and feature :-

- 1> Device Management :-
- 2> File Management
- 3> Memory "
- 4> Process "
- 5> user interface

Type of O.S :-

- 1> Batch :-
- 2> Multiprogramming
- 3> Real time
- 4> Embedded
- 5> Time sharing

UNIT-4

- : Process Scheduling :- (Scheduling)

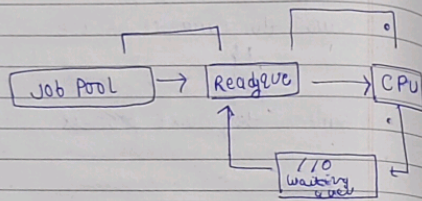
The process of selecting which process should be executed next in an operating system.

Type of Scheduling

Long term

Short term

- 1) Long Term
- 2) Short Term
- 3) Medium Term



Long	Short	Medium
1) it is a job scheduler	it is CPU scheduler	It is swapping
2) Speed is less than short term	speed is very fast	speed is medium
3) Control the degree of multiprogramming	less control degree of multiprogramming	Reduce the degree of multiprogramming
4) Absent or minimal in time sharing system	Minimal in TSS	TSS use medium term scheduler
5) Process state (New to Ready)	" " (Ready to Run)	" "

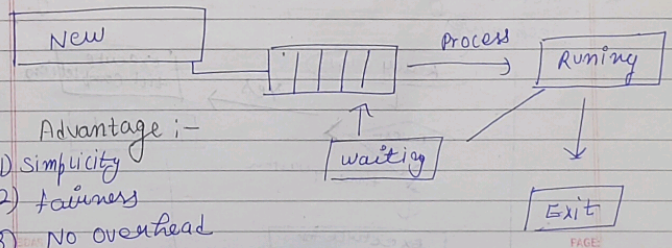
Scheduling :- is the process of organizing and planning tasks or event in a specific order.

Scheduling Algorithm

set of rules determine which task to execute at a given time.

- 1) FCFS - first come first serve
- 2) SJF - shortest job first
- 3) RR - Round Robin

1) First Come first serve (FCFS)
 that processes tasks in the order they arrive in a queue also known as FIFO



Advantage :-

- 1) Simplicity
- 2) Fairness
- 3) No overhead

* SJF (Shortest Job first)

is a scheduling algorithm that select the process with the smallest execution time to execute next

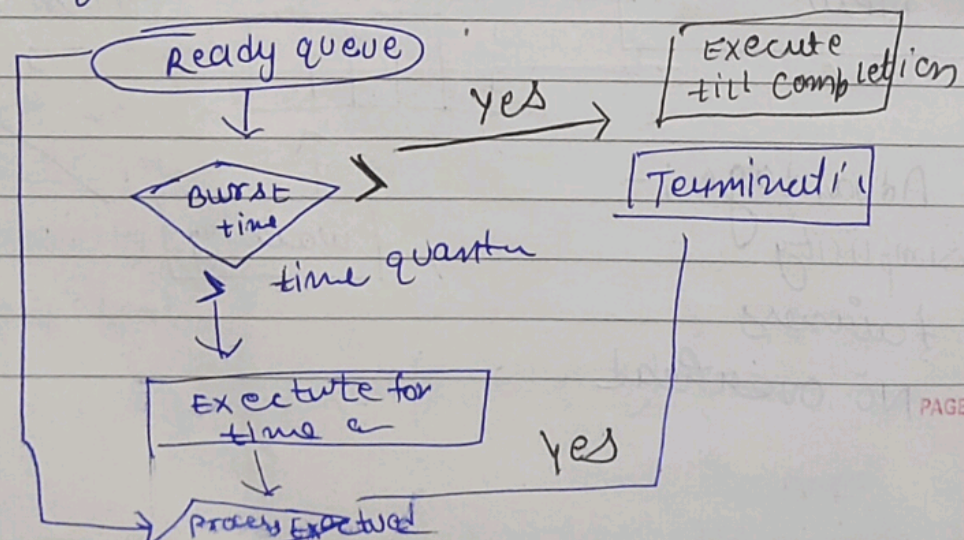
Advantage

- 1) Reduce the average waiting time
- 2) used for long term scheduling

* Round Robin

is a CPU scheduling algorithm where each process is cyclically assigned a fixed time slot.

- * It is preemptive version of FCFS
- * Generally focused on Time sharing techniques

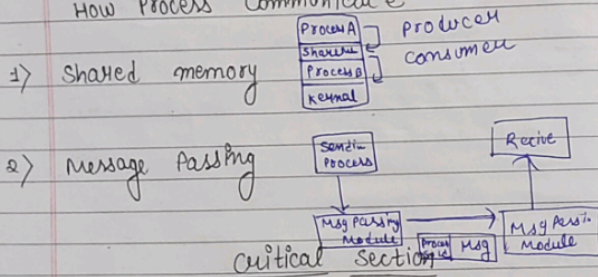


UNIT-5

Inter Process Communication

IPC is a set of methods that allow different processes or application in an O.S to communicate and share data.

How Process Communicate



When more than one processes try to access the same code segment that segment is known that critical section

They contains Shared Variable and resources

Tools to synchronization

- Mutex :- Ensure one process uses a resource.
- Semaphores :- Prevent conflicts.

UNIT-7

Memory Management

How OS Managed memory (RAM)

Memory Management :-

The process of controlling and allocating a computer's main memory.

Logical Address

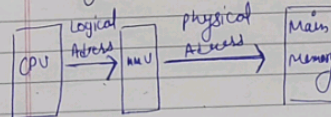
- 1) Generated by CPU
- 2) User can view the logical address of a Program
- 3) Not Physically exist
- 4) Varies
- 5) Vanished
- 6) It is used to access Physical address indirectly

Physical Address

- 1) Location in a memory unit.
- 2) User can never view Physical Address of Program.
- 3) Physically exist
- 4) Constant
- 5) Exit
- 6) Can't be access directly

Logical is virtual

Physical is actual



* Fragmentation :-

the process of breaking something into small pieces.

- * making is difficult to allocate

There are 2 types

- 1) Internal
- 2) External

1) Internal $\Rightarrow$ when a memory block is allocated to a process that is larger than the amount of memory requested.

- * wasted space inside blocks

2) External $\Rightarrow$ occur when free memory is divided into small blocks,

Wasted space outside blocks

- * Paging divided memory into small pieces
- * And divided the physical memory into same size-block ~~shape~~ (frame)

* Paging :-

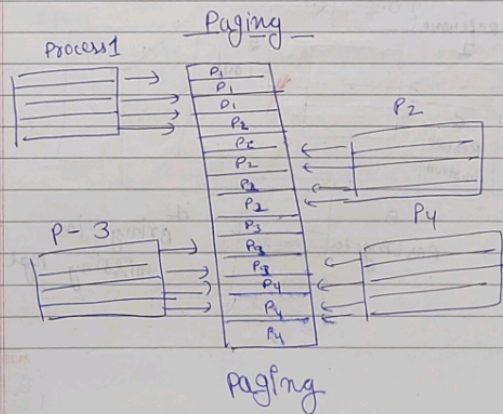
Memory Management technique in an OS that allows program to access virtual memory address and use secondary memory storage to exceed the size of the physical memory.

- * Divide memory into fixed size Pages

• Compaction :-

Process that moves memory around to create larger contiguous blocks of free memory.

जो मेमोरी को डब-डब ले जाकर free memory के बड़े हिस्से बना देती है,



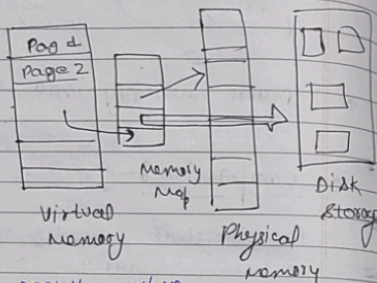
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Virtual Memory

is a memory management technique that allows a computer to use its hard drive or SSD (solid state drive) as if it were RAM

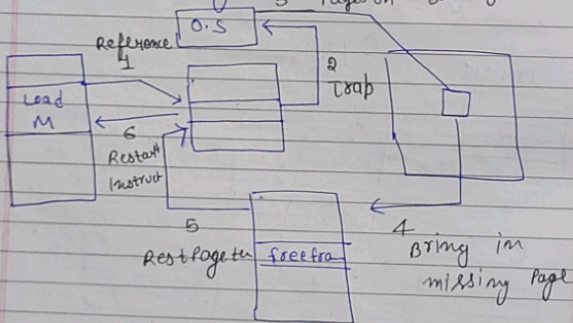
Two Type

- 1) Paging
- 2) Segmentation



* Page fault :-

An error that occurs when a program attempts to access data that is not currently in the main memory or RAM.



Working set :-

the collection of pages in the process's virtual address space that are currently in physical memory.

Dirty Bit

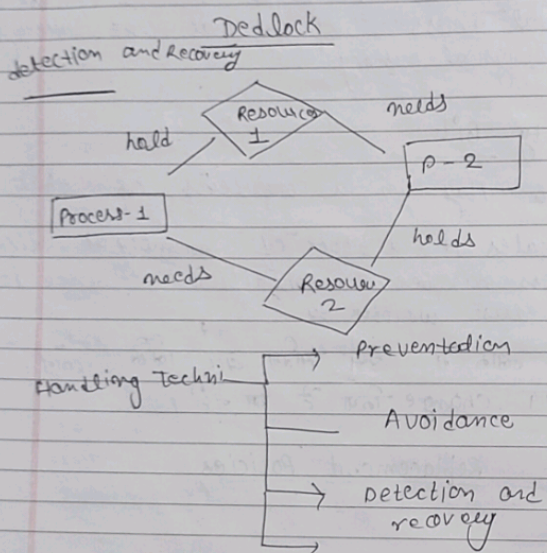
is a flag in a computer's OS that indicates if a block of memory or disk address has been modified since it was last written to.

जिसी ब्लॉक में उसे अंतिम बार लिखे जाने के बाद change किया है या नहीं।

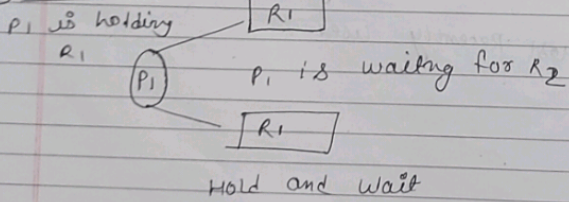
Page Replacement Policies

- 1) FIFO
- 2) LRU (Least Recently used)
- 3) Most Recently used

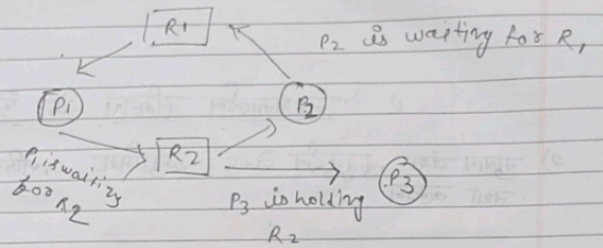
FILE MANAGEMENT



① Prevention:-



Avoidance



③ detection and Recovery :-

Prevention	(1)
Avoidance	(2)
Detection and Recovery	(3)
Hold and wait	(4)

Prevention	(1)
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Detection and Recovery	(3)
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