

2/3/23

Operating System (OS)



Operating System :-

Operating system is defined as an interface b/w the user and Hardware. It is responsible for all the processes, Resources Allocation, File management and CPU management and many other tasks. The purpose of an OS is to provide an

Types of OS :-

- ① Batch OS :- (one by one)
- ② Multiprogramming OS :-(Computer's OS doesn't sit idle).
- ③ Multitasking OS :- (Combination of Multiprogramming OS and CPU Scheduling)
- ④ Time Sharing OS :- (Requires interaction with the user through input devices)
- ⑤ Real time OS :- (dedicated systems use this OS to achieve / accomplish a specific set of task in within dead line).

Process :- A process is a program under execution
Program counter is the value that indicates the next address of instruction that is being executed.
of the process

Program Process Control Block represents each process.

Process Scheduling :-

- ① Arrival time (AT)
- ② Completion time (CT)
- ③ Burst time (BT)

- ④ Turn Around time
 $TAT = CT - AT$
- ⑤ Waiting time

$$WT = TAT - BT$$

Thread :- (child process of a given process)

1. It is a lightweight process.
2. Forms a basic unit of CPU utilization.
3. A Thread has its own Program counter, Stack, Register set.
4. A Thread shares resources with other threads of the same process : Code section, Data section, files, signals.

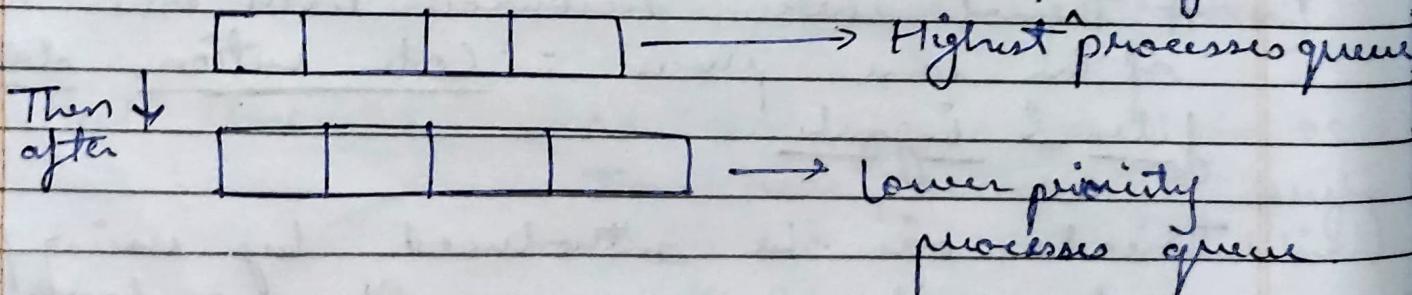
Threads can be introduced by using `fork()` system call. A process with `fork()` system call generates $2^n - 1$ child processes.

Two types of Threads :-

- ① User threads (implemented by user)
- ② Kernel threads (" " OS)

Preemptive - Running state to ready state
Non-Preemptive - Running from to waiting

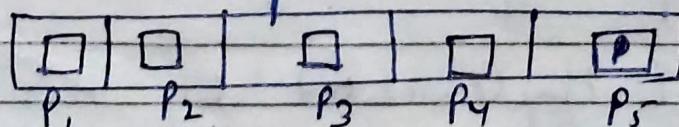
Scheduling Algorithms :-

1. First come first serve (FCFS)
2. Shortest Job first (shortest burst time)
3. Shortest Remaining Time first
4. Round Robin (Assigned a fixed time in a cyclic way).
5. Priority based Sched. (Non-Preemptive)
If $P_1 = P_2$ then according to Arrival Time.
6. Highest Response Ratio Next (HRRN)
A avoids Starvation
 $HRRN = (WT + BT) / BT$
7. Multilevel Queue Sched.
Then ↓ after


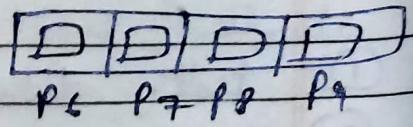
Then ↓ after

Highest priority processes queue

lower priority processes queue
8. Multilevel Feedback Queue Sched.
Processes separate based on their BT.



Higher priority (lower BT)



lower priority (High BT)

The Critical Section Problem :-

1. Critical Section :- Portion of code where shared variables are accessed and/or updated. in the program
2. Race around condition
2. Remainder Section :- The final output of the code is dependent on the order in which the variables are accessed.
3. Remainder Section :- The remaining portion of the code, excluding the critical section. in the program

Solution for critical Section :-

1. Mutual Exclusion
2. Progress.
3. Bounded waiting

Synchronization Tools :-

2. Semaphore :- It is an integer variable that solves the critical section problem. After initialization it can only be accessed by two atomic operations :-

1. wait (S)

{

while ($S <= 0$) ;

$S = S - 1$;

2. Signal (S)

}

$S = S + 1$;

}

Two types of Semaphores :-

1. Binary Semaphore :- 0 and 1 as value
Implement mutual exclusion
Synchronize concurrent processes
2. Counting Semaphores :- Integer value whose range is can be in unrestricted domain.
 $(-\infty \text{ to } \infty)$

Example program :-

```
do { initializations and initializations;
    {
        wait (S);
        // critical section
        Signal (S);
        // remainder section
    }
    while (T)
```

Mutex :- It is a program object.
Gives permission to processes to access Resources.

It is a key.

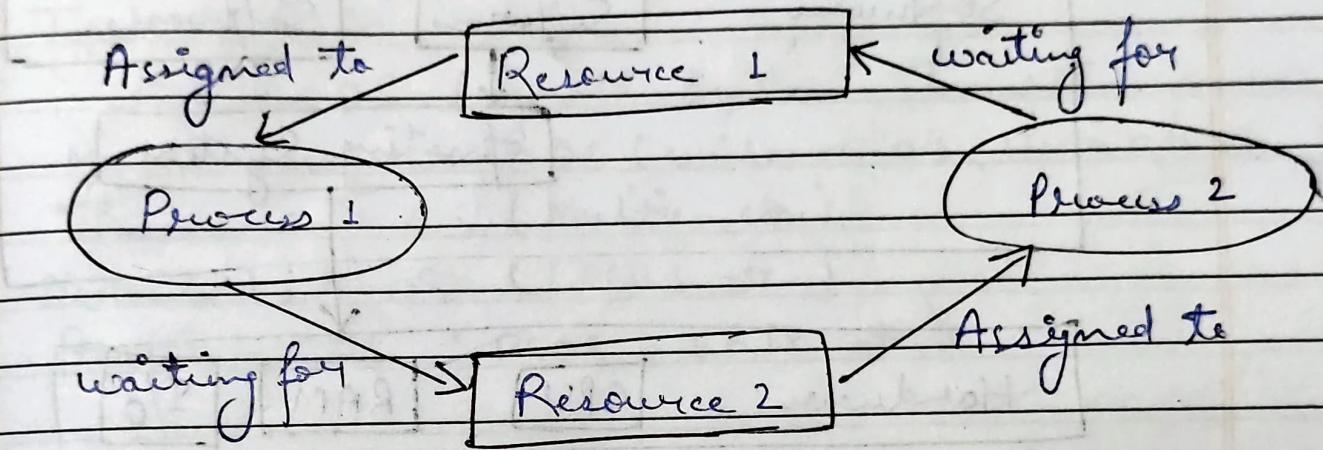
Only one thread at a time can have lock mutex.

Preempt - Forcefully taking resource for high priority process.

No Preempt - Don't use force, but wait for completion of process to release resource.

Deadlock :-

Each process is waiting for resource that is occupied by other process.

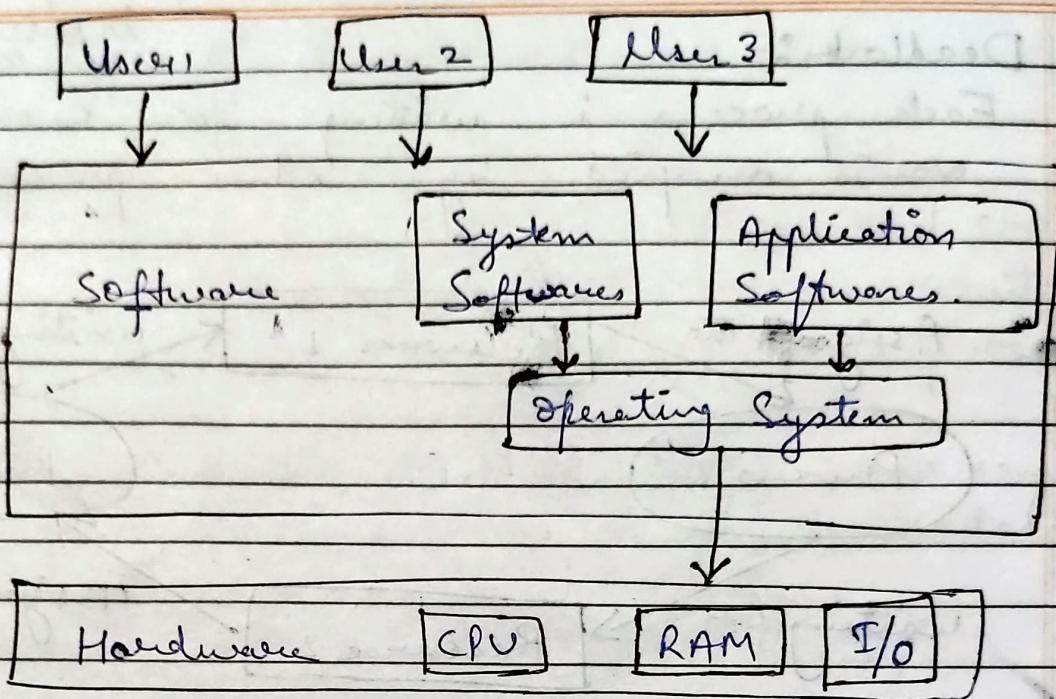


Necessary conditions for deadlock :-

1. Mutual Exclusion - Only one process at a time.
2. Hold and wait.
3. No preemption.
4. Circular wait.

Methods for handling deadlock :-

1. Deadlock prevention and avoidance. (avoid deadlock)
2. Deadlock detection and recovery. (do preemption)
3. Ignore the problems altogether. (reboot the system)



Functions of OS :-

- ① Acts as an Interface.
- ② Memory and Processor Management
- ③ Security
- ④ Scheduling of resources and jobs
- ⑤ Error Detection
- ⑥ File Management and Device management

Ans 1 Importance of OS :-

- ① Interaction b/w softwares installed on OS and user.
- ② Communicate with H/w and maintain balance b/w H/w and CPU.
- ③ Provides a platform to run SW on.

Ans 2 Main purpose of OS :-

- ① Execute user programs (S/w)
- ② Helps user to run applications and interact with them

- ③ Manage all computational activities
④ Manage CPU memory, processes, and operation of all HW and SW.

Type of OS

- ① Batched OS (Payroll System, Transaction process, etc.)
- ② Multi programmed OS (Windows O/S, UNIX O/S, etc.)
- ③ Timesharing OS (Multics, etc.)
- ④ Distributed OS (LOCUS, etc.)
- ⑤ Realtime OS (PSOS, VRTX, etc.)

Ans 3. A Multiprocessor system is a type of system that includes two or more CPUs and they all share same memory and multi programs can be executed on same time using this system.

Benefits of

- ① Improve performance in systems that are running multiple programs concurrently.
- ② less time for completing tasks.
- ③ cost effective as processors share same resources.
- ④ Reliability of the computer system.

Ans 4. RAID (Redundant Arrays of Independent Disks) is a method to store data on multiple disks therefore it is considered as data storage virtualization technology.

Balances data protection, storage space, system performance, etc.

It is used to achieve data redundancy to reduce data loss.

- (3) Manage all computational activities.
- (4) Manage CPU memory, processes, and operation of all H/w and S/w.

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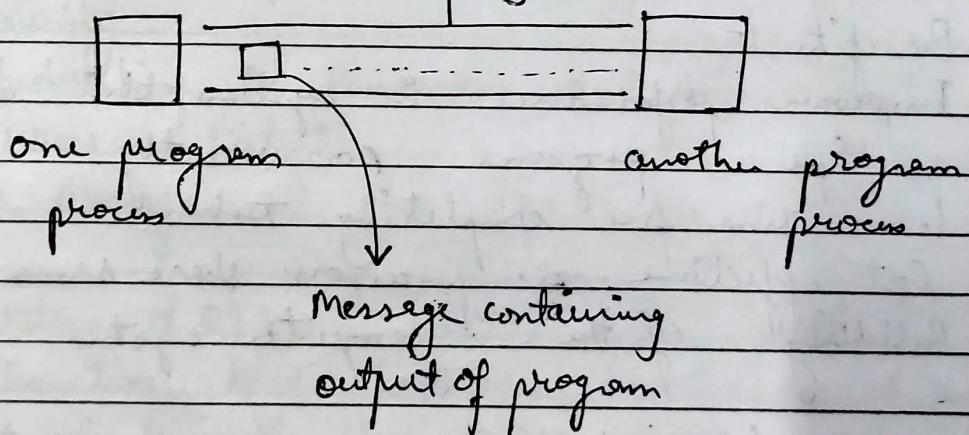
Nowadays, RAID is available in 7 different levels from level 0 to level 6.

Ans 5. GUI (Graphical user interface)

GUI is a type of user interface that allows users to use graphics to interact with OS. Its main purpose is to increase efficiency and ease to use by avoiding complex commands to do something using CLI (Command line interface).
Ex's Microsoft Windows, MAC OS, Apple IOS, Linux.

Ans 6. The pipe is a connection b/w two or more processes that are interrelated to each other.

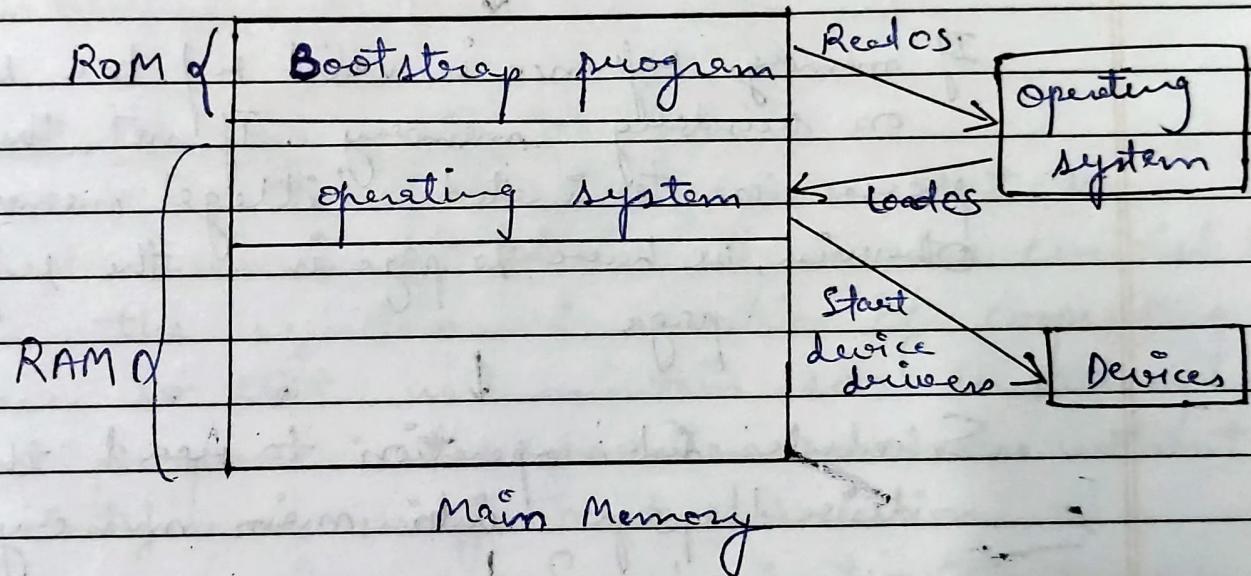
one way



Ans 7. Two operations that are possible :-

- ① wait()
- ② Signal()

Ans 8. Bootstrap program in OS
 Program that initialize OS during startup.
 OS is loaded through bootstrapping process
 by booting programs.
 It locates kernel and loads it into the
 main memory after which the program starts
 its execution.



Ans 9. Demand Paging :-

Loads ~~memory~~ page into memory on demand. Mostly used in virtual memory. In this, a page is only brought into memory when a location on that particular page is referenced during execution.

These steps are generally followed :-

Attempt to access the page
↓

If the page is valid (in memory) then continue processing instructions as normal.
↓

If a page is invalid then a page-fault trap occurs.
↓

If memory response is valid ref to a location on secondary memory. If not, the process is terminated (illegal memory access). Otherwise, we have to page in the required page.
↓

Schedule disk operation to read the desired page into main memory.
↓

Restart the instruction that was interrupted by the OS trap.

Ans 10. RTOS (Real-Time Operating System)

Used for real-time applications for those apps where data processing should be done in a fixed and small measure of time.

Takes care of execution, monitoring and all controlling processing processes.

Occupies less memory and consumes less resources.

Types of RTOS:-

- ① Hard RTOS
- ② Firm RT
- ③ Soft RT.

RTOS is used for Air Traffic control systems, Anti-lock Brake systems and Heart p. Heart pacemakers.

Ans 11. Process Synchronization

It is a way to coordinate processes that use shared resources or data. It is also essential to ensure the synchronized execution of cooperating processes so that will maintain data consistency.

Main purpose is to share resources without any interference using mutual exclusion.

Two Types of Process Synchronization:

- ① Independent Process
- ② Cooperative Process.

Ans 12. IPC (Inter process Communication)

Shared resources b/w processes or threads.
different IPC Mechanisms :-

- ① Pipes
- ② Message Queuing
- ③ Semaphores
- ④ Socket
- ⑤ Shared memory
- ⑥ Signals.

Ans 13. RAM :- Main memory / Primary memory / Internal memory.

Ex :- RAM

Secondary memory :- Stores data of different formats and size in large volume.

Ex :- Hard drives, USB flash drives, C.Ds, etc.

Ans 14. Overlays in OS :-

Overlays is basically a programming method that divides process into pieces so that instructions that are important and need can be saved in memory.

It doesn't need any type of support from the OS. It can run programs that are bigger in size than physical memory by only keeping only important data and instructions that can be needed at any given time.

Ans 15. Top 10 OS Examples :-

- ① MS - Windows
- ② Ubuntu
- ③ Mac OS
- ④ Fedora
- ⑤ Suse Linux
- ⑥ Free BSD
- ⑦ Chrome OS
- ⑧ Cent OS
- ⑨ Debian
- ⑩ Android

Threshing :- If a computer has to swap data b/w virtual memory and main memory too often, the computer will begin to slow down the process. This is called Threshing.

Ans 16. Virtual Memory :-

It is a memory management technique where secondary memory banks used as if it were a part of the main memory.

Programs are stored on storage as Pages.

It is slower as compared to RAM but it allows us to have a memory protection.

Ans 17. Thread :-

- ① child process of a given process.
- ② It is called lightweight process.
- ③ It shares resources with its sibling thread.
- ④ Each of them has their own Stack, Register set, State, Program counter, and Thread ID.
- ⑤ It is a basic unit of CPU utilization.

They can share :- Address space, static data, code section, data section, file, global variables, etc.

Ans 18. Process :- It is a program that is currently under being execution.

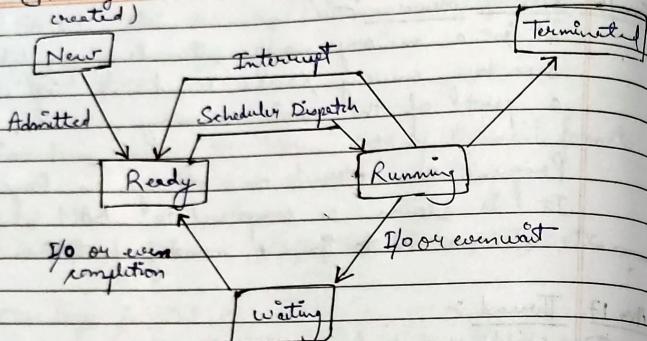
Process is divided into four sections :-
Stack, Heap, Text, and Data.

Two types of processes :-

- ① OS processes
- ② User processes.

Starvation: It is a problem of resource management where in the OS, the process doesn't have resources because it is being used by other processes.

(process just created)



Process state.

Ans 19. FCFS = (First come first serve)

The process that arrives first will be executed first.
Non-preemptive in nature.

Can cause problem of starvation.

Implementation is generally managed with help of the FIFO queue.

Ans 20. Recency:

It is a function in which various clients can use and share a single copy of a program during a similar period.

It is associated with OS code and doesn't deal with concurrency. It has two major features:

- ① Program / code can't change or modify itself.
- ② Local data of client (every client) process needs to be stored in different disks.

Ans 21. A scheduling Algo. is a process used to improve efficiency by utilizing maximum CPU and providing minimum waiting time to tasks.

It allocates resources to different tasks in such a way that it may result in efficient execution of all processes and it maintains fairness amongst different jobs / tasks.

Type of scheduling algo.

Multilevel Feedback Queue Sch.

FCFS

Multilevel Queue Sch.

Shortest Job first (SJF)

Highest Response Ratio

Scheduling Algo.

Priority based Sch.

Shortest Remaining Time first (SRTF)

Round Robin (RR)

Ans 22. Paging: It is generally a memory management technique that allows OS to retrieve processes to main memory from secondary memory.

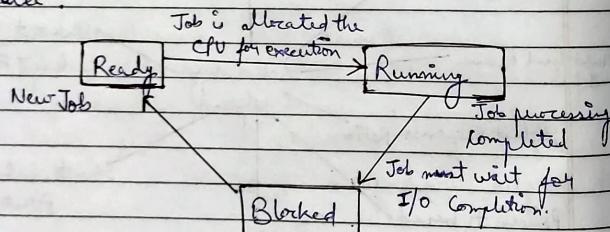
It is Non-contiguous allocation technique that divides each process into the form of page.

Segmentation: It is generally a memory management technique that divides processes into modules and parts of different sizes. modules and parts are known as segments.

Ans 23. Threading :- It is generally a situation where the CPU performs less productive work and more swapping or paging work.

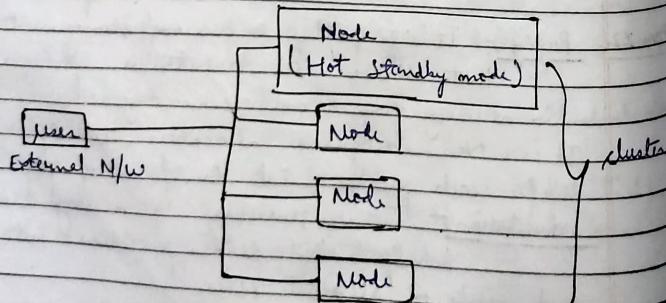
It occurs when the process does not have enough pages due to which the page-fault rate is increased.

Ans 24. Multiprogramming :- It is the coordination of execution of various programs simultaneously on a single processor (CPU). It makes sure to utilise CPU and organizes many jobs where the CPU always has one to execute.



Multiprogramming system.

Ans 25.



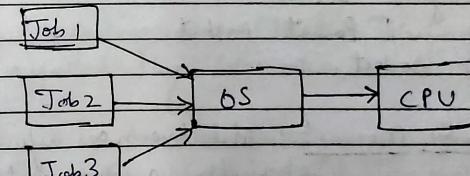
Asymmetric clustering system

Asymmetric clustering is generally a system in which one of the nodes among all nodes is in hot standby mode whereas the rest of all nodes run different applications.

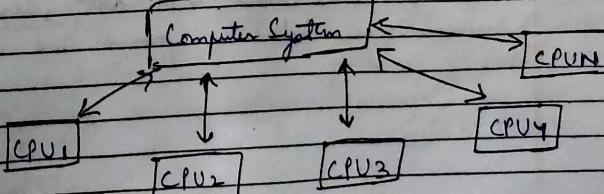
It simply uses whole or entire H/w resources therefore it is considered a more reliable system as compared to others.

Ans 26. Multitasking :- This system works on more than one task at one time by rapidly switching b/w various tasks.

These systems are also known as Time-sharing systems.



Multiprocessing :- It is a system that allows multiple or various processors in a computer to process two or more different portions of the same program simultaneously.



Ans 27. Sockets is generally referred to as endpoint for IPC (Inter process communication). Here, the endpoint is referred to as a combination of IP address and port number. They can used to make it easy for Software developers to create N/w-enabled program.

It is used for communication b/w processes on different OS Same Machine.

Mostly used in client-server based systems.

Types of Sockets is (4 types)

- (1) Stream socket
- (2) Datagram socket
- (3) Sequenced Packet socket
- (4) Raw socket.

Ans 28. Zombie Process: Also known as defunct process, is basically a process that is terminated or completed but the whole process control block is not cleaned up from the memory because it still has an entry in the process table to report to its parent process.

It does not consume any resources and is dead, but it still exists. It also shows that resources are held by process and are not free.

Ans 29. Cascading termination: It is a process of termination in which if the parent process is exiting or terminating then the children will also get terminated. It is generally initiated by OS.

Ans 30. Starvation: It is generally a problem when a process lacks resources for its execution for a long period of time. Low priority processes suffers because they get blocked and lack resources whereas high priority processes proceeds towards completion.

Priority Scheduling and Shortest Job first scheduling gets affected by starvation.

Aging: It is the best technique to resolve the Starvation problem and to ensure that low level queue jobs or processes complete their execution.

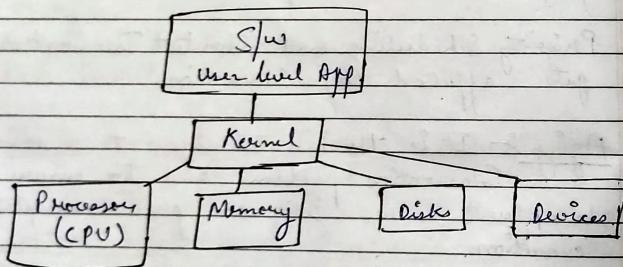
It increases the priority of processes that wait in the system for resources for a long period of time.

Ans 31. Semaphores: It is a signalling mechanism. It only holds one positive Integer value. It is used to solve the problem of critical sections in synchronization process by using two atomic operations, i.e., `wait()` and `signal()`.

Two types of semaphores :-

- ① Binary Semaphores (0 & 1)
- ② Counting Semaphores. (0 to ∞ any value).

Ans 32. Kernel :- It is a computer program considered as a central component or module of OS. It is responsible for managing, handling and controlling all operations of computer systems and H/w. whenever the system starts, the kernel is loaded first and remains in main memory. It acts as an interface b/w user application & H/w.



Function of Kernel :-

- ① Manages all computer resources such as CPU, memory, file, process, etc.
- ② works as an interface for S/w and components of H/w
- ③ Manages RAM for efficiently handling processes
- ④ Manages access and use of all peripherals.
- ⑤

Ans 33. There are 5 types of kernels :-

- ① Monolithic Kernel
- ② Micro-kernel
- ③ Hybrid Kernel
- ④ Nano Kernel
- ⑤ Exo Kernel.

Ans 34. Microkernel :- It is a minimal OS that executes only important functions of OS.

It only contains nearly-minimum number of features and functions that are required to implement OS.
Ex:- QNX, Mac OS X, etc.

Monolithic :- It supports all basic features of computer components such as resource management, memory, file, etc. It is an OS Architecture.

Ex:- Solaris, DOS, Linux, etc.

Ans 35. Symmetric Multiprocessing :- (SMP)

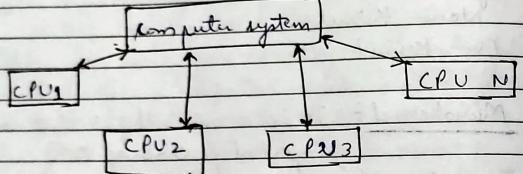
It is referred to as computer architecture in which processing of programs is done by multiple processors that share a common OS and memory.

They enable any processor to work on any of the tasks no matter where data or resources for the tasks are located in memory.
Multiprocessor H/w can use SMP for taking H/w's advantage.

They are more reliable than single-processor systems.

Ans 36.

Time-sharing system :- It is a system that allows more than one user to access the resource of a particular system in many locations. It uses single processor to perform multiple tasks.



Ans 37. Context Switching :- It involves storing the context or state of a process so that it can be reloaded when required and execution can be resumed from the same point as earlier.

This is a feature of multitasking OS and allows a single CPU to be shared by multiple processes.

Ans 38.

Kernel :- It is a system program that controls all programs on the computer. It acts as a bridge b/w S/W and H/W of the system.

OS :- It is a system program that runs on the computer to provide an interface to computer user so that they can easily operate on the computer.

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Path of execution :- It is a possible flow of control of a program.

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Ans 39.

Process :- It is the program that is currently under execution by one or more threads.

Threads :- It is a path of execution that is composed of the program counter, thread Id, register set and stack within the process.

Ans 40.

There are four sections of the process :-

- ① Stack :- used for local and static variables and returns addresses.
- ② Heap :- It is used for dynamic memory allocation.
- ③ Data :- It stores global and static variables.
- ④ Code or text :- It comprises compiled program code.

Ans 41.

Deadlock (Refer previous notes for answer).

Ans 42.

Belady's Anomaly :- In OS, process data is loaded in fixed size chunks and each chunk is referred to as page. The processor load these pages into fixed-sized chunks of memory called frames. Belady's Anomaly is a phenomena in if we increase no. of frames then no. of page faults increases.

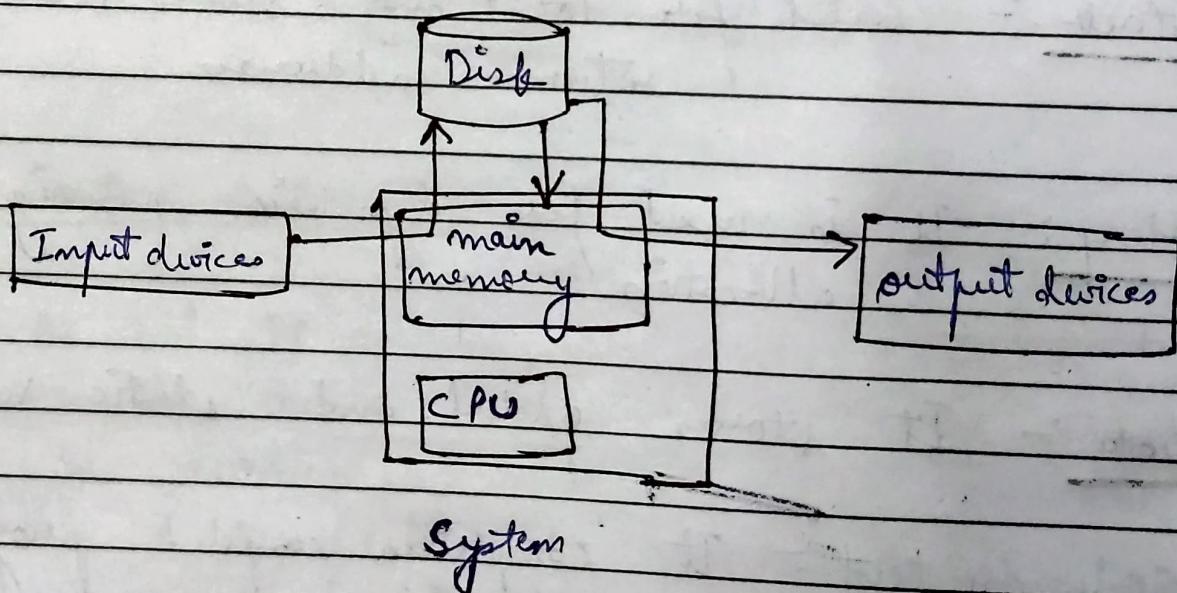
It generally occurs in FIFO page replacement algo.

Ans 43

Spooling :- Spooling stands for Simultaneous peripheral operations online.

In spooling more than one I/O operations can be performed simultaneously utilizing the CPU.

It uses buffer (special area in memory or HDD) to store data and this data can be accessed by any I/O devices.



It uses disk as a very large buffer.