

# **Computer Fundamentals And Operating System Concepts**



## ➤ Process Management

- When we say an OS does process management it means **an OS is responsible for process creation, to provide environment for an execution of a process, resource allocation, scheduling, resources management, inter process communication, process coordination, and terminate the process.**

### Q. What is a Program?

#### ❑ User view:

- Program is a finite set of instructions written in any programming language given to the machine to do specific task.

#### ❑ System view:

- Program is an executable file in HDD which divided logically into sections like exe header, bss section, data section, rodata section, code section, symbol table.



## Q. What is a Process?

### □ User view:

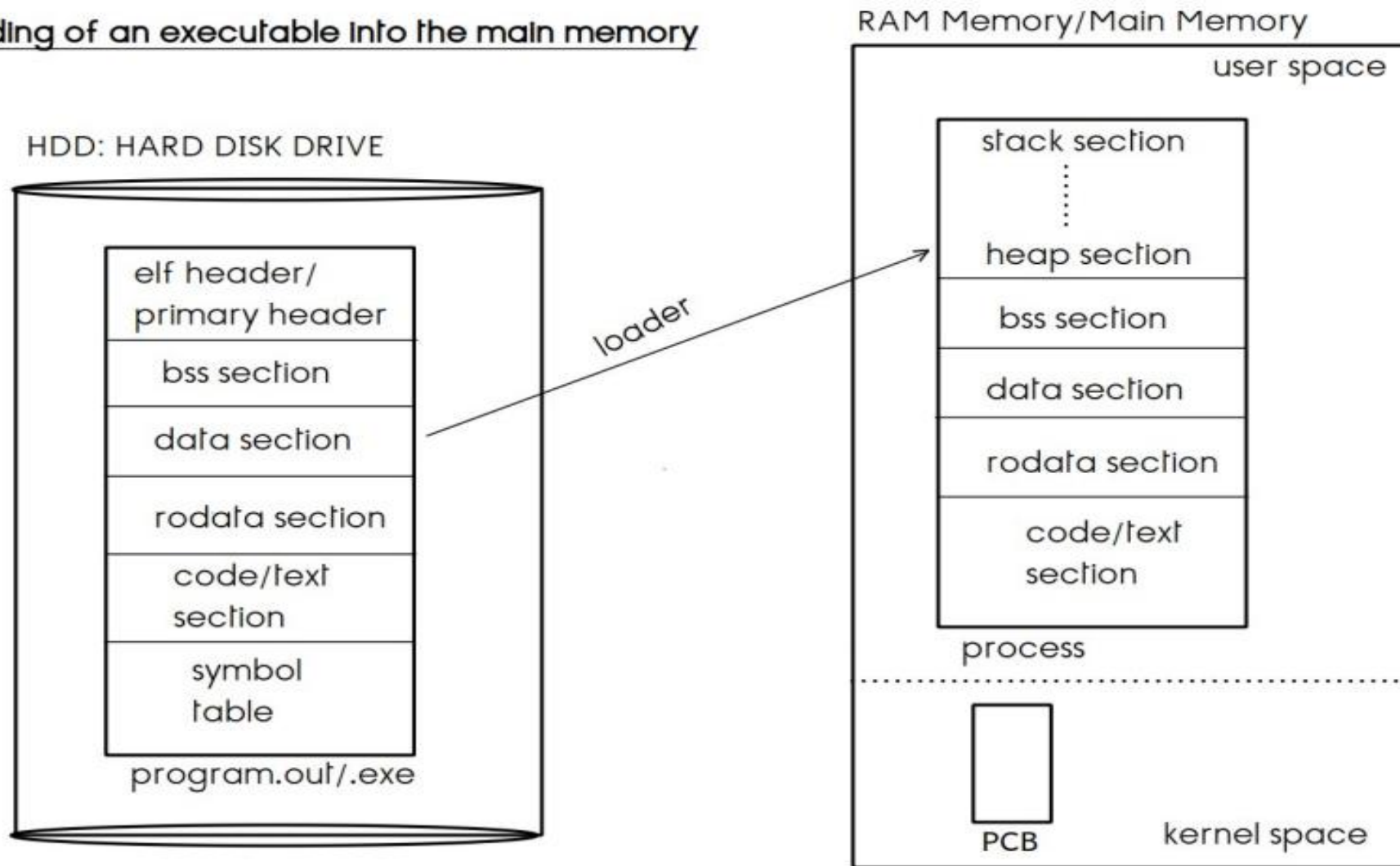
- Program in execution is called as **a process**.
- Running program is called as **a process**.
- When a program gets loaded into the main memory it is referred as **a process**.
- Running instance of a program is referred as **a process**.

### □ System view:

- Process is a program loaded into the main memory which has got PCB into the main memory inside kernel space and program itself into the main memory inside user space has **got bss section, rodata section, code section, and two new sections gets added for the process** .
  - **stack section:** contains function activation records of called functions.
  - **heap section:** dynamically allocated memory

# Operating Systems and Computer Fundamentals

## Loading of an executable into the main memory



# Operating Systems and Computer Fundamentals

- As a kernel, core program of an OS runs continuously into the main memory, part of the main memory which is occupied by the kernel **referred as kernel space** and whichever part is left is **referred as an user space**, so **main memory is divided logically into two parts: kernel space & user space.**
- **User programs gets loaded into the user space only.**
- When we execute a program or upon submission of a process very first one structure gets created into the main memory inside kernel space by an OS in which all **the information which is required to control an execution of that process** can be kept, this structure is referred as a **PCB.**
- **PCB : Process Control Block, is also called as a Process Descriptor.**
- Per process one PCB gets created and PCB remains inside the main memory throughout an execution of a program, upon exit PCB gets destroyed from the main memory.



# Operating Systems and Computer Fundamentals

❖ **PCB mainly contains:**

- **PID : Process ID**
- **PPID : Parent Processes ID**
- **PC : Program Counter**
- **Execution context**
- **Kernel stack**
- **Exit status**
- **CPU sched information, memory management information, information about resources allocated for that process, execution context etc...**



# Operating Systems and Computer Fundamentals

## 1. Resident monitor

## 2. Batch System

- The batch/group of similar programs is loaded in the computer, from which OS loads one program in the memory and execute it. The programs are executed one after another.
- In this case, if any process is performing IO, CPU will wait for that process and hence not utilized efficiently.

## 3. Multi-programming

- Better utilization of CPU
- Loading multiple Programs in memory
- Mixed program(CPU bound + IO bound)



## 4. Time-sharing/Multitasking

- Sharing CPU time among multiple process/task present in main memory and ready for execution
- Any process should have response time should be less then 1sec
- Multi-tasking is divided into two types
  - Process based multitasking
  - Thread based multitasking
    - Thread is a light weight process .
    - When new thread is created a new stack and new TCB is created.
    - Thread Share text, data, heap sections with the parent process
- Process and thread
  - Process is a container for resources.
  - Thread is unit of execution/ scheduler.
  - For each process one thread is created by default it is called as main thread





## 5. Multi-user system

- Multiple users runs multiple programs concurrently.

## 6. Multi-processor/ Mutli-core system

- System can run on a machine in which more than one CPU's are connected in a closed circuit.
- Multiprocessing Advantage is it increased throughput (amount of work done in unit time)
- There are two types of multiprocessor systems:

### ❖ Asymmetric Multi-processing

### ❖ Symmetric Multi-processing

#### ▪ Asymmetric Multi-processing

- OS treats one of the processor as master processor and schedule task for it. The task is in turn divided into smaller tasks and get them done from other processors.

#### ▪ Symmetric Multi-processing

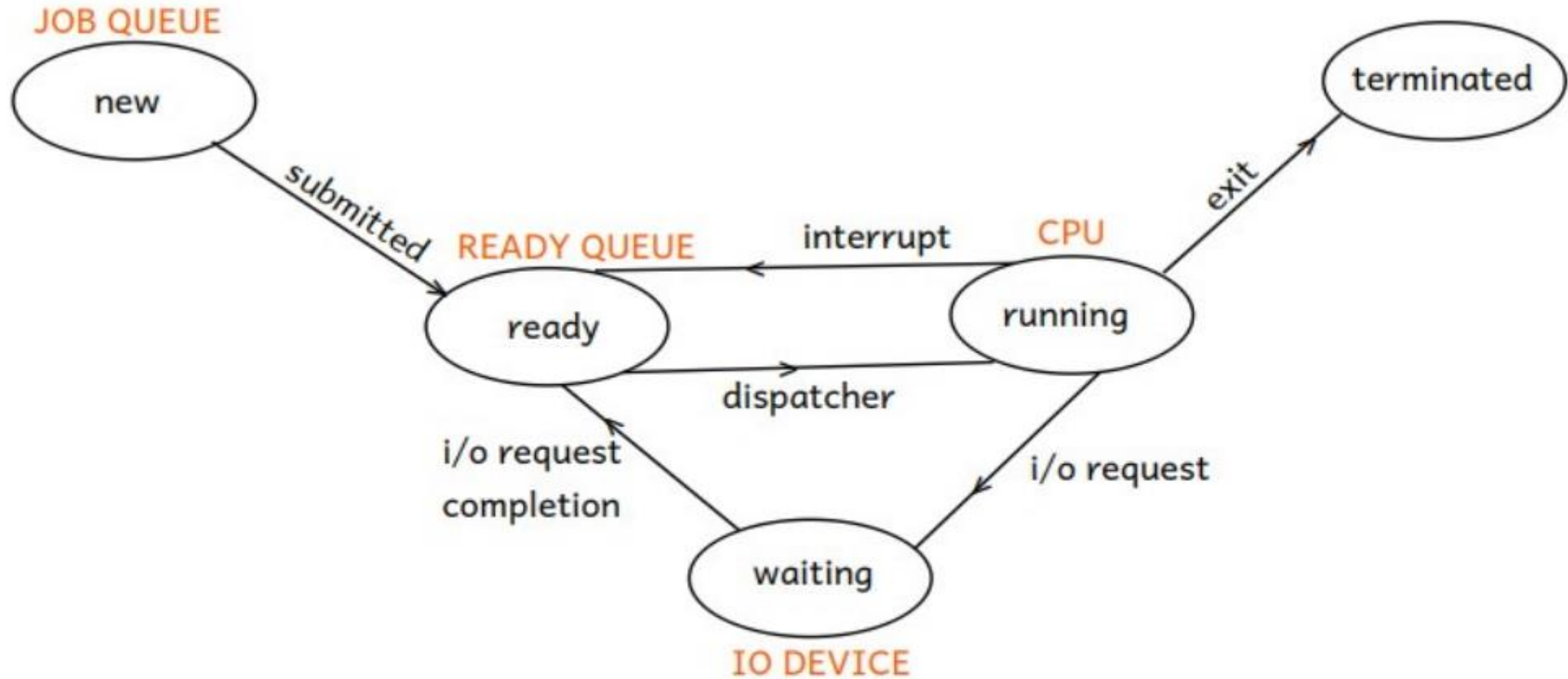
- -OS considers all processors at same level and schedule tasks on each processor individually. All modern desktop systems are SMP.

## ➤ Process States:

- Throughout execution, process goes through different states out of which at a time it can be only in a one state.
- States of the process:
  1. **New state:** upon submission or when a **PCB** for a process gets created into the main memory process is in a **new state**.
  2. **Ready state:** after submission, if process is in the main memory and waiting for the CPU time, it is in a **ready state**.
  3. **Running state:** if currently the CPU is executing any process then state of that process is considered as a **running state**.
  4. **Waiting state:** if a process is requesting for any i/o device then state of that process is considered as a **waiting state**.
  5. **Terminated state:** upon exit, process goes into terminated state and its PCB gets destroyed from the main memory.



# Operating Systems and Computer Fundamentals



PROCESS STATE DIAGRAM



## ➤ Process States:

○ To keep track on all running programs, an OS maintains few data structures referred as **kernel data structures**:

1. **Job queue:** it contains list of PCB's of all submitted processes.
2. **Ready queue:** it contains list of PCB's of processes which are in the main memory and waiting for the CPU time.
3. **Waiting queue:** it contains list of PCB's of processes which are requesting for that particular device.

1. **Job Scheduler/Long Term Scheduler:** it is a system program which selects/schedules jobs/processes from job queue to **load them onto the ready queue**.
2. **CPU Scheduler/Short Term Scheduler:** it is a system program which selects/schedules job/process from ready queue to **load it onto the CPU**.

**Dispatcher:** it is a system program which loads a process onto the CPU which is scheduled by the CPU scheduler, and **the time required for the dispatcher to stops an execution of one process and to starts an execution of another process is referred as dispatcher latency**.

## ➤ Context Switch:

- As during context-switch, the CPU gets switched from an execution context of one process onto an execution context of another process, and hence it is referred as "**context-switch**".
- **context-switch** = **state-save** + **state-restore**
- **state-save** of suspended process can be done i.e. an execution context of suspended process gets saved into its PCB.
- **state-restore** of a process which is scheduled by the CPU scheduler can be done by the dispatcher, dispatcher copies an execution context of process scheduled by the cpu scheduler from its PCB and restore it onto the CPU registers.
- When a high priority process arrived into the ready queue, low priority process gets suspended by means of sending an interrupt, and control of the CPU gets allocated to the high priority process, and its execution gets completed first, then low priority process can be resumed back, i.e. the CPU starts executing suspended process from the point at which it was suspended and onwards.



# Operating Systems and Computer Fundamentals

○ CPU Scheduler gets called in the following four cases:

**Case-1: Running -> Terminated**

**Case-2: Running -> Waiting**

**Case 3: Running -> Ready**

**Case-4: Waiting -> Ready**

- There are two types of CPU scheduling:

- 1. Non-preemptive:** under non-preemptive cpu scheduling, **process releases the control of the CPU by its own i.e. voluntarily.**
  - e.g. in above case 1 & case 2
- 2. Preemptive:** under preemptive cpu scheduling, **control of the CPU taken away forcefully from the process.**
  - e.g. in above case 3 & 4.



## Following algorithms used for CPU Scheduling:

1. **FCFS (First Come First Served) CPU Scheduling**
2. **SJF (Shortest Job First) CPU Scheduling**
3. **Round Robin CPU Scheduling**
4. **Priority CPU Scheduling**

- Multiple algorithms are there for CPU scheduling, so there is need to decide which algorithm is best suited at specific situation and which algorithm is an efficient one, to decide this there are certain criteria's **called as scheduling criteria's: cpu utilization, throughput, waiting time, response time and turn-around-time.**





## ➤ CPU Scheduling Criteria's:

1. **CPU Utilization:** one need to select such an algorithm in which utilization of the CPU must be as **maximum as a possible**.
2. **Throughput:** total work done per unit time. One need to select such an algorithm in which throughput must be **as maximum possible**.
3. **Waiting Time:** it is the total amount of time spent by the process into the ready queue for waiting to get control of the CPU from its time of submission. One need to select such an algorithm in which waiting time must be as **minimum as possible**.
4. **Response Time:** it is a time required for the process to get first response from the CPU from its time of submission. One need to select such an algorithm in which response time must be as **minimum as possible**





- 5. Turn-Around -Time:** it is the total amount of time required for the process to complete its execution from its time of submission.
- One need to select such an algorithm in which turn-around-time must be as **minimum as possible**.
  - **Execution Time:** it is the **total amount of time spent by the process onto the CPU to complete its execution**.
    - **OR CPU Burst Time:** total no. of CPU cycles required for the process to complete its execution.
  - **Turn-Around-Time = Waiting Time + Execution Time.**
  - **Turn-around-time is the sum of periods spent by the process into ready queue for waiting and onto the CPU for execution from its time of submission.**



## ➤ CPU Scheduling

### 1. FCFS (First Come First Served ) CPU Scheduling

- In this algorithm, process which is arrived first into the ready queue gets the control of the CPU first i.e. control of the CPU gets allocated for processes as per their order of an arrival into the ready queue.
- This algorithm is simple to implement and can be implemented by using fifo queue.
- It is a non-preemptive scheduling algorithm.

❑ **Convoy effect:** in fcfs, due to an arrival of longer process before shorter processes, shorter processes has to wait for longer duration and due to which average waiting time gets increases, which results into an increase in an average turn-around-time and hence overall system performance gets down.

## ➤FCFS Scheduling

Process	Arrival Time	CPU Burst	Wait Time	Turn Around Time
P1	0	24		
P2	0	3		
P3	0	3		

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## 2. SJF(Shortest Job First) CPU Scheduling:

- In this algorithm, process which is having minimum CPU burst time gets the control of the CPU first, and whenever tie is there it can be resolved by using fcfs. - SJF algorithm ensures minimum waiting time.
  - Under non-preemptive SJF, algorithm fails if the submission time of processes are not same, and hence it can be implemented as preemptive as well.
  - Non-preemptive SJF is also called as SNTF(Shortest-Next-Time-First).
  - Preemptive SJF is also called as SRTF(Shortest-Remaining-Time-First).
- ❑ **Starvation:** in this algorithm, as shorter processes has got higher priority, process which is having larger CPU burst time may gets blocked i.e. control of the CPU will never gets allocated for it, such situation is called as starvation/indefinite blocking.



## ➤ SJF/SNTF Scheduling

Process	Arrival Time	CPU Burst	Wait Time	Turn Around Time
P1	0	7		
P2	2	4		
P3	4	1		
P4	5	4		

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## ➤ SRTF Scheduling

Process	Arrival Time	CPU Burst	Remaining Time	Wait Time	Turn Around Time
P1	0	7			
P2	2	4			
P3	4	1			
P4	5	4			

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## 3. Round Robin Scheduling Algorithm

- In this algorithm, before allocating the CPU for processes, **some fixed time slice or time quantum** gets decided in advanced, and at any given time control of the CPU may remains allocated with any process maximum for that decided time-slice, once the given time slice is finished of that process, it gets suspended and control of the CPU will be allocated to the next process again for maximum that decided time slice and so on..., each process gets control of the CPU in a round robin manner i.e. cpu gets shared among processes equally.
- If any process completes its execution before allocated time slice then control of the CPU will be released by that process and CPU gets allocated to the next process as soon as it is completed for effective utilization of the CPU.
- **There is no starvation in RR Scheduling algorithm.**
- This algorithm is **purely preemptive**.
- This algorithm **ensures minimum response time**.
- **If time slice is minimum then there will be extra overhead onto the CPU due to frequent context-switch.**



## ➤ Round Robin Scheduling

Process	CPU Burst	Remaining Time	Wait Time	Response Time
P1	53			
P2	17			
P3	68			
P4	24			

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## 4. Priority Scheduling

- In this algorithm, process which is having highest priority gets control of the CPU first, **each process is having priority in its PCB.**
- priority for a process can be decided by two ways:
  1. **internally** – priority for process can be decided by an OS depends on no. of resources required for it.
  2. **externally** – priority for process can be decided by the user depends on requirement.
- **Minimum priority value indicates highest priority.**
- This algorithm is purely preemptive.
- **Due to the very low priority process may gets blocked into the ready queue and control of the CPU will never gets allocated for such a process, this situation is referred as a starvation or indefinite blocking.**
- **Ageing:** it is a technique in which, an OS gradually increments priority of blocked process, i.e. priority of blocked process gets incremented after some fixed time interval by an OS, so that priority of blocked process becomes sufficient enough to get control of the CPU, and starvation can be avoided.



## ➤ Priority Scheduling

Process	Arrival Time	CPU Burst	Priority	Wait Time
P1	0	10	<del>3</del> 50	
P2	0 2	<u>1</u> 00	<del>1</del> 1 ✓	
P3	0 3	2	4 —	
P4	0 4	5	2 —	

P5

P6

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# Thank you!

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