CHANDIGARH UNIVERSITY

Discover. Learn. Empower.

# UNIVERSITY INSTITUTE OF ENGINEERING

## Bachelor of Engineering (Computer Science & Engineering)

## Operating System (CST-328)

**Subject Coordinator: Er. Puneet kaur(E6913)**

# Lecture 6

# CPU Scheduling

- CPU Scheduling
- Goals of Scheduling (objectives)
- Preemptive Vs Nonpreemptive Scheduling
- CPU Scheduling Algorithms
  - First-Come, First-Served (FCFS) Scheduling
  - Shortest-Job-Next (SJN) Scheduling
  - Priority Scheduling
  - Shortest Remaining Time
  - Round Robin(RR) Scheduling
  - Multiple-Level Queues Scheduling

# CPU Scheduling

- CPU scheduling is the basis of multi-programmed operating systems. By switching the CPU among processes, the operating system can make the computer more productive.
- Scheduling is a fundamental operating-system function. Almost all computer resources are scheduled before use.

# Context Switch

- To give each process on a multi-programmed machine a fair share of the CPU, a hardware clock generates interrupts periodically. This allows the operating system to schedule all processes in main memory (using scheduling algorithm) to run on the CPU at equal intervals. Each switch of the CPU from one process to another is called a context switch.

# CPU scheduling decisions may take place under the following four circumstances:

1. When a process switches from the running state to the waiting state (for. example, I/O request, or invocation of wait for the termination of one of the child processes).
2. When a process switches from the running state to the ready state (for example, when an interrupt occurs).
3. When a process switches from the waiting state to the ready state (for example, completion of I/O).
4. When a process terminates.

# Criteria used for CPU scheduling algorithms are:

- CPU utilization.
- Throughput.
- Arrival Time
- Burst Time
- Turnaround time= Exit time - Arrival Time
- Waiting time.
- Response time.
- Exit time

# Goals of Scheduling

- **Fairness**
- **Policy Enforcement**
- **Efficiency**
- **Response Time**
- **Turnaround Time**
- **Throughput**

# Preemptive/ Non-preemptive Scheduling

- A scheduling discipline is non-preemptive if, once a process has been given the CPU, the CPU cannot be taken away from that process.

- A scheduling discipline is preemptive if, once a process has been given the CPU, the CPU can be taken away.

# CPU Scheduling Algorithms

- First-Come, First-Served (FCFS) Scheduling
- Shortest-Job-Next (SJN) Scheduling
- Priority Scheduling
- Shortest Remaining Time
- Round Robin(RR) Scheduling
- Multiple-Level Queues Scheduling

# First Come First Serve (FCFS)

- Jobs are executed on first come, first serve basis.
- It is a non-preemptive scheduling algorithm.
- Easy to understand and implement.
- Its implementation is based on FIFO queue.
- Poor in performance as average wait time is high.

# FCFS

| Process | Arrival Time | Execute Time | Service Time |
|---|---|---|---|
| P0 | 0 | 5 | 0 |
| P1 | 1 | 3 | 5 |
| P2 | 2 | 8 | 8 |
| P3 | 3 | 6 | 16 |

# Shortest Job Next (SJN)

- This is also known as **shortest job first**, or SJF
- This is a non-preemptive scheduling algorithm.
- Best approach to minimize waiting time.
- Easy to implement in Batch systems where required CPU time is known in advance.
- Impossible to implement in interactive systems where required CPU time is not known.
- The processer should know in advance how much time process will take.
- Given: Table of processes, and their Arrival time, Execution time

# Shortest Job Next (SJN)

| Process | Arrival Time | Execution Time | Service Time |
|---|---|---|---|
| P0 | 0 | 5 | 0 |
| P1 | 1 | 3 | 5 |
| P2 | 2 | 8 | 14 |
| P3 | 3 | 6 | 8 |

| Process | Waiting Time |
|---|---|
| P0 | 0 - 0 = 0 |
| P1 | 5 - 1 = 4 |
| P2 | 14 - 2 = 12 |
| P3 | 8 - 3 = 5 |

# Priority Based Scheduling

- Priority scheduling is a non-preemptive algorithm and one of the most common scheduling algorithms in batch systems.
- Each process is assigned a priority. Process with highest priority is to be executed first and so on.
- Processes with same priority are executed on first come first served basis.
- Priority can be decided based on memory requirements, time requirements or any other resource requirement.

# Priority Based Scheduling

| Process | Arrival Time | Execution Time | Priority | Service Time |
|---|---|---|---|---|
| P0 | 0 | 5 | 1 | 0 |
| P1 | 1 | 3 | 2 | 11 |
| P2 | 2 | 8 | 1 | 14 |
| P3 | 3 | 6 | 3 | 5 |


**Waiting time** of each process is as follows –

| Process | Waiting Time |
|---|---|
| P0 | 0 - 0 = 0 |
| P1 | 11 - 1 = 10 |
| P2 | 14 - 2 = 12 |
| P3 | 5 - 3 = 2 |

Average Wait Time: (0 + 10 + 12 + 2)/4 = 24 / 4 = 6

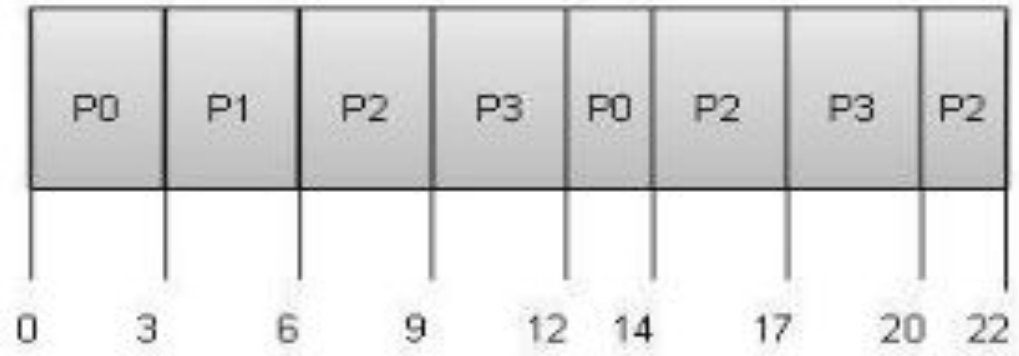
# Shortest Remaining Time

- Shortest remaining time (SRT) is the preemptive version of the SJN algorithm.
- The processor is allocated to the job closest to completion but it can be preempted by a newer ready job with shorter time to completion.
- Impossible to implement in interactive systems where required CPU time is not known.
- It is often used in batch environments where short jobs need to give preference.

# Round Robin Scheduling

- Round Robin is the preemptive process scheduling algorithm.
- Each process is provided a fix time to execute, it is called a **quantum**.
- Once a process is executed for a given time period, it is preempted and other process executes for a given time period.
- Context switching is used to save states of preempted processes.

# Round Robin Scheduling




**Wait time** of each process is as follows –

| Process | Wait Time : Service Time - Arrival Time |
|---|---|
| P0 | (0 - 0) + (12 - 3) = 9 |
| P1 | (3 - 1) = 2 |
| P2 | (6 - 2) + (14 - 9) + (20 - 17) = 12 |
| P3 | (9 - 3) + (17 - 12) = 11 |

Average Wait Time: (9+2+12+11) / 4 = 8.5

# Conclusion

Learning this topic will enable you to understand various types of CPU scheduling algorithm. To compare the performance of various Scheduling algorithms you need to implement these algorithms in OS Labs.

# References


https://www.includehelp.com/c-programming-questions/

https://www.studytonight.com/operating-system/

https://computing.llnl.gov/tutorials/

https://www.tutorialspoint.com/operating_system/index.htm#:~:text=An%20operating%20system%20(OS)%20is,software%20in%20a%20computer%20system.

https://www.javatpoint.com/os-tutorial

https://www.guru99.com/operating-system-tutorial.html

https://www.geeksforgeeks.org/operating-systems/