Scheduling Algorithms

Process Scheduling

The process scheduling is the job of the process manager that handles the removal of the current running process from the CPU and the selection of another process on the basis of a particular approach. It is an essential part of a multiprogramming operating system. Such operating systems allow more than one process to be loaded into the executable memory at a time. In multiprogramming systems, one process can use CPU while another is waiting for I/O. This is possible only with process scheduling. Following are the algorithms that are used by the Operating System to select processes for scheduling to CPU.

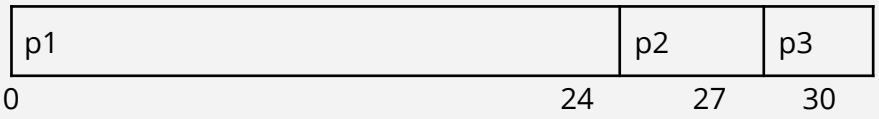
First-come first-served (FCFS) scheduling

The process that asks for the CPU first is given to the CPU first. The implementation of FCFS policy is easily handled with the FIFO queue. The average waiting time under the FCFS policy, however, is often quite long.
It is non-preemptive.
It has a high average waiting time.

Example:

Process	Burst Time
P1	24
P2	3
P3	3

If the processes arrive in the order PI, P2, P3, and are served in FCFS order, we get the result shown in the following Gantt chart:



Average waiting time = (0+24+27) / 3 = 17 ms
Average turnaround time = (24+27+30) / 3 = 27 ms

The FCFS algorithm is particularly troublesome for time – sharing systems, where it is important that each user get a share of the cpu at regular intervals.

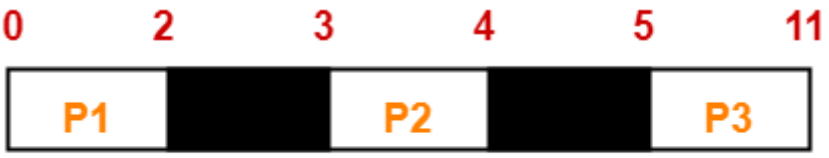
Example Problem:

Consider the set of 3 processes whose arrival time and burst time are given below-

Process Id	Arrival Time	Burst Time
P1	0	2
P2	3	1
P3	5	6

If the CPU scheduling policy is FCFS, calculate the average waiting time and average turnaround time.

Solution:



Gantt Chart

Now, we know:

- Turn Around time = Exit time – Arrival time
- Waiting time = Turnaround time – Burst time

Process Id	Exit time	Turn Around time	Waiting time
P1	2	2 – 0 = 2	2 – 2 = 0
P2	4	4 – 3 = 1	1 – 1 = 0
P3	11	11- 5 = 6	6 – 6 = 0

Now,

- Average Turnaround time = (2 + 1 + 6) / 3 = 9 / 3 = 3 unit
- Average waiting time = (0 + 0 + 0) / 3 = 0 / 3 = 0 unit

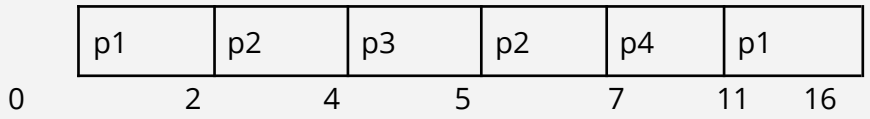
Shortest Job First Scheduling Algorithm

This algorithm is associated with each process length of the next CPU storage. When the CPU is available, it is given a process with the next minimum CPU bust. If the two processes are the same length for the next CPU explosion, the FCFS configuration is used to break the tire.
This scheduling algorithm has a preemptive version as well. If a new process arrives with CPU burst length less than remaining time of the current executing process, then the current executing process is preempted, this scheme is known as the Preemptive Shortest Job First Scheduling algorithm.
SJF is optimal – gives a minimum average waiting time for a given set of processes.

Example of Preemptive SJF

Process	Arrival Time	Burst Time
P1	0.0	7
P2	2.0	4
P3	4.0	1
P4	5.0	4

Gantt Chart:



SJF (preemptive)
Average waiting time = (9 + 1 + 0 +2)/4 = 3 ms

Example Problem on Non Preemptive Shortest Job Scheduling algorithm:

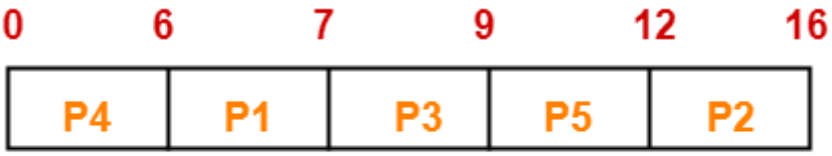
Consider the set of 5 processes whose arrival time and burst time are given below-

Process Id	Arrival time	Burst time
P1	**3**	**1**
P2	**1**	**4**
P3	**4**	**2**
P4	**0**	**6**
P5	**2**	**3**

If the CPU scheduling policy is SJF non-preemptive, calculate the average waiting time and average turnaround time.

Solution

Gantt Chart-



Gantt Chart

Now, we know-

- Turn Around time = Exit time – Arrival time
- Waiting time = Turnaround time – Burst time

Process Id	Exit time	Turn Around time	Waiting time
P1	7	7 – 3 = 4	4 – 1 = 3
P2	16	16 – 1 = 15	15 – 4 = 11
P3	9	9 – 4 = 5	5 – 2 = 3
P4	6	6 – 0 = 6	6 – 6 = 0
P5	12	12 – 2 = 10	10 – 3 = 7

Now,

- Average Turnaround time = (4 + 15 + 5 + 6 + 10) / 5 = 40 / 5 = 8 unit
- Average waiting time = (3 + 11 + 3 + 0 + 7) / 5 = 24 / 5 = 4.8 unit

Example Problem on Preemptive Shortest Job Scheduling algorithm

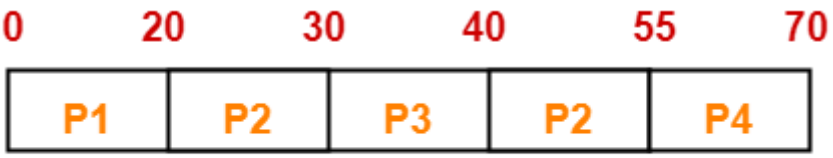
Consider the set of 4 processes whose arrival time and burst time are given below-

Process Id	**Arrival time**	**Burst time**
P1	**0**	**20**
P2	**15**	**25**
P3	**30**	**10**
P4	**45**	**15**

If the CPU scheduling policy is Preemptive SJF, calculate the waiting time of process P2.

Solution:

Gantt Chart-



Gantt Chart

Now, we know-

Turn Around time = Exit time – Arrival time

Waiting time = Turnaround time – Burst time

Thus,

- Turn Around Time of process P2 = 55 – 15 = 40 unit
- Waiting time of process P2 = 40 – 25 = 15 unit

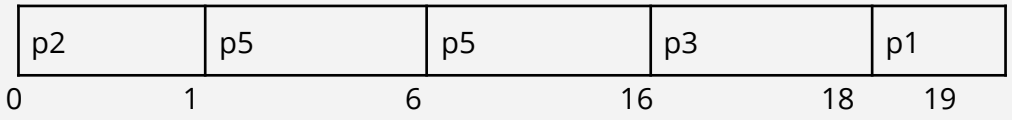
Priority Scheduling

- CPU is allocated to the particular process with the highest priority .
- Priority range be 0 to 7 (say), with 0 representing the highest or the lowest priority
- Priority may depend on internal factors (time limit, memory requirement, number of open files, etc.) and external factors (user, department, etc.)
- May be preemptive or non-preemptive .
- SJF is an important case of priority scheduling, with priority inversely proportional to predicted CPU burst length.
- May cause starvation, i.e. indefinite blocking of processes

Example:

Process	Burst Time	Priority
P1	10	3
P2	1	1
P3	2	4
P4	1	5
P5	5	2

Gantt chart:



AWT = 8.2 mS

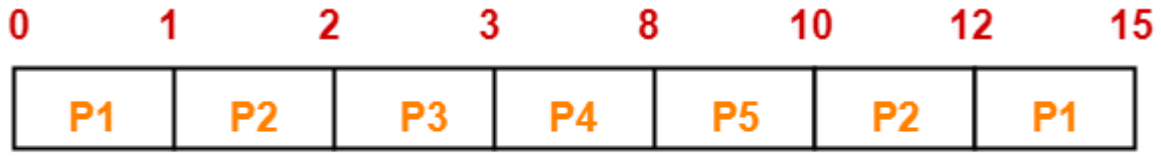
Example Problems:

Consider the set of 5 processes whose arrival time and burst time are given below-

Process Id	Arrival time	Burst time	Priority
P1	**0**	**4**	**2**
P2	**1**	**3**	**3**
P3	**2**	**1**	**4**
P4	**3**	**5**	**5**
P5	**4**	**2**	**5**

If the CPU scheduling policy is priority preemptive, calculate the average waiting time and average turnaround time. (Higher number represents higher priority)
Solution-

Gantt Chart-



Gantt Chart

Now, we know-

- Turn Around time = Exit time – Arrival time
- Waiting time = Turnaround time – Burst time

Process Id	Exit time	Turn Around time	Waiting time
P1	15	15 – 0 = 15	15 – 4 = 11
P2	12	12 – 1 = 11	11 – 3 = 8
P3	3	3 – 2 = 1	1 – 1 = 0
P4	8	8 – 3 = 5	5 – 5 = 0
P5	10	10 – 4 = 6	6 – 2 = 4

Now,

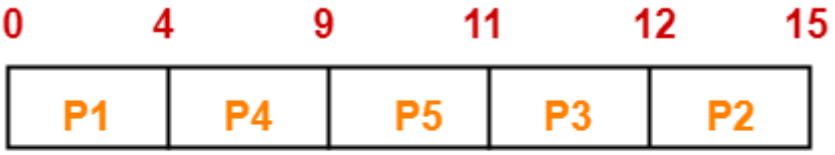
- Average Turnaround time = (15 + 11 + 1 + 5 + 6) / 5 = 38 / 5 = 7.6 unit
- Average waiting time = (11 + 8 + 0 + 0 + 4) / 5 = 23 / 5 = 4.6 unit

Problem: Consider the set of 5 processes whose arrival time and burst time are given below-

Process Id	**Arrival time**	**Burst time**	**Priority**
P1	**0**	**4**	**2**
P2	**1**	**3**	**3**
P3	**2**	**1**	**4**
P4	**3**	**5**	**5**
P5	**4**	**2**	**5**

If the CPU scheduling policy is priority non-preemptive, calculate the average waiting time and average turnaround time. (Higher number represents higher priority)

Solution-



Gantt Chart

Now, we know-

- Turn Around time = Exit time – Arrival time
- Waiting time = Turnaround time – Burst time

Process Id	Exit time	Turn Around time	Waiting time
P1	4	4 – 0 = 4	4 – 4 = 0
P2	15	15 – 1 = 14	14 – 3 = 11
P3	12	12 – 2 = 10	10 – 1 = 9
P4	9	9 – 3 = 6	6 – 5 = 1
P5	11	11 – 4 = 7	7 – 2 = 5

Now,

- Average Turnaround time = (4 + 14 + 10 + 6 + 7) / 5 = 41 / 5 = 8.2 unit
- Average waiting time = (0 + 11 + 9 + 1 + 5) / 5 = 26 / 5 = 5.2 unit