Let's take three processes that arrive at the same time in this order:

Process	CPU Time Needed (ms)
P1	24
P2	3
P3	3

The processes are assumed to have arrived in order P1, P2 and P3, all at time 0.
Draw Gantt Chart, calculate Turnaround Time, Waiting Time, Average Turnaround Time and Average Waiting Time.

Ans
P1 starts at time 0 and ends at time 24.
P2 starts at time 24 and ends at time 27.
P3 starts at time 27 and ends at time 30.

Thus, P2 has to wait 24 milliseconds to start and P3 has to wait 27 milliseconds. The average waiting time here is:

Gantt chart:

P1	P2	P3	
0	**24**	**27**	**30**

P1's waiting time=0

P2's waiting time=24

P3's waiting time=27

Average waiting time is the sum of waiting times of all the processes divided by number of processes.

Average Waiting Time

=(0+24+27)/3

=51/3

=17milliseconds

Turnaround Time

It is computed by subtracting the time the process entered the system from the time it terminated. Therefore we can say that:

Turnaround Time = Burst Time + Waiting Time

Process	**Turnaround Time**
P1	24+0=24
P2	3+24=27
P3	3+27=30

Average Turnaround Time

=(24+27+30)/3

=81/3

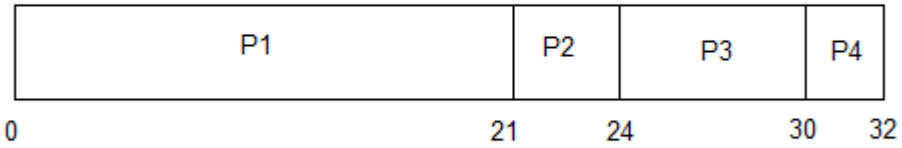
27 milliseconds

<u>First Come First Serve(FCFS) Scheduling</u>

- Jobs are executed on first come, first serve basis.
- Easy to understand and implement.
- Poor in performance as average wait time is high.

PROCESS	BURST TIME
P1	21
P2	3
P3	6
P4	2

The average waiting time will be = (0 + 21 + 24 + 30)/4 = 18.75 ms



This is the GANTT chart for the above processes

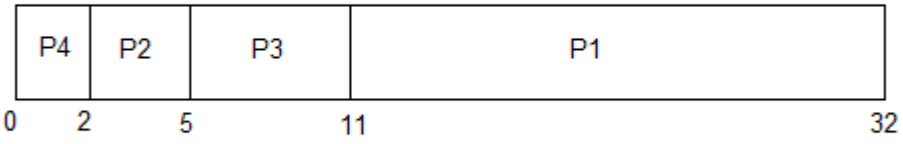
Shortest-Job-First(SJF) Scheduling

- Best approach to minimize waiting time.
- Actual time taken by the process is already known to processor.
- Impossible to implement.

PROCESS	BURST TIME
P1	21
P2	3
P3	6
P4	2

In Shortest Job First Scheduling, the shortest Process is executed first.

Hence the GANTT chart will be following :



Now, the average waiting time will be = (0 + 2 + 5 + 11)/4 = 4.5 ms

Priority Scheduling

- Priority is assigned for each process.
- Process with highest priority is executed first and so on.
- Processes with same priority are executed in FCFS manner.
- Priority can be decided based on memory requirements, time requirements or any other resource requirement.

PROCESS	BURST TIME	PRIORITY
P1	21	2
P2	3	1
P3	6	4
P4	2	3

The GANTT chart for following processes based on Priority scheduling will be,

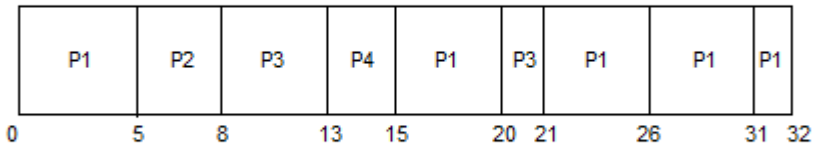
The average waiting time will be, (0 + 3 + 24 + 26)/4 = 13.25 ms

Round Robin(RR) Scheduling

- A fixed time is allotted to each process, called quantum, for execution.
- Once a process is executed for given time period that process is preemptied and other process executes for given time period.
- Context switching is used to save states of preemptied processes.

PROCESS	BURST TIME
P1	21
P2	3
P3	6
P4	2

The GANTT chart for round robin scheduling will be,



The average waiting time will be, 11 ms.