# Process scheduling examples:

**Q1: Find the average waiting time and average turnaround time for executing the following processes using FCFS (first-come first-service) scheduling?**

| Process | Burst time |
|---------|------------|
| P0 | 7 |
| P1 | 5 |
| P2 | 2 |
| P3 | 9 |

Answer:

The first step of the solution is founding the Gantt chart.

**Gantt chart:**

| P0 | P1 | P2 | P3 |
|----|----|----|----|

0          7          12    14                        23

The waiting time of P0 = 0
The waiting time of P1 = 7
The waiting time of P2 = 12
The waiting time of P3 = 14
The average waiting time = (0 + 7 + 12 + 14) /4 = 33/4 = 8.25

The turnaround time of p0 = 7
The turnaround time of p1 = 12
The turnaround time of p2 = 14
The turnaround time of p3 = 23
The average turnaround time = (7+12+14+23)/4 =  56/4 = 14

**Q2: Find the average waiting time (A.W.T) and average turnaround time (A.T.A.T) for executing the following process using (1) Preemptive short-job first (2) Non-preemptive short-job first?**

| Process | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| Burst time | 5 | 13 | 8 | 4 | 10 |
| Arrival time | 2 | 3 | 0 | 5 | 1 |

**Answer**

## (1) Using preemptive short-job first
Gantt chart

| P3 | P1 | P4 | P3 | P5 | P2 |
|---|---|---|---|---|---|
| 0 2 | 7 | 11 | 17 | 27 | 40 |

W.T. of p1 = 2 -2 = 0                   T.A.T. of P1=7 – 2 = 5

W.T. of p2 = 27 – 3 = 24                T.A.T. of P2= 40 – 3 = 37

W.T. of p3 = 0+ (11-2) = 9              T.A.T. of P3= 17 – 0 = 17

W.T. of p4 = 7 – 5 = 2                  T.A.T. of P4= 11 – 5 = 6

W.T. of p5 = 17 – 1 = 16               T.A.T. of P5= 27 -1 = 26

A.W.T. = ( 0+24+9+2+16)/5 = 51/5 = 10.2

A.T.A.T = ( 5+37+17+6+26)/5 = 91/5 =18.2

## 2) Using non- preemptive short-job first

Gantt chart

| P3 | P4 | P1 | P5 | P2 |
|----|----|----|----|----|
| 0 | 8 | 12 | 17 | 27 | 40 |

W.T. of p1 = 12 -2 = 10                    T.A.T. of P1= 17 – 2 = 15

W.T. of p2 = 27 – 3 = 24                   T.A.T. of P2= 40 – 3 = 37

W.T. of p3 = 0                             T.A.T. of P3= 8 – 0 = 8

W.T. of p4 = 8 – 5 = 3                     T.A.T. of P4= 12 – 5 = 7

W.T. of p5 = 17 – 1 = 16                   T.A.T. of P5= 27 -1 = 26


A.W.T. = ( 10+24+0+3+16)/5 = 53/5 = 10.6

A.T.A.T = ( 15+37+8+7+26)/5 =  93/5 = 18.6

**Q3: Find the average waiting time and turnaround time for executing the following process using priority scheduling algorithm?**

| Process | P1 | P2 | P3 | P4 | P5 |
|---------|----|----|----|----|----|
| Burst time | 5 | 13 | 8 | 6 | 12 |
| Priority | 1 | 3 | 0 | 4 | 2 |

## Answer

Gantt chart

| P3 | P1 | P5 | P2 | P4 |
|----|----|----|----|----|

0          8          13          25          38          44

W.T. of p1 = 8                     T.A.T. of P1=13

W.T. of p2 = 25                    T.A.T. of P2= 38

W.T. of p3 = 0                     T.A.T. of P3= 8

W.T. of p4 = 38                    T.A.T. of P4= 44

W.T. of p5 = 13                    T.A.T. of P5= 25


A.W.T. = (8+25+0+38+13)/5 = 84/5 = 16.8

A.T.A.T = (13+38+8+44+25)/5 =  128/5 =25.6


**Q4: Find the average waiting time (A.W.T.) and the average turnaround time (A.T.A.T.) for executing the following processes using round-robin algorithm, where time quantum is 5?**

| Process | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| Burst time | 11 | 4 | 14 | 9 | 21 |
| Arrival time | 5 | 0 | 0 | 1 | 2 |

## Answer

P2= 4̶ 0
P3= 1̶4̶ 9̶ 4̶ 0
P4= 9̶ 4̶ 0
P5= 2̶1̶ 1̶6̶ 1̶1̶ 6̶ 1̶ 0
P1= 1̶1̶ 6̶ 1̶ 0

Gantt chart

| P2 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P5 | P1 | P5 | P5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 9 | 14 | 19 | 24 | 29 | 33 | 38 | 43 | 47 | 52 | 53 | 58 59 |

W.T. of P1 =( 19-5)+(38-24)+(52-43) = 14 + 14+9 = **37**
W.T. of P2 = **0**
W.T. of P3 = (4-0) + (24-9) + (43-29) = 4 + 15 + 14 = **33**
W.T. of P4 = (9-1) + (29-14) = 8 + 15 = **23**
W.T. of P5 = (14-2) + (33-19) + (47-38) + (53-52) = 12+14+9+1=**36**
**A.W.T. = (37 + 0+ 33 + 23 + 36) /5 = 129 /5 = 25.8**

T.A.T of P1 = (53-5)= **48**
T.A.T of P2 = (4-0) = **4**
T.A.T of P 3= (47 – 0 ) = **47**
T.A.T of P 4= (33-1) = **32**
T.A.T of P 5= (59-2) = **57**
**A.T.A.T. = (48 + 4+ 47 + 32 + 57) /5 = 188/5 = 37.6**

**Q25: Consider a multilevel feedback queue scheduling (MLFBQ) with three queues q1, q2, and q3. q1 and q2 use round-robin algorithm with time quantum (TQ) = 5, and 4 respectively. q3 use first-come first-service algorithm. Find the average waiting time (A.W.T) and average turnaround time (A.T.A.T) for executing the following process?**

| Processes | P1 | P2 | P3 | P4 |
|-----------|----|----|----|----|
| Burst time | 8 | 22 | 4 | 12 |

## Answer

In MLFBQ scheduling algorithm, the process move between queues. If a process uses too much CPU time, it will be moved to a lower-priority queue.

```
       q1   q2   q3
P1:    8    3    -
P2:    22   17   13

P3:    4    -    -

P4: 12      7    3
```



q1 → P4, P3, P2, P1
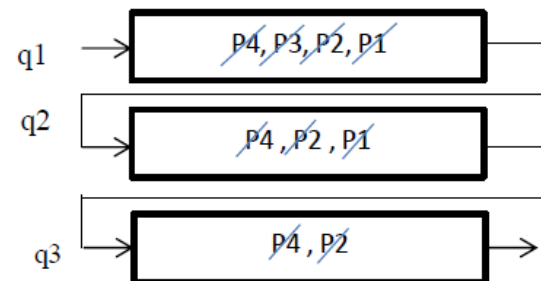
q2 → P4 , P2 , P1

q3 → P4 , P2

Gantt chart

| P1 | P2 | P3 | P4 | P1 | P2 | P4 | P2 | P4 | |
|----|----|----|----|----|----|----|----|----|----|
| 0 | 5 | 10 | 14 | 19 | 22 | 26 | 30 | 43 | 46 |

W.T. of p1 = 0 + (19-5) = 14                     T.A.T. of P1=22

W.T. of p2 = 5+ (22-10) + (30-26) = 5+12+4 = 21         T.A.T. of P2= 43

W.T. of p3 = 10                                 T.A.T. of P3= 14

W.T. of p4 = 14 + (26-19) + (43-30) = 14+7+13= 34       T.A.T. of P4= 46


A.W.T. = (14 + 21 +10 + 34)/4 = 79/4 = 19.75

A.T.A.T = (22 + 43 + 14 + 46) = 125/4 = 31.25