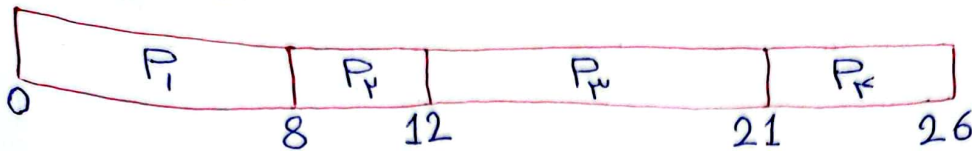


The Gantt Chart for the schedule is:



first come first served (اولویت بر اساس زمان ورود)

FCFS: ترتیب service $P_1 \rightarrow P_2 \rightarrow P_3 \rightarrow P_4$
دادن (اولویت) زمان ورود 0 1 2 3

Waiting time for $P_1=0$; $P_2=8-1=7$; $P_3=12-2=10$; $P_4=21-3=18$

Response time for $P_1=8$; $P_2=12-1=11$; $P_3=21-2=19$; $P_4=26-3=23$

Turnaround time for $P_1=8-0=8$; $P_2=12-1=11$; $P_3=21-2=19$; $P_4=26-3=23$

Average Waiting time = $\frac{0+7+10+18}{4} = 8.75$, Average Response time = $\frac{8+11+19+23}{4} = 15.25$

Average turnaround time = $\frac{8+11+19+23}{4} = 15.25$

CPU utilization = $\frac{\text{busy time}}{\text{busy time} + \text{idle time}} \times 100 = \frac{26}{26+0} \times 100 = 100\%$

چون زمان context switching صفری شود.

بهره‌وری CPU 100% است.

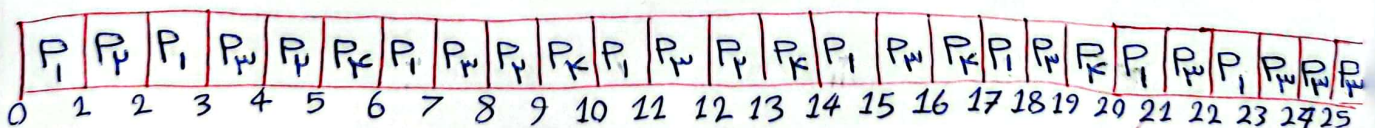
Turnaround time = Completion time - Arrival time

Waiting time = Turnaround time - Burst time

The Gantt chart for the schedule is:

RR with $q=1ms$

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Waiting time for $P_1=23-8=15$; $P_2=12-4=8$; $P_3=24-9=15$; $P_4=20-5=15$

Response time for $P_1=1-0=1$; $P_2=2-1=1$; $P_3=4-2=2$; $P_4=6-3=3$

Turnaround time for $P_1=23-0=23$; $P_2=13-1=12$; $P_3=26-2=24$; $P_4=20-3=17$

CPU queue ~~P1~~ ~~P2~~ ~~P3~~ ~~P4~~ ~~P1~~ ~~P2~~ ~~P3~~ ~~P4~~ ...

enter time 0 1 1 2 2 3 3 4 5 6

Ave Waiting time = $\frac{15+8+15+12}{4} = 12.5$

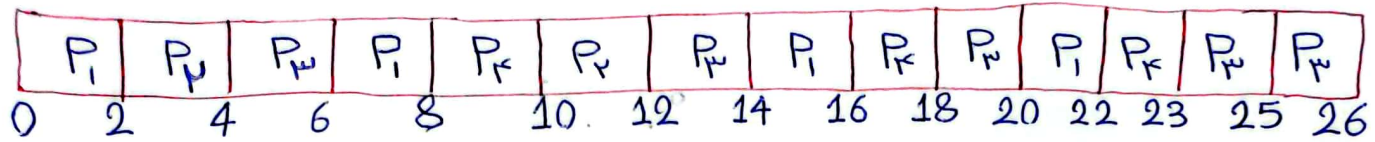
Ave Response time = $\frac{1+1+2+3}{4} = 1.75$

Ave Turnaround time = $\frac{23+12+24+17}{4} = 19$

10/20/2022

The Gantt chart for the schedule is:

RR with $q = 2\text{ms}$ (ب)



Waiting time for $P_1 = 22 - 8 = 14$; $P_2 = 11 - 4 = 7$; $P_3 = 24 - 9 = 15$; $P_4 = 20 - 5 = 15$

Response time for $P_1 = 2 - 0 = 2$; $P_2 = 4 - 1 = 3$; $P_3 = 6 - 2 = 4$; $P_4 = 10 - 3 = 7$

Turnaround time for $P_1 = 22 - 0 = 22$; $P_2 = 12 - 1 = 11$; $P_3 = 26 - 2 = 24$; $P_4 = 23 - 3 = 20$

CPU ready queue: $P_1, P_2, P_3, P_4, P_1, P_2, P_3, P_4, \dots$ تناوبی کنند تا هر یک تمام شوند

enter time 0 1 2 2 3 4 6 8 10

Ave Waiting time = $\frac{14+7+15+15}{4} = 12.75$ Ave Turnaround time = $\frac{22+11+24+20}{4}$

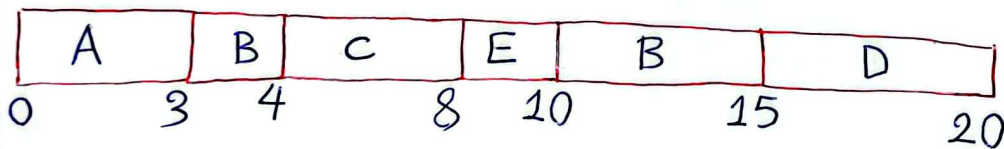
Ave Response time = $\frac{2+3+4+7}{4} = 4$ = 19.25

RR با $q = \text{largest CPU Burst}$ (ج) در واقع اگر $q \text{ large} \Rightarrow \text{FIFO}$

اجرای RR انبساطی الگوریتم FCFS اجرای شود.

The Gantt Chart for schedule is:

shortest-remaining-time-first (د)

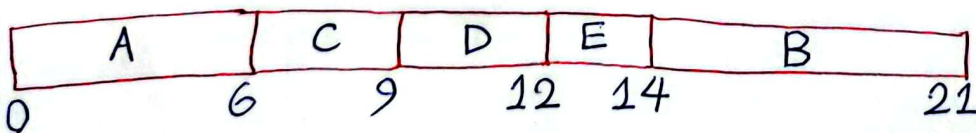


Turnaround time for $A = 3 - 0 = 3$; $B = 15 - 2 = 13$; $C = 8 - 4 = 4$; $D = 20 - 6 = 14$; $E = 10 - 8 = 2$

Average turnaround time = $\frac{3+13+4+14+2}{5} = 7.2$ (turnaround time Completion time - Arrival time)

time	0	2	3	4	8	10	15	20
Remaining time	A(3)	A(1); B(6)	B(6)	B(5); C(4)	B(5); D(5); E(2)	B(5); D(5)	D(5)	

Response Ratio = $\frac{W + S}{S}$ $W = \text{waiting time}$ $S = \text{burst time}$ Highest Response Ratio Next (Non-Preemptive) (ک)



At time $t = 6$, A completes its execution, Now, B, C, D are available in ready queue. Using formula, Calculate Response Ratios.

Response Ratio for $B = \frac{(6-1)+7}{7} \approx 1.7$; $C = \frac{(6-3)+3}{3} = 2$; $D = \frac{(6-5)+3}{3} \approx 1.3$

C has the highest Response Ratio so it gets scheduled.

At time = 9

Response Ratio for $B = \frac{(9-1)+7}{7} \approx 2.1$; $D = \frac{(9-5)+3}{3} \approx 2.3$; $E = \frac{(9-7)+2}{2} = 2$

D is chosen

At time = 12 Response Ratio for $B = \frac{(12-1)+7}{7} \approx 2.5$; $E = \frac{(12-7)+2}{2} = 3.5$

E is chosen

At time = 14, After Completion of process E, B is selected at last & execute till it gets finished.

Waiting Time for $A=0$ $B=14-1=13$ $C=6-3=3$ $D=9-5=4$ $E=12-7=5$

Average Waiting time = $\frac{0+13+3+4+5}{5} = 5$

الف) الگوریتم هایی که اولویت دارند (Priority Scheduling) مستعد starvation هستند.

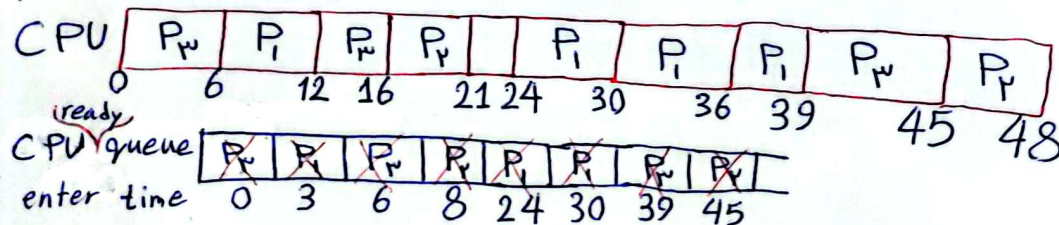
چرا که امکان دارد low priority processes may never execute یعنی پروسس های با اولویت پایین هیچ وقت اجرا نشوند. راه حل این مشکل استفاده از Aging است.

Aging: as time progresses increase the priority of the process.

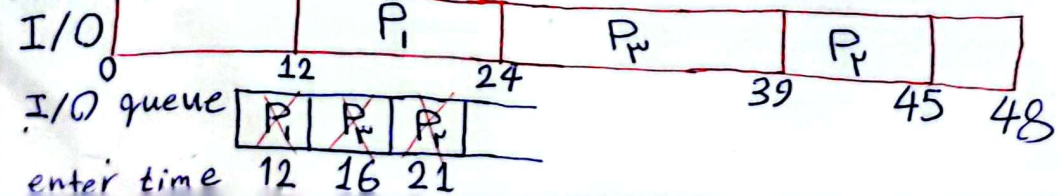
به طور مثال الگوریتم های SJF, SRTF, Priority Scheduling باعث starvation می شوند.

پروسس با اولویت پایین ممکن است هیچ وقت اجرا نشود.
پروسس با remaining time زیاد ممکن است هیچ وقت اجرا نشود.
پروسس با burst time زیاد ممکن است اجرا نشود.
اگر در حین اجرا arrival time های جدید داشته باشد و پروسس های جدیدی با burst کم بیایند هم پروسس ها اول با هم وارد نشوند.

RR
 $q=6ms$



FIFO



Turnaround time for $P_1 = 39 - 3 = 36$; $P_2 = 48 - 8 = 40$; $P_3 = 45 - 0 = 45$

$$\text{Average turnaround time} = \frac{36 + 40 + 45}{3} \approx 40.3 \text{ ms}$$

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