

CPU Scheduling - Algorithms - CS52005

Module - 3

Example 1:

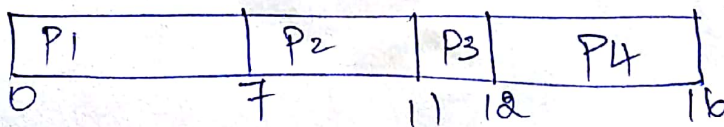
FCFS, SJF, Priority and Round Robin Scheduling

Consider the following ^{system of} processes with their burst times. Present the schedule of processes through a Gantt chart and compute the average waiting time and average turn-around time. Assume that all processes have arrived at the same time, $t = 0$.

FCFS scheduling:

Process ID	Burst Time	Wait Time	Turn-Around Time
P ₁	7	0	7
P ₂	4	7	11
P ₃	1	11	12
P ₄	4	12	16

Gantt Chart



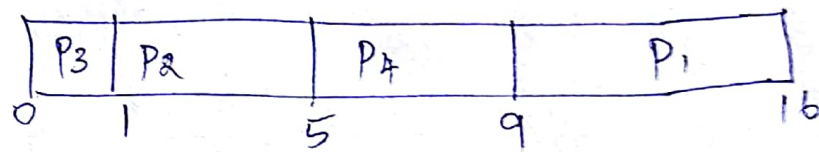
$$\text{Average Waiting Time} = \frac{(0+7+11+12)}{4}$$

$$= \frac{30}{4} = 7.5 \text{ time unit}$$

$$\text{Average Turn-Around Time} = \frac{16}{4} = 4 \text{ time unit}$$

<u>SJF</u> Scheduling	Process ID	Burst Time	Turn Around Time	Wait Time
	P ₁	7	16	9
	P ₂	4	5	1
	P ₃	1	1	0
	P ₄	4	9	5

Gantt chart

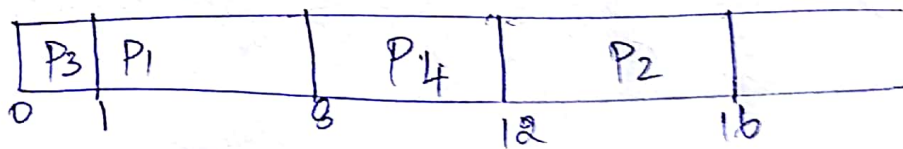


Average Waiting Time = $15/4 = 3.75$ time unit

Average Turn Around Time = $31/4 = 7.75$ time unit

Priority Scheduling : Priority is {2, 4, 1, 2}

Process ID	Burst Time	Priority	Turn Around Time	Wait Time
P ₁	7	2	8	1
P ₂	4	4	16	12
P ₃	1	1	1	0
P ₄	4	2	12	8



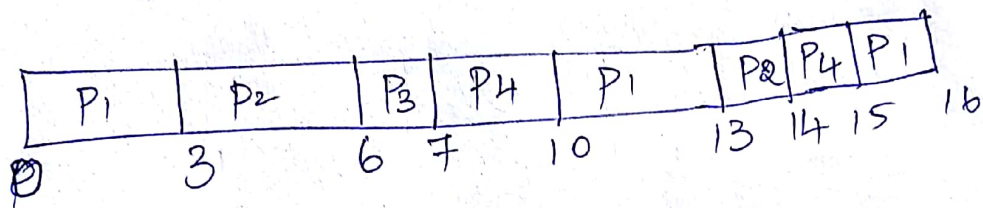
Average waiting Time = $21/4 = 5.25$ time unit

Average Turn Around Time = $37/4 = 9.25$ time unit

Round-Robin (RR) scheduling

Time Quantum = 3 time unit

Process ID	Burst Time	Turn Around Time	Wait Time
P ₁	7	16	9
P ₂	4	14	10
P ₃	1	7	6
P ₄	4	15	11



$$\text{Average Waiting Time} = (9 + 10 + 6 + 11) / 4 = 36 / 4 = 9 \text{ time unit}$$

$$\text{Average Turn Around Time} = 52 / 4 = 13 \text{ time unit}$$

∴ For the given system of 4 processes burst time, priority and time quantum = 3 time unit; SJF algorithm has suffered from the least average waiting time of 3.75 time unit.

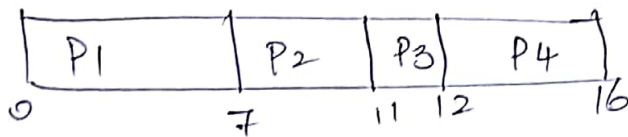
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Example 2: Consider the system of processes as given in Example 1 with different arrival times of processes and apply all algorithms further provide your conclusions on average waiting time.

FCFS scheduling:

Process ID	Burst Time	Arrival Time	Turn Around Time	Waiting Time
P ₁	7	0	7	0
P ₂	4	1	10	6
P ₃	1	2	10	9
P ₄	4	3	13	9

Gantt chart:

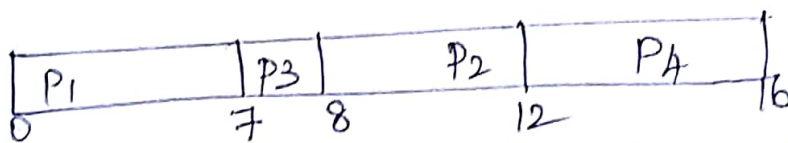


$$\text{Average Waiting Time} = \frac{(0+6+9+9)}{4} = 6 \text{ time units}$$

SJF Scheduling: (without preemption)

Process ID	Burst Time	Arrival Time	Turn Around Time	Waiting Time
P ₁	7	0	7	0
P ₂	4	1	11	7
P ₃	1	2	6	5
P ₄	4	3	13	9

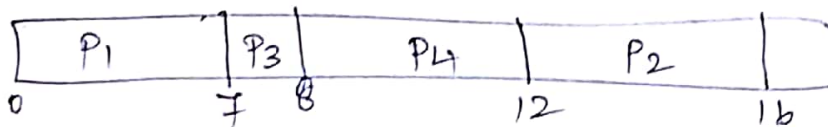
Gantt Chart:



$$\text{Average Waiting Time} = \frac{(0+7+5+9)}{4} = 5.25 \text{ time units}$$

Priority scheduling (non-preemptive) :

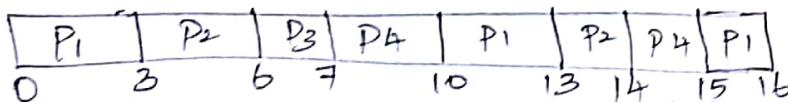
Process ID	Burst Time	Priority	Arrival Time	Turnaround Time	Waiting Time
P ₁	7	2	0	7	0
P ₂	4	4	1	15	11
P ₃	1	1	2	6	5
P ₄	4	2	3	9	5



Average Waiting Time = $(0+11+5+5)/4 = 5.25$ time units.

Round Robin scheduling with Time Quantum = 3 time units :

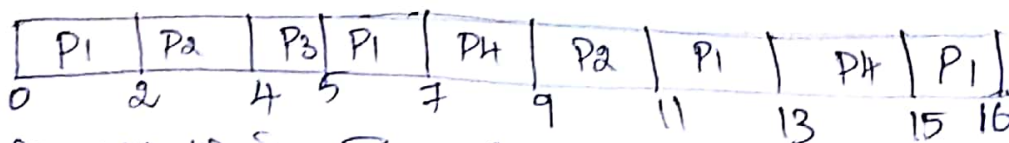
Process ID	Burst Time	Arrival Time	Turnaround Time	Waiting Time
P ₁	7	0	16	9
P ₂	4	1	13	9
P ₃	1	2	5	4
P ₄	4	3	12	8



Average Waiting Time = $(9+9+4+8)/4 = 30/4 = 7.5$ time units.

Round-Robin scheduling with Time Quantum = 2 time units :

Process ID	Burst Time	Arrival Time	Turnaround Time	Waiting Time
P ₁	7	0	16	9
P ₂	4	1	10	6
P ₃	1	2	3	2
P ₄	4	3	12	8



Average Waiting Time = $(9+6+2+8)/4 = 25/4 = 6.25$ time units.

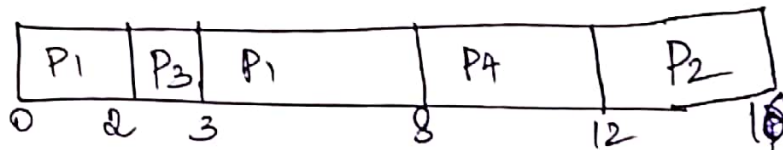
Rough Table :

Arrival/Re-arrival time → 0 1 2 2 3 4 7 9 13
 Process ID → P₁ P₂ P₃ P₁ P₄ P₂ P₁ P₄ P₁
 Remaining Burst time → 7 4 1 5 4 2 3 2 1

Priority scheduling with preemption:

Process ID	Burst Time	Priority	Arrival Time	Turnaround Time	Wait Time
P ₁	7	2	0	8	1
P ₂	4	4	1	15	11
P ₃	1	1	2	1	0
P ₄	4	2	3	9	5

Gantt chart:

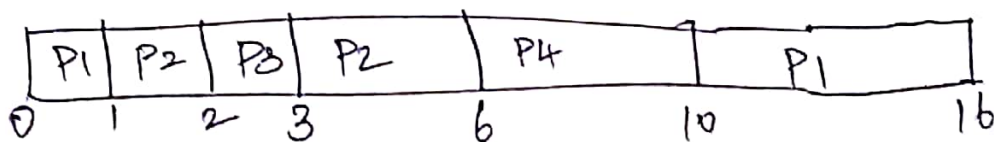


$$\text{Average Waiting Time} = (1 + 11 + 0 + 5) / 4 = 17/4 = 4.25 \text{ time units}$$

Shortest Remaining Time First / Next (SRTF / SRTN | SJF with preemption):

Process ID	Burst Time	Arrival Time	Turnaround Time	Waiting Time
P ₁	7	0	16	9
P ₂	4	1	5	1
P ₃	1	2	1	0
P ₄	4	3	7	3

Gantt chart:



$$\text{Average Waiting Time} = (9 + 1 + 0 + 3) / 4 = 13/4 = 3.25 \text{ time units}$$

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