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COURSE NAME : 19CSB201 – OPERATING SYSTEMS

II YEAR/ IV SEMESTER

UNIT – II Process Scheduling And Synchronization

Topic: CPU Scheduling : Scheduling Algorithms

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CPU Scheduling Algorithms

There are many CPU scheduling algorithms for deciding which of the process in the ready queue is to be allocated to the CPU.

Types

- First Come First Serve Scheduling
- Shortest Job First Scheduling
- Priority Scheduling
- Round Robin Scheduling

First Come First Serve Scheduling

- It is the simplest CPU Scheduling algorithm
- In this, the process that requests the CPU first is allocated to the CPU first.
- The Implementation of FCFS is easily managed with a FIFO queue.

FIFO Queue

- The process enters the ready queue onto the tail of the queue
- When the CPU is free the process at the head of the queue will be allocated

FCFS Scheduling

Consider the following set of processes Arrives at time 0, with the length of the CPU burst time given in milliseconds

Process	Burst Time
P_1	24
P_2	3
P_3	3

i. Draw gantt chart illustrating process execution for all scheduling
ii. Find Turn around time
iii. Find Waiting time

Gantt Chart

It is a bar chart that illustrates the process schedule, including the start and finish times of each participating processes.

Waiting Time

Waiting Time is the sum of time period spent waiting in the ready queue.

Turnaround Time

Turnaround time is the sum of period spent waiting to get into memory, waiting in the ready queue, executing on the CPU and doing I/O

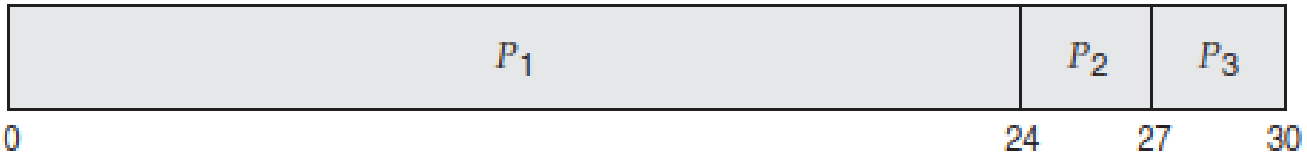
FCFS Scheduling

Example 1

Process	Burst Time
P_1	24
P_2	3
P_3	3

Arrives at time 0

Gantt Chart



Process	Burst Time	Waiting Time	Turnaround Time
P1	24	0	24
P2	3	24	27
P3	3	27	30
Average Waiting Time/ Turnaround Time		(51/3) = 17	(81/3) = 27

Example 1

- Average Waiting Time(Wt) = (Wt P1 + Wt P2 + Wt P3) / 3

  = (0+24+27) / 3

  = 51 / 3 = 17

- Average Turnaround Time(Tt) = (Tt P1 + Tt P2 + Tt P3) / 3

  = (24+27+30) / 3

  = 81 / 3 = 27

FCFS Scheduling

Process	Burst Time
P_1	24
P_2	3
P_3	3

- Suppose that the processes arrive in the order: P_1 , P_2 , P_3 The Gantt Chart for the schedule is:

- Waiting time for P_1 = 0; P_2 = 24; P_3 = 27
- Average waiting time: (0 + 24 + 27)/3 = 17
- **Convoy effect** - short process behind long process

FCFS Scheduling

Suppose that the processes arrive in the order:

$$P_2 , P_3 , P_1$$

- The Gantt chart for the schedule is:

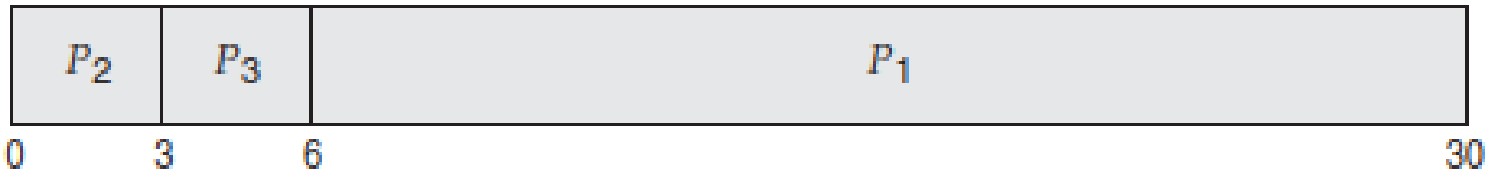
- Waiting time for $P_1 = 6; P_2 = 0, P_3 = 3$
- Average waiting time: (6 + 0 + 3)/3 = 3
- Much better than previous case

FCFS Scheduling

Example 2

Process	Burst Time	Arrival Time
P1	24	3
P2	3	0
P3	3	1

Gantt Chart



Process	Burst Time	Waiting Time	Turnaround Time
P1	24	6-3 = 3	3+24 = 27
P2	3	0-0 = 0	0+3 = 3
P3	3	3-1 = 2	2+3 = 5
Average Waiting Time/ Turnaround Time		(5/3) = 1.67	(35/3) = 11.67

Formulae

Waiting Time

Waiting Time = Starting Time – Arrival Time

Turnaround Time

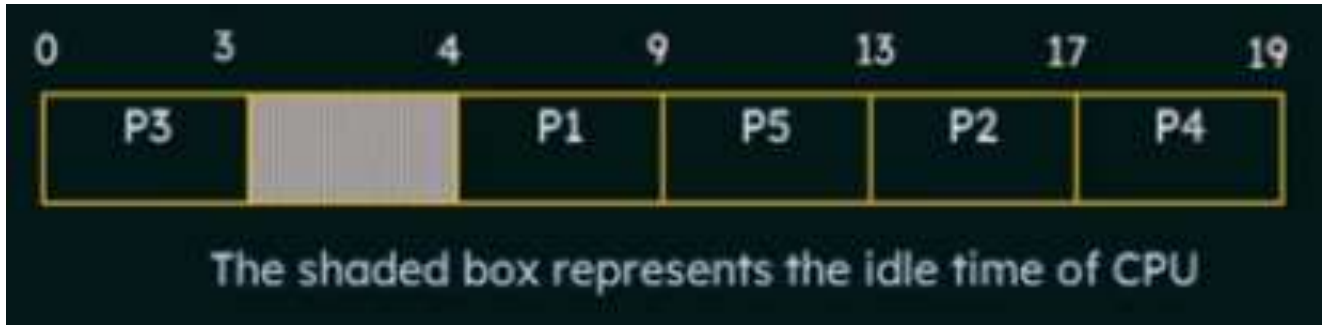
Turnaround time = Waiting Time + Burst Time

FCFS Scheduling

Example 3

Process ID	Arrival Time	Burst Time
P1	4	5
P2	6	4
P3	0	3
P4	6	2
P5	5	4

Gantt Chart



Process ID	Completion Time	Turnaround Time	Waiting Time
P1	9	9 - 4 = 5	5 - 5 = 0
P2	17	17 - 6 = 11	11 - 4 = 7
P3	3	3 - 0 = 3	3 - 3 = 0
P4	19	19 - 6 = 13	13 - 2 = 11
P5	13	13 - 5 = 8	8 - 4 = 4

Formulae

Turnaround Time

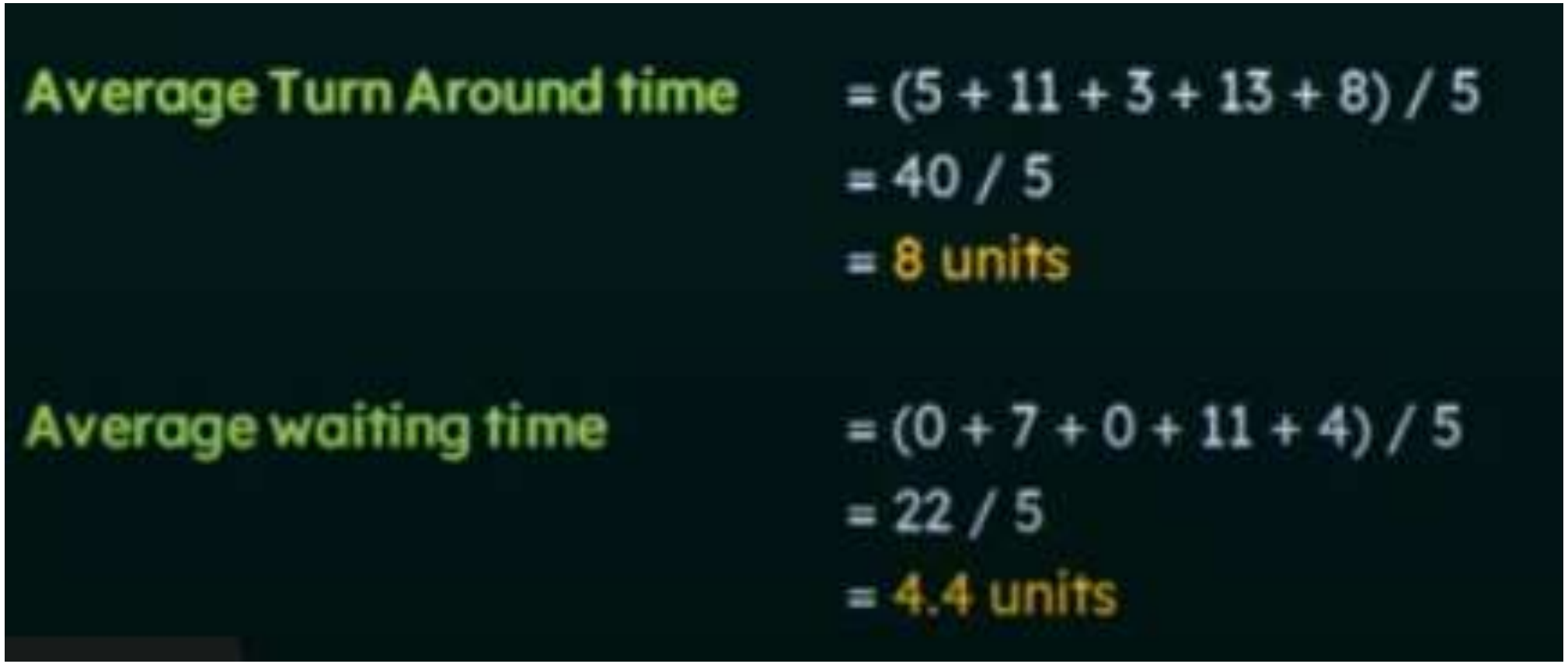
Turnaround Time = Completion Time – Arrival Time

Waiting Time

Waiting Time = Turnaround Time – Burst Time

FCFS Scheduling

Example 3



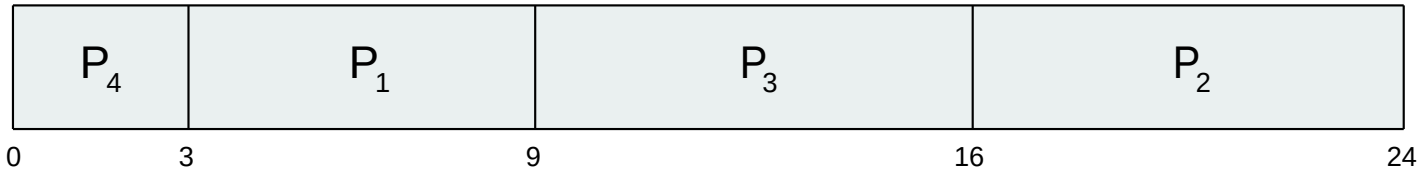
Shortest Job First Scheduling

- This algorithm associate with each process the length of its next CPU burst
  - Use these lengths to schedule the process with the shortest time
- SJF is optimal – gives minimum average waiting time for a given set of processes
  - The difficulty is knowing the length of the next CPU request

SJF Scheduling

Process	Burst Time
P_1	6
P_2	8
P_3	7
P_4	3

- SJF scheduling chart



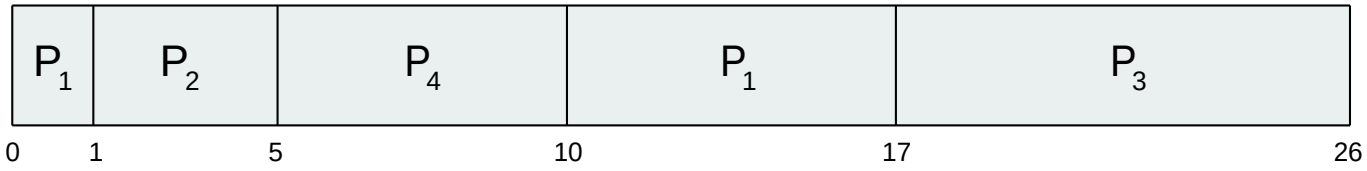
- Average waiting time = (3 + 16 + 9 + 0) / 4 = 7
- Average Turnaround time

Preemptive SJF

Preemptive version called **shortest-remaining-time-first**

Process	*Arrival* Time	Burst Time
P_1	0	8
P_2	1	4
P_3	2	9
P_4	3	5

- *Preemptive* SJF Gantt Chart



- Average waiting time = [(10-1)+(1-1)+(17-2)+5-3)]/4 = 26/4 = 6.5 msec

Priority Scheduling

- A priority number (integer) is associated with each process
- The CPU is allocated to the process with the highest priority (smallest integer ≡ highest priority)

Types

- Preemptive
- Nonpreemptive

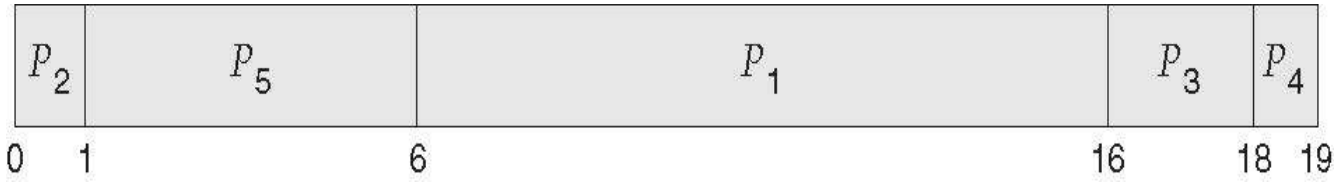
Priority Scheduling

- SJF is priority scheduling where priority is the inverse of predicted next CPU burst time
- Problem ≡ **Starvation** – low priority processes may never execute
- Solution ≡ **Aging** – as time progresses increase the priority of the process

Non-Preemptive

Process	Burst Time	Priority
P_1	10	3
P_2	1	1
P_3	2	4
P_4	1	5
P_5	5	2

- Priority scheduling Gantt Chart

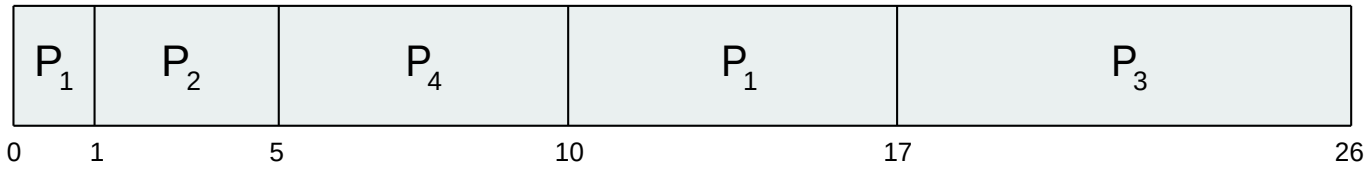


- Average waiting time = 8.2 msec

Preemptive

Process	Arrrival Time	Burst Time	Priority
P_1	0	8	3
P_2	1	4	1
P_3	2	9	4
P_4	3	5	2

- Priority scheduling Gantt Chart



- Average waiting time = 6.5 msec

Round Robin Scheduling

- It is similar to FCFS Scheduling, but preemption is added to enable switch between processes.

- A small unit of time called time quantum or time slice is defined.
- After the execution of time quantum period, the running process will be placed at back of ready queue & allows next process to occupy the CPU.

Round Robin Scheduling

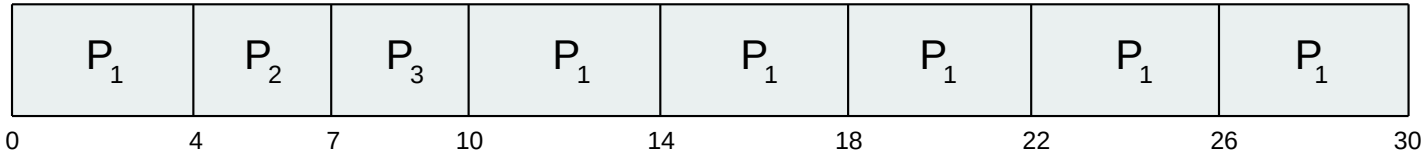
- Each process gets a small unit of CPU time (**time quantum** q), usually 10-100 milliseconds. After this time has elapsed, the process is preempted and added to the end of the ready queue.
- If there are n processes in the ready queue and the time quantum is q, then each process gets $1/n$ of the CPU time in chunks of at most q time units at once. No process waits more than $(n-1)q$ time units.
- Timer interrupts every quantum to schedule next process
- Performance
  - q large $\Rightarrow$ FIFO
  - q small $\Rightarrow$ q must be large with respect to context switch, otherwise overhead is too high

Round Robin Scheduling

Process	Burst Time
P_1	24
P_2	3
P_3	3

If Time Quantum is 4 milliseconds

- The Gantt chart is:



Typically, higher average turnaround than SJF, but better ***response***

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R4. William Stallings, “Operating Systems – Internals and Design Principles”, 7th Edition, Prentice Hall, 2011


THANK
YOU!