# CS & IT ENGINEERING


## Operating System

### CPU Scheduling

Lecture -3


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# Recap of Previous Lecture

- **Topic** LJF, LRTF Scheduling
- **Topic** HRRN Algorithms
- **Topic** Priority Based Scheduling
- **Topic** Round Robin Scheduling

# Topics to be Covered

- Topic: Multilevel Queue Scheduling
- Topic: Multilevel Feedback Queue Scheduling
- Topic: Questions on Scheduling

# Topic : Round Robin (RR)

Scheduling Criteria: Arrival time and Quantum time

Type of Algorithm: preemptive

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if 2 processes arrive together (equal AT) ⇒ Add the process of smaller id first in queue.

if a process arrives at the same time when the current running process is preempted ⇒ Add the new process first and preempted process in last in queue.

# Topic : Round Robin (RR)

Q = 2

| Process | Arrival Time | Burst Time |
|---|---|---|
| P1 | 0 | 3 |
| P2 | 0 | 6 |
| P3 | 0 | 4 |
| P4 | 0 | 5 |

no. of context switches

$$= \left\lceil \frac{3}{2} \right\rceil + \left\lceil \frac{6}{2} \right\rceil + \left\lceil \frac{4}{2} \right\rceil + \left\lceil \frac{5}{2} \right\rceil - 1$$

| Time | Ready Queue |
|---|---|
| 0 | ~~P1~~, P2, P3, P4 |
| 2 | ~~P2~~, P3, P4, P1 |
| 4 | ~~P3~~, P4, P1, P2 |
| 6 | ~~P4~~, P1, P2, P3 |
| 8 | ~~P1~~, P2, P3, P4 |
| 9 | P2, ~~P3~~, P4 |

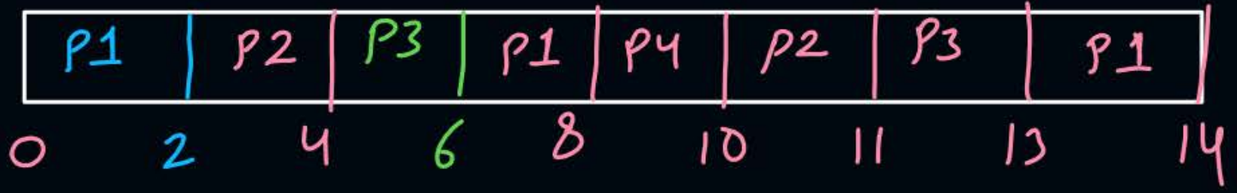

no. of context switches = 9

Ques-2)

| Pid | AT | BT |
|---|---|---|
| P1 | 0 | 5 |
| P2 | 1 | 3 |
| P3 | 2 | 4 |
| P4 | 3 | 2 |

| Time | Ready Queue |
|---|---|
| 0 | ~~P1~~ |
| 2 | ~~P2~~, P3, P1 |
| 4 | ~~P3~~, P1, P4, P2 |
| 6 | P1, P4, P2, P3 |
| | ✓ ✗ ✗ ✓ |

Q = 2




no. of context switches = 7

# Topic : Round Robin (RR)

Q = 2

| Process | Arrival Time | Burst Time | |
|---|---|---|---|
| P1 | 0 | 6 | 3 |
| P2 | 1 | 5 | 3 |
| P3 | 2 | 4 | 2 |
| P4 | 3 | 3 | 2 |
| P5 | 4 | 2 | 1 |
| P6 | 5 | 4 | 2 |

| Time | Ready Queue |
|---|---|
| 0 | P1 |
| 2 | P2, P3, P1 |
| 4 | P3, P1, P4, P5, P2 |
| 6 | P1, P4, P5, P2, P6, P3 |

13 − 1 = 12 ← context switches

| P1 | P2 | P3 | P1 | P4 | P5 | P2 | P6 | P3 | P1 | P4 | P2 | P6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

0 2 4 6 8 10 12 14 16 18 20 21 22 24

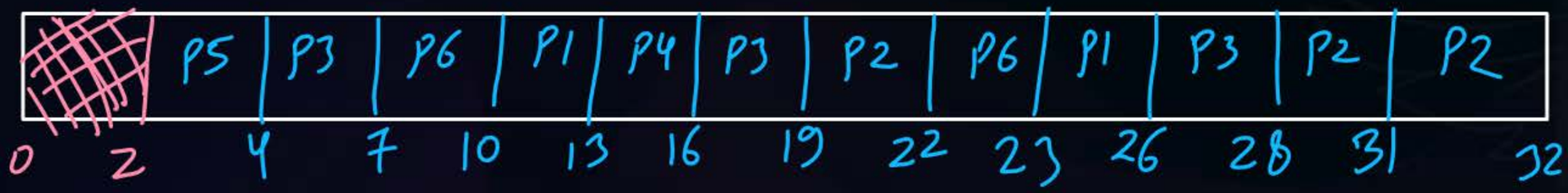
# Topic : Round Robin (RR)

Q = 3

| Process | Arrival Time | Burst Time | |
|---|---|---|---|
| P1 | 5 | 6 | 2 |
| P2 | 8 | 7 | 3 |
| P3 | 3 | 8 | 3 |
| P4 | 6 | 3 | 1 |
| P5 | 2 | 2 | 1 |
| P6 | 4 | 4 | 2 |

| Time | R.Q. |
|---|---|
| 2 | P5 |
| 4 | P3, P6 |
| 7 | P6, P1, P4, P3 |
| 10 | P1, P4, P3, P2, P6 |

12 − 1 = 11 ⇐ no. of context switches



# Topic : Round Robin (RR)

H.W.

Q = 3

| Process | Arrival Time | Burst Time |
|---|---|---|
| P1 | 0 | 12 |
| P2 | 0 | 5 |
| P3 | 3 | 9 |
| P4 | 5 | 6 |
| P5 | 2 | 8 |
| P6 | 4 | 2 |
| P7 | 1 | 7 |

# Topic : What Should Be the Quantum Value?

very-very small

CPU efficiency $\cong 0$

CPU spends more time on context switch than process execution

$\gtrsim$ small

Interactive

large

less interactive

very-very large

RR degrades to FCFS

# Topic : RR

**Advantages:**

1. All processes execute one by one, so no starvation
2. Better interactiveness
3. Burst time is not required to be known in advance ⇒ Practically implemented

**Disadvantages:**

1. Average waiting time and turnaround time are more
2. Can degrade to FCFS

# [MCQ]

#Q. If the time-slice used in the round-robin scheduling policy is more than the maximum time required to execute any process, then the policy will?

A. Degenerate to shortest job first

B. Degenerate to priority scheduling

C. Degenerate to first come first serve ✓

D. None of the above

[MCQ]

H.W.

#Q. A scheduling algorithm assigns priority proportional to the waiting time of a process. Every process starts with priority zero (the lowest priority). The scheduler re-evaluates the process priorities every T time units and decides the next process to schedule. Which one of the following is TRUE if the processes have no I/O operations and all arrive at time zero?

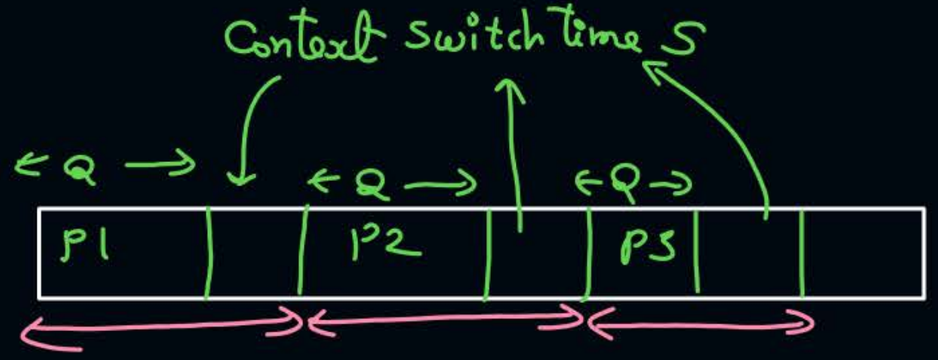
**GATE-2013**

A. This algorithm is equivalent to the first-come-first-serve algorithm

B. This algorithm is equivalent to the round-robin algorithm.

C. This algorithm is equivalent to the shortest-job-first algorithm

D. This algorithm is equivalent to the shortest-remaining-time-first algorithm




$$\text{CPU efficiency} = \frac{Q}{Q+S}$$

# Topic : Multilevel Queue Scheduling

There are multiple ready queue.
and processes are kept in queues as per their behaviour
for each Queue a diff. algo is used.

# Topic : Multilevel Queue Scheduling

3 queues

**System Processes**

↳ RR Q = 2

**Foreground Processes**

↳ RR Q = 4

**Background Processes**

↳ FCFS

# Topic : Multilevel Queue Scheduling

1. Fixed priority preemptive scheduling method ⇒ starvation

2. Time slicing

# Topic : Multilevel Queue Scheduling

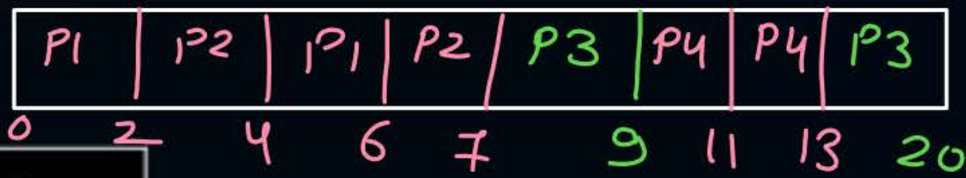
fixed priority preemptive

Queue 1: RR with Q=2 (Higher)

Q1 : ~~P1, P2~~, P4

Queue 2: FCFS (Lower)

Q2 : P3,




| Process | Arrival Time | Burst Time | Queue |
|---|---|---|---|
| P1 | 0 | ~~4~~ 2 | 1 |
| P2 | 0 | ~~3~~ 1 | 1 |
| P3 | 0 | ~~9~~ 7 | 2 |
| P4 | 9 | ~~4~~ 2 | 1 |

# Topic : Multilevel Queue Scheduling

H.W.

Queue 1: RR with Q=3

Higher

Queue 2: FCFS

| Process | Arrival Time | Burst Time | Queue |
|---|---|---|---|
| P1 | 0 | 3 | 1 |
| P2 | 0 | 3 | 1 |
| P3 | 2 | 8 | 2 |
| P4 | 10 | 4 | 1 |
| P5 | 11 | 6 | 2 |
| P6 | 11 | 3 | 1 |
| P7 | 19 | 2 | 1 |
| P8 | 13 | 5 | 2 |

# Topic : Multilevel Queue Scheduling

**Disadvantages:**

1. Some processes may starve for CPU if some higher priority queues are never becoming empty

2. It is inflexible in nature. ⟶ Processes can not be shifted b/w queue.

# Topic : Multilevel Feedback Queue Scheduling

Processes can be moved to higher or lower priority queue.

# Topic : Multilevel Feedback Queue Scheduling

System Processes

Foreground Processes

Background Processes

# Topic : Multilevel Feedback Queue Scheduling

**Disadvantage:**

1. Some processes may starve for CPU if some higher priority queues are never becoming empty.

**Advantage:**

1. Flexible

# [NAT] Homework

#Q. Consider the following set of processes:

| Process | Arrival Time | Burst Time |
|---|---|---|
| P1 | 0 | 10ms |
| P2 | 0 | 29ms |
| P3 | 0 | 3ms |
| P4 | 0 | 7ms |
| P5 | 0 | 12ms |

FCFS = 28

SJF =13

SRTF =13

RR =23

Calculate average waiting time for:
FCFS, Non-preemptive SJF, SRTF and Round-robin (quantum = 10ms)

# 2 mins Summary

**Topic** Multilevel Queue Scheduling

**Topic** Multilevel Feedback Queue Scheduling

**Topic** Questions on Scheduling

# Happy Learning

# THANK - YOU