CS & IT ENGINEERING

Operating System

CPU Scheduling

Lecture - 05

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Recap of Previous Lecture

Topic Priority based algorithm

Topic Round Robin Algorithm

Topics to be Covered

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

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, hence implemented practically

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]

#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. with time slice = T.

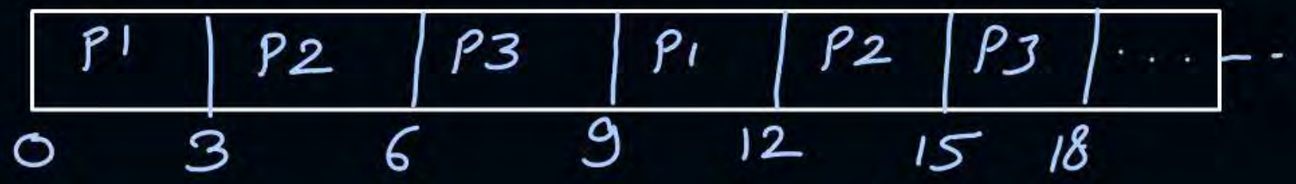
C. This algorithm is equivalent to the shortest-job-first algorithm

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

Ex:-

	AT	Priority
P1	0	~~0~~ ~~3~~ ~~6~~ ~~9~~ 12
P2	0	~~0~~ ~~3~~ ~~6~~ ~~9~~ 12
P3	0	~~0~~ ~~3~~ ~~6~~ ~~9~~ 12

T = 3



Topic : Multilevel Queue Scheduling

⇒ multiple ready Queues

⇒ one scheduling algo per Queue.

Topic : Multilevel Queue Scheduling

Queue 1

System Processes

Queue 2

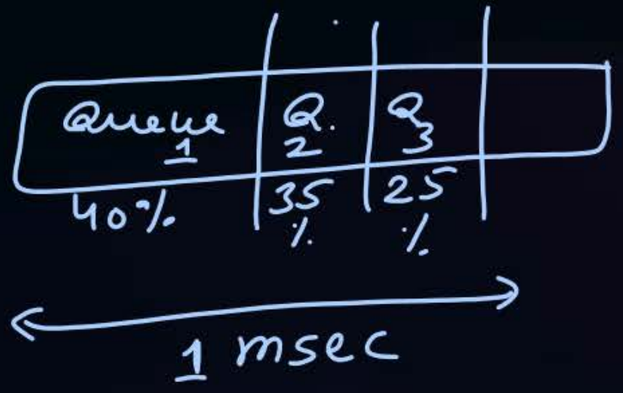
Foreground Processes

Queue 3

Background Processes

Topic : Multilevel Queue Scheduling

1. Fixed priority preemptive scheduling method
2. Time slicing



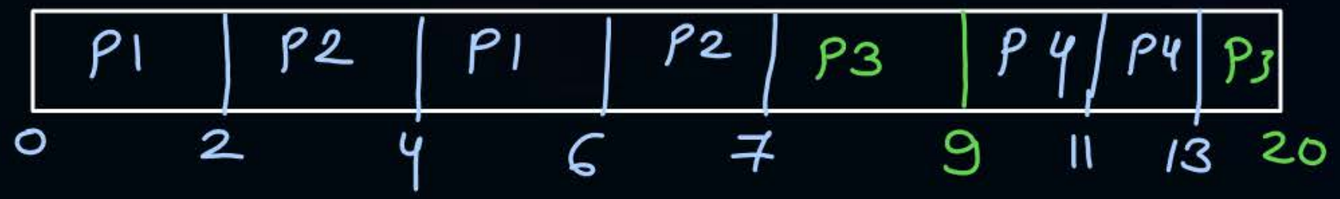
Every queue gets a fixed priority & processes from highest priority queue execute first.
when all processes of highest priority queue are executed then next queue's processes start executing.
Arrival in higher priority queue preempts a process of low priority queue.

Topic : Multilevel Queue Scheduling

fixed priority preemptive

Queue 1: RR with Q=2
↳ Higher

Queue 2: FCFS



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

Q1 => ~~P1~~, ~~P2~~, ~~P4~~

Q2 => P3

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 switched from one queue to another.

Topic : Multilevel Feedback Queue Scheduling

Extension of M.L. Queue scheduling.

processes can be upgraded to higher priority Queue

or —11— downgraded to lower —11— ——

Topic : Multilevel Feedback Queue Scheduling

System Processes

Foreground Processes

Background Processes

feedback

Topic : Multilevel Queue Scheduling

Disadvantage:

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

Advantage:

1. Flexible

Topic : Analysis of Scheduling Algorithms

Basis of Analysis	Algorithm
Minimum average WT among non-preemptive	SJF
Minimum average WT among all algo^s	SRTF (Preemptive)
Non-preemptive always	FCFS, SJF, LJF, HRRN, Non-preemptive priority
Preemptive always	—
SRTF behaves as SJF	① when all processes arrive together. ② when later arriving processes are not smaller than running process
Preemptive Priority behaves as Non-Preemptive	① when all processes arrive together. ② when later arriving processes have lower priority.

Topic : Analysis of Scheduling Algorithms

Basis of Analysis	Algorithm
RR behaves as Non-Preemptive	Max (BT of all processes) $\leq$ Q
Convoy Effect	FCFS, LJF, LRTF
Starvation	SJF, SRTF, Priority algo both type, LJF, LRTF
when LRTF is non-preemptive	when all processes have BT = 1

ex:- when SRTF behaves like SJF :-

①

	AT	BT
P1	0	5
P2	0	3
P3	0	4

②

	AT	BT
P1	0	10
P2	1	20
P3	2	30

⇒ SJF & SRTF also are priority based algorithm where lowest B.T. process gets highest priority.

ex:- Preemptive priority algo behaves as non-preemptive priority

ex:- ①

	AT	Priority
P1	0	5
P2	0	2 (Highest)
P3	0	8

ex ②

	AT	Priority
P1	0	1 (Highest)
P2	1	2
P3	2	3

[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

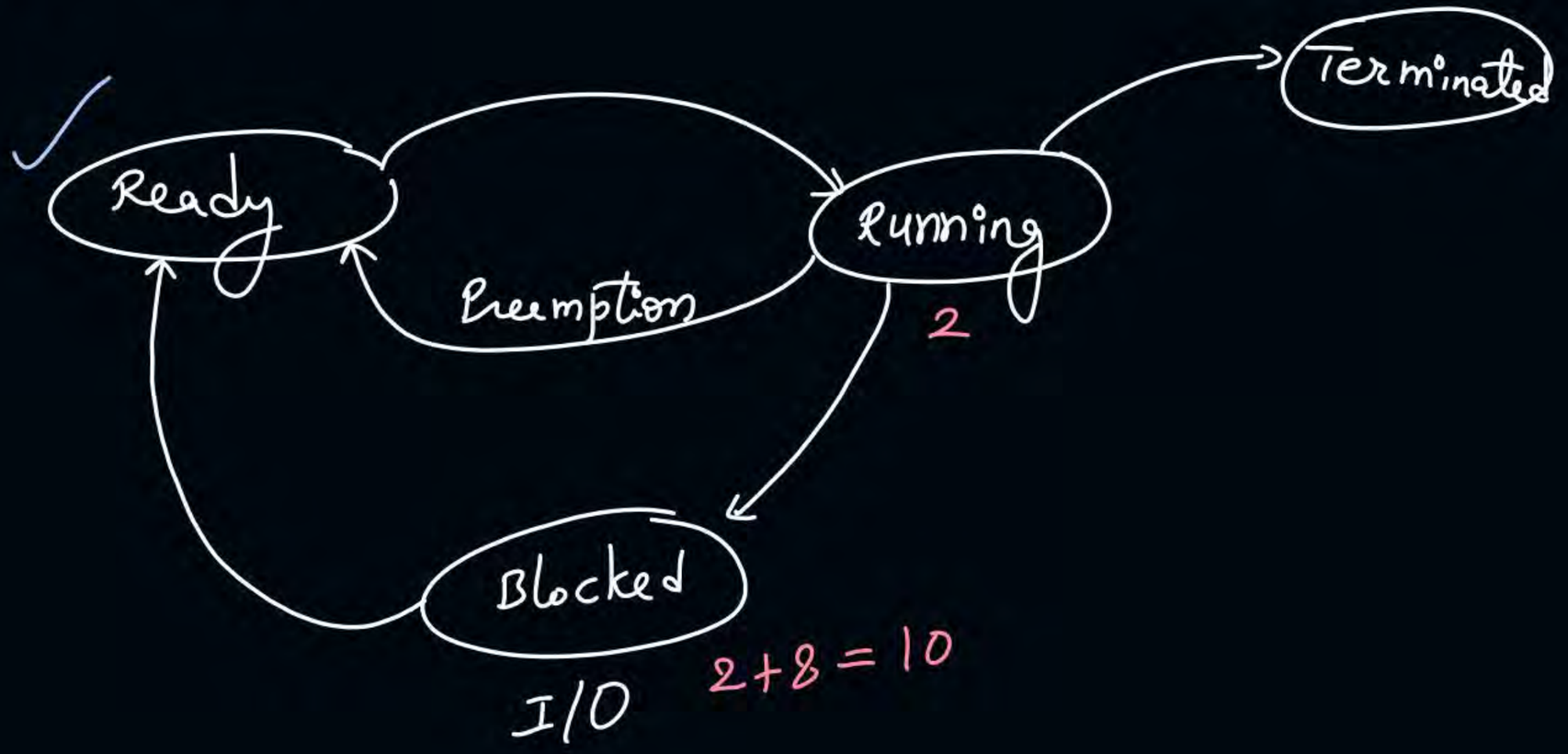
SJF =13

SRTF =13

RR =23

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

Process state :-



[MCQ]

$$\text{avg } wT = \frac{7 + 14 + 3 + 12}{4} = 9$$

#Q. Consider a process scenario in which each process executes first in CPU then goes for IO operation, then once again process needs a CPU bursts and then terminates. Following is given a process scenario in which for CPU execution system uses non-preemptive SJF algorithm. Consider system has enough number of resources to carry out IO operations for all processes in parallel at a time. What is the average waiting time for the execution for the processes?

WT in Ready Queue = (TAT − sum of all burst time)

CT	TAT	WT	Process	Arrival Time	CPU Burst Time	IO Burst Time	CPU Burst Time
22	22	7	P1	0	2	8	5
30	30	14	P2	0	4	5	7
17	17	3	P3	0	3	9	2
23	23	12	P4	0	6	4	1

P1 I/O
2+8 = 10

P3 I/O
5+9=14

P2 I/O
9+5=14

P4 I/O
15+4=19

	Ready Queue
0	~~P1~~, P2, P3, P4
2	P2, P3, P4
5	P2, P4
9	P4
15	P1, P2, P3
17	P1, P2

	Ready Queue
22	P2, P4
23	P2

[MCQ]

#Q. Consider a process scenario in which each process executes first in CPU then goes for IO operation, then once again process needs a CPU bursts and then terminates. Following is given a process scenario in which for CPU execution system uses preemptive SRTF algorithm. Consider system has enough number of resources to carry out IO operations for all processes in parallel at a time. What is the average waiting time for the execution for the processes?

Process	Arrival Time	CPU Burst Time	IO Burst Time	CPU Burst Time
P1	0	6	7	1
P2	1	4	2	9
P3	2	1	6	5

P3 I/O
3+6 = 9

P1 I/O
11+7 = 18

P2
6+2=8

	R.Q.
0	P1
1	P1, P2
2	P1, P2, P3
3	P1, P2
6	P1

	R.Q.
8	P1, P2
9	P1, P2, P3
11	P2, P3
16	P2
18	P2, P1

[MCQ]

H.W.

#Q. The arrival time, priority and duration of the CPU and I/O bursts for each of three processes P1, P2 and P3 are given in the table below. Each process has a CPU burst followed by an I.O burst followed by another CPU burst. Assume that each process has its own I/O resource.

Process	AT	Priority	BT (CPU)	BT(I/O)	BT(CPU)
P1	0	2	1	5	3
P2	2	3(lowest)	3	3	1
P3	3	1(highest)	2	3	1

The multi – programmed operating system uses preemptive priority scheduling. What are the finish times of the process P1, P2 and P3 ? **GATE - 2006**

A 11, 15, 9

B 10, 15, 9

C 11, 16, 10

D 12, 17, 11

[MCQ]

H.W.

#Q. Multilevel Queue Scheduling, with fixed priority preemptive algorithm

High ↙ Queue 1: RR with Q=2

Queue 2: SJF

Process	Arrival Time	Burst Time	Queue
P1	0	3	1
P2	1	3	2
P3	2	5	2
P4	1	4	1
P5	11	4	2
P6	15	3	1
P7	16	2	1

2 mins Summary

Topic Multilevel Queue Scheduling

Topic Multilevel Feedback Queue Scheduling

Topic Questions on Scheduling

Happy Learning

THANK - YOU