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CPU Scheduling Algo: MLQ, MLFQ & Questions

Comprehensive Course on Operating System for GATE - 2024/25

Vishvadeep Gothi • Lesson 9 • Apr 28, 2023

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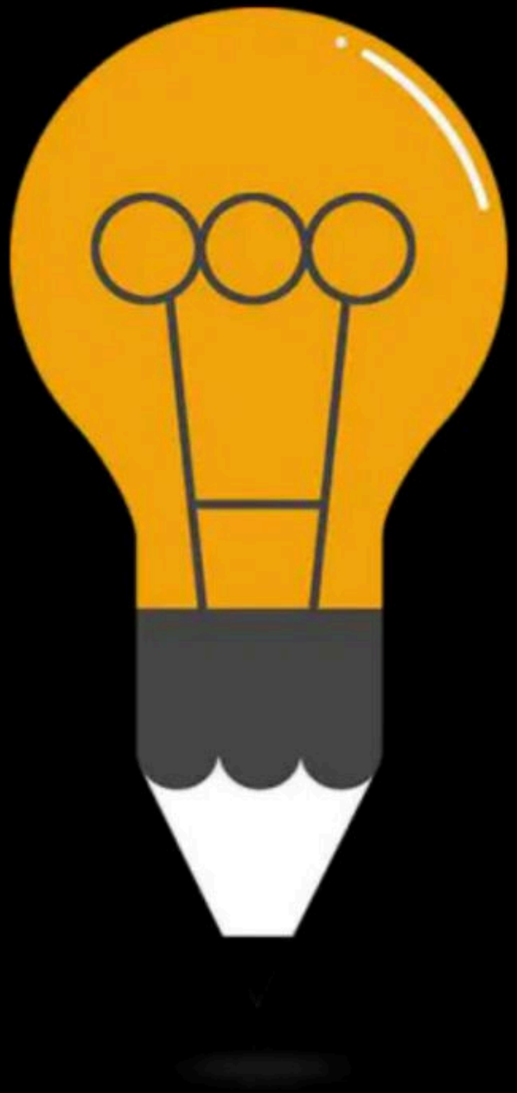
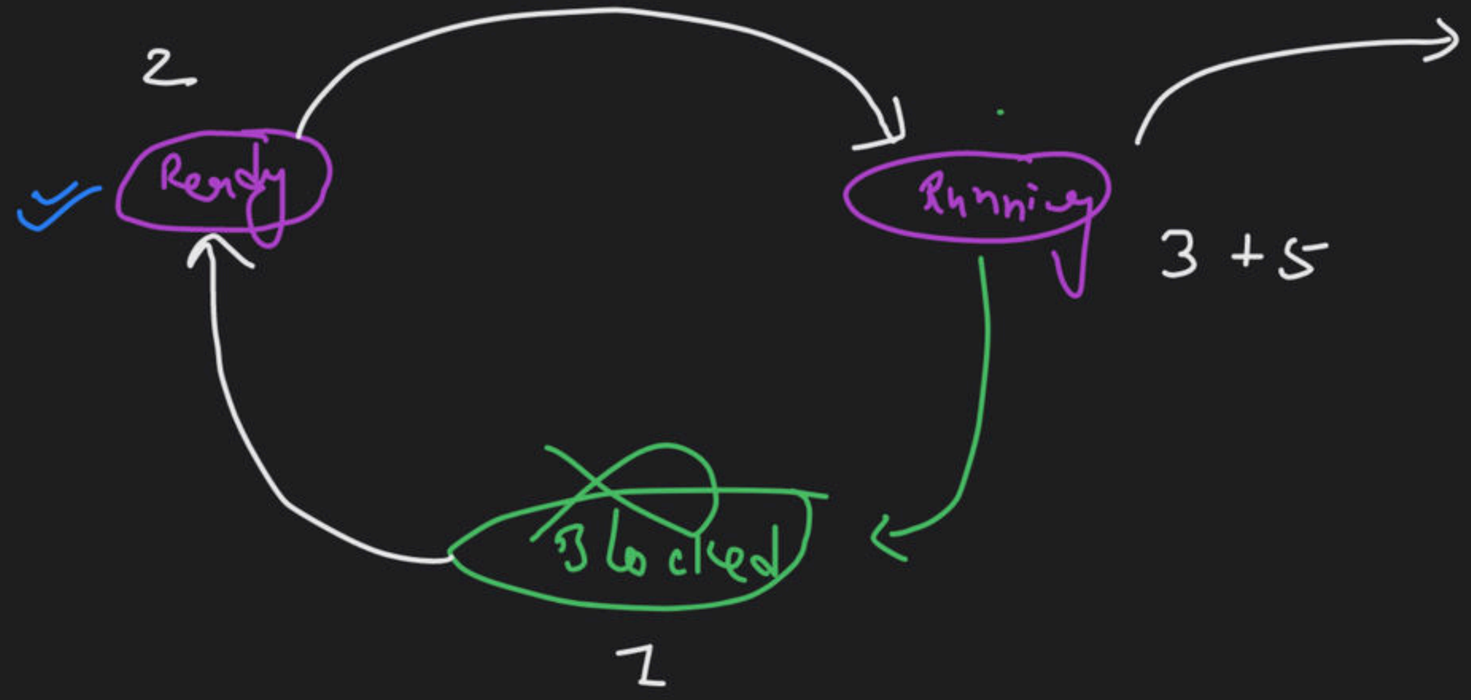


Operating System

MLQ & MLFQ Scheduling

By: Vishvadeep Gothi



$WT = TAT - (CPU + \dots + I/O)$

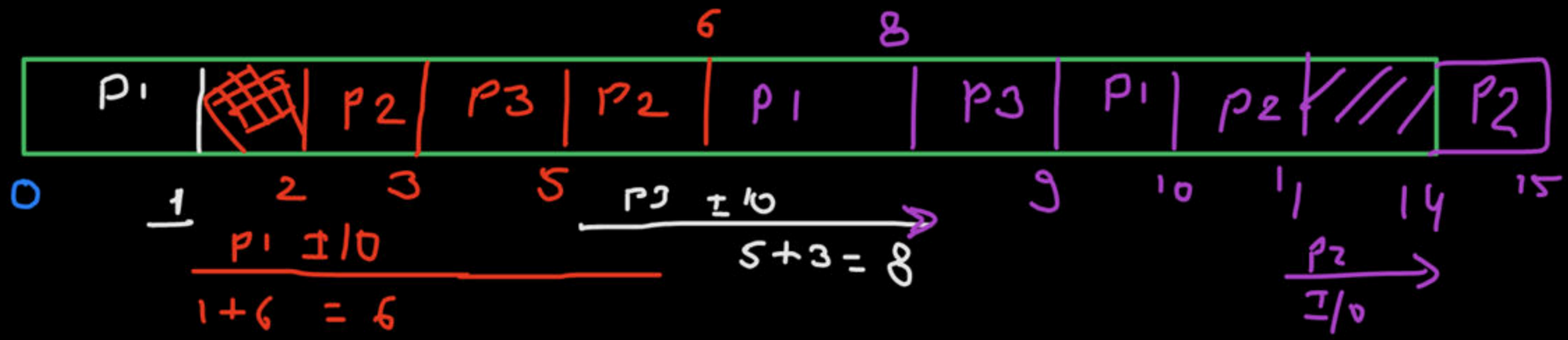
TAT – CPU Burst Time –

Question GATE-2006

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. The multi-programmed operating system uses preemptive priority scheduling. What are the finish times of the processes P1, P2 and P3 ?

Process	Arrival Time	Priority	CPU, IO, CPU Bursts
P1	0	2	1, 5, 3
P2	2	3 (Lowest)	3, 3, 1
P3	3	1 (Highest)	2, 3, 1

10, 15, 9



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Question

If the waiting for a process is p for IO and there are n processes in the memory, then the CPU utilization is?

1 process :-

CPU utilizat^{n} = $1 - p$

2 processes :-

I/O requirement = $p * p$

CPU utilizat^{n} = $1 - p^{2}$

for n processes

CPU utilizat^{n} = $1 - p^{n}$

Ques Consider $p = 0.2$

no. of processes = 5

CPU utilizatn = ?

$= 1 - (0.2)^5$

$= 0.99968$

K = kilo = 2^{10}

M = Mega = 2^{20}

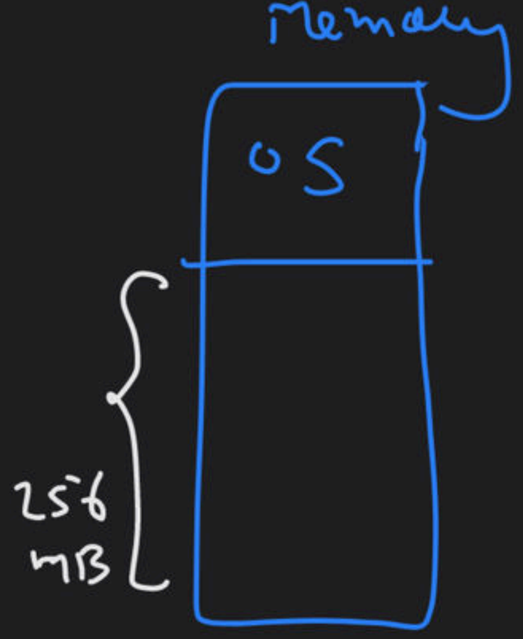
G = Giga = 2^{30}

Ques) Assume $p = 0.15$

Memory size to store user processes = 256 MB

each process to be stored on 4 MB.

CPU utilizat^n = ?



no. of processes = $\frac{256\,MB}{4\,MB} = 64$

CPU utilizat^n $= 1 - 0.15^{64}$

$= 0.99$

Multilevel Queue Scheduling

All processes in ready state are distributed over multiple ready Queues. And to run process of each Queue, a different scheduling algo is used.

Multilevel Queue Scheduling

Highest priority

System Processes

Foreground Processes

Background Processes

Lowest priority

ex:-

RR Q = 2

FCFS

RR Q = 4

Multilevel Queue Scheduling

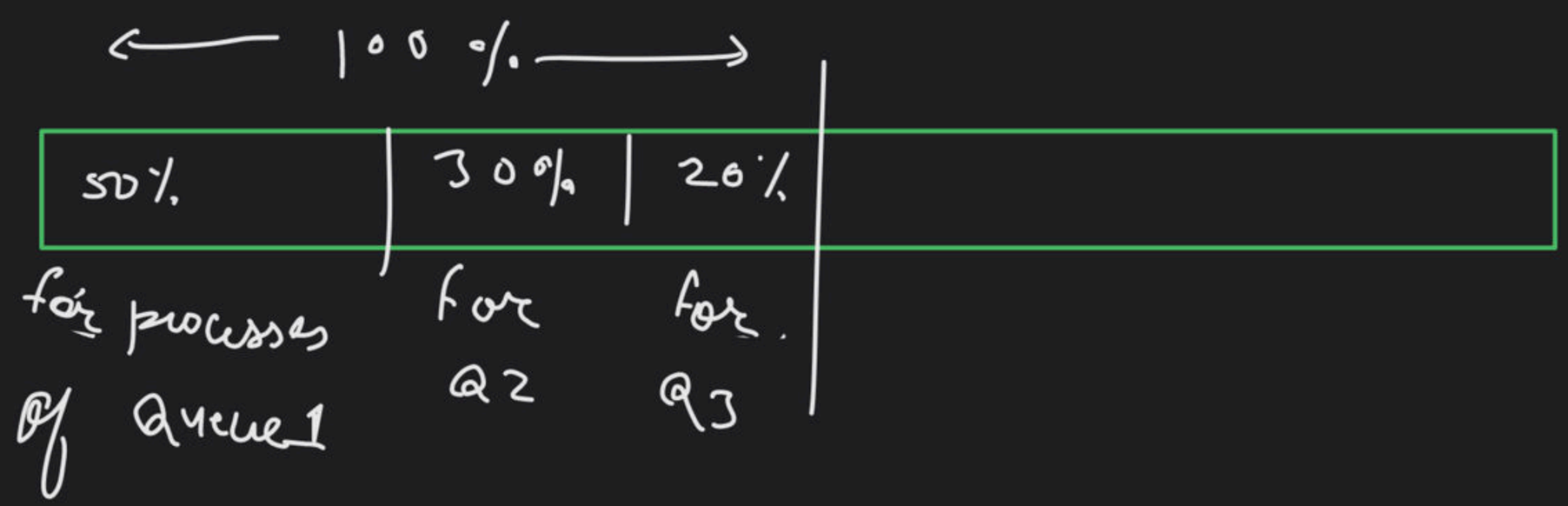
1. Fixed priority preemptive scheduling method → Queues have priority
2. Time slicing

once a higher priority queue is empty then only, processes of next priority Queue are executed.

⇒ Running process from lower priority queue is preempted when a new process arrives in high priority Queue.

Processes from lower priority Queue suffers from starvation

2. Time slicing :-

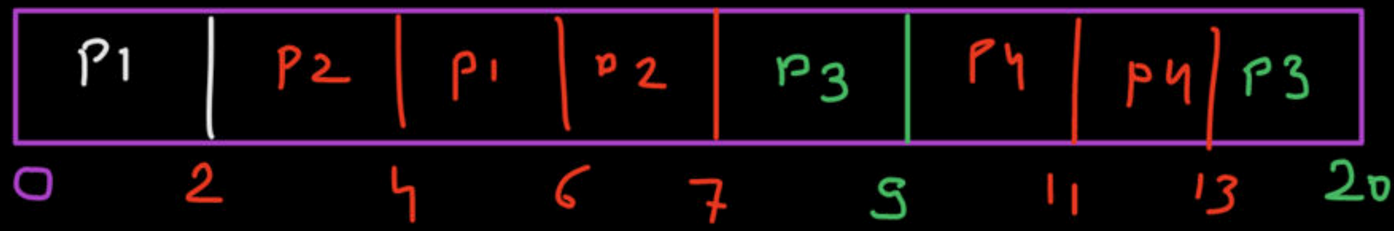


Multilevel Queue Scheduling

Queue 1: RR with Q=2
Queue 2: FCFS

fixed priority preemptive
Queue 1 = higher priority

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



Queue 1 :- ~~P1~~, ~~P2~~ P4

Queue 2 :- P3

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Multilevel Queue Scheduling

Queue 1: RR with Q=3
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

Multilevel Queue Scheduling

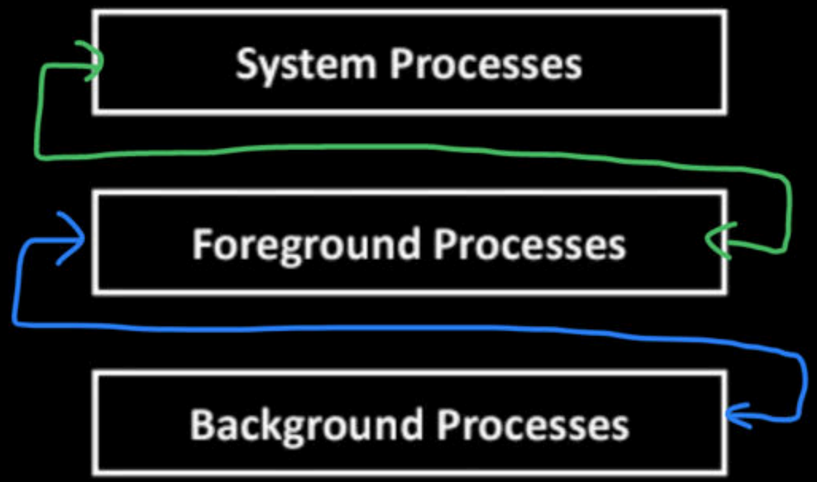
Disadvantages:

1. Some processes may starve for CPU if some higher priority queues are never becoming empty ⟶ fixed priority preemptive
2. It is inflexible in nature.
   - ↳ processes can not shift b/w queue.

Multilevel Feedback Queue Scheduling

⇒ same as multilevel queue scheduling, but here processes can be upgraded to higher queues or degraded to lower queues, based on some criteria.

Multilevel Feedback Queue Scheduling



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Multilevel Queue Scheduling

feed back

Disadvantage:

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

Advantage:

1. Flexible

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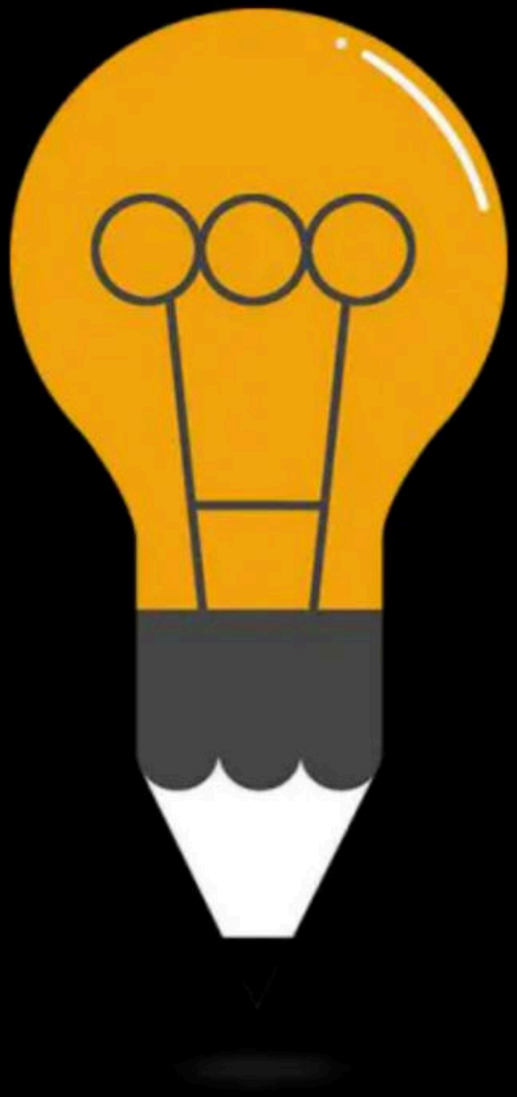

DPP

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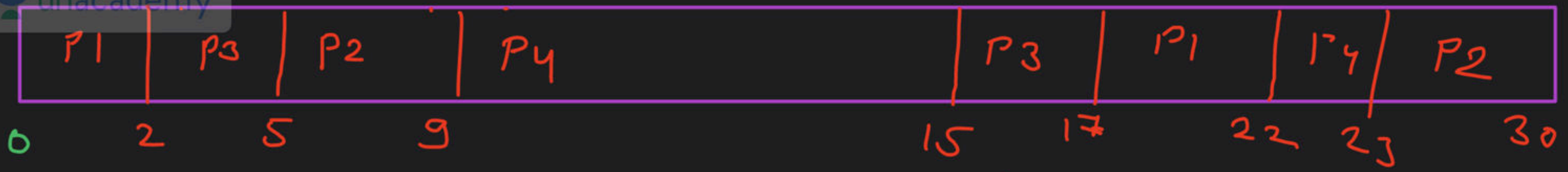
Question 1

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 only 2 processes in parallel at a time. What is the average waiting time for the execution for the processes?

→ only In Ready Queue

Process	Arrival Time	CPU Burst Time	IO Burst Time	CPU Burst Time
P1	0	2	8	5
P2	0	4	5	7
P3	0	3	9	2
P4	0	6	4	1



P4 I/O

15 + 4 = 19

P1 I/O

2 + 8 = 10

10

P3 I/O

5 + 9 = 14

14

9 10

P2 I/O

P2

10 + 5 = 15

15

I/O wait

~~P1, P2, P3~~

R. State

, P4

	CT	TAT	WT
P1	22	22	7
P2	36	36	14 ⟹
P3	17	17	3
P4	23	23	12

13 time unit in Ready state ⇓ for CPU + 1 time unit in blocked state ⇓ for I/O

overall avg WT = $\frac{7+14+3+12}{4}$

including wait for I/O

$= \frac{36}{4}$

$= 9$

avg WT only in Ready state $= \frac{7+13+3+12}{4} = \frac{35}{4}$

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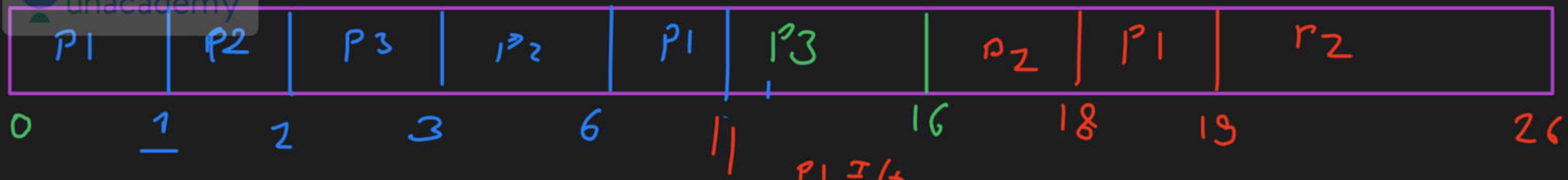
Question 2

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	CT	TAT	WT
P1	0	6	7	1	19	19	5
P2	1	4	2	9	26	25	10
P3	2	1	6	5	16	14	2

avg WT = $\frac{5+10+2}{3} = \frac{17}{3} = 5.67$



P1 IO

11 + 7 = 18

P3 IO

3 + 6 = 9

P2 IO

6 + 2 = 8

~~P3 = 5~~

P2 = 9

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Question 3 H.W.

Consider a following process scenario in which each process first executes on CPU for given time duration then goes for IO operations and then again executes on CPU before termination. CPU uses non-preemptive SJF algorithm and consider each process has its separate set of IO devices to work in parallel with other process. avg WT

Process	Arrival Time	Burst Time CPU	IO Time	Burst Time CPU
P1	0	6	4	7
P2	1	4	3	5
P3	2	5	5	2
P4	4	2	2	4

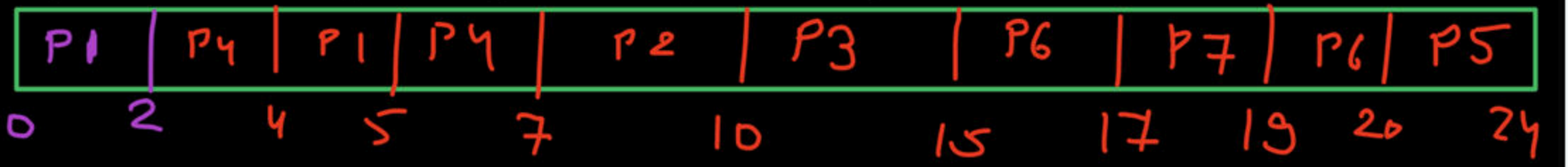
Question 4

higher priority

Multilevel Queue Scheduling, with fixed priority preemptive algorithm

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

Q1 :- ~~P1~~, ~~P4~~, ~~P1~~, ~~P6~~, P7, P6

Q2 :- ~~P2~~, ~~P3~~, P5

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Question 5

A computer system has 2GB of RAM and OS occupies 256MB of RAM. All the processes are of 128MB and have same characteristics. If the goal is 99% CPU utilization, then the maximum I/O wait that can be tolerated?

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Happy Learning.!