

ECE 4310
Operating Systems for Embedded Application

Homework 2

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1 (10 pts) Explain in detail the difference between preemptive and non-preemptive scheduling.

Preemptive scheduling can happen when a process switches from the running state to the waiting state, when a process switches from the running state to the ready state, when a process switches from the waiting state to the ready state, or when a process terminate; whereas nonpreemptive scheduling take place only when a process switches from the running state to the waiting state or when a process terminate.

2 (15 pts) Consider the following processes arriving at the ready queue and dispatched to a single core CPU:

PID	Arrival Time	Burst (ms)	Priority
10	0	4	9
11	2	5	4
12	7	9	3
13	11	2	12
14	20	11	7
15	23	6	4

Using the following scheduling algorithms:

First-come first-served (FCFS)

Preemptive shortest job first (PSJF)

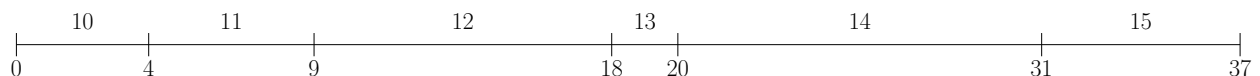
Preemptive Round-robin with 4 ms quantum

Priority with a priority aging of +1 every 8 ms while in the ready queue

Answer the following:

- Draw a Gantt chart showing the arrival time and run times for each process.
- Calculate the wait time for each process and average waiting time.
- Calculate the turnaround time for each process.

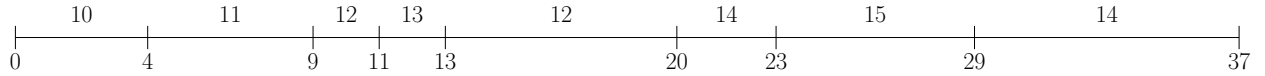
FCFS



PID	Wait Time	Turnaround Time
10	$0 - 0 = 0$	$4 - 0 = 4$
11	$4 - 2 = 2$	$9 - 2 = 7$
12	$9 - 7 = 2$	$18 - 7 = 11$
13	$18 - 11 = 7$	$20 - 11 = 9$
14	$20 - 20 = 0$	$31 - 20 = 11$
15	$31 - 23 = 8$	$37 - 23 = 14$

$$\text{Average wait time} = \frac{1}{6}(0 + 2 + 2 + 7 + 0 + 8) \approx 3.17$$

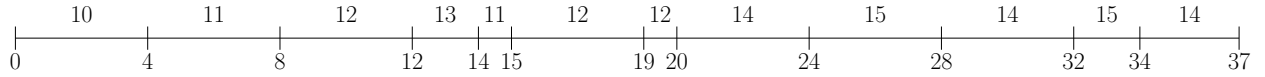
PSJF



PID	Wait Time	Turnaround Time
10	$0 - 0 = 0$	$4 - 0 = 4$
11	$4 - 2 = 2$	$9 - 2 = 7$
12	$(13 - 11) + (9 - 7) = 4$	$20 - 7 = 13$
13	$11 - 11 = 0$	$13 - 11 = 2$
14	$(29 - 23) + (20 - 20) = 6$	$37 - 20 = 17$
15	$23 - 23 = 0$	$29 - 23 = 6$

Average wait time = $\frac{1}{6}(0 + 2 + 4 + 0 + 6 + 0) = 2$

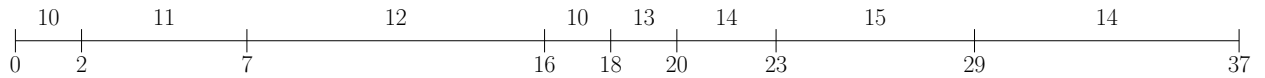
Preemptive Round-robin with 4 ms quantum



PID	Wait Time	Turnaround Time
10	$0 - 0 = 0$	$4 - 0 = 4$
11	$(14 - 8) + (4 - 2) = 8$	$15 - 2 = 13$
12	$(15 - 12) + (8 - 7) = 4$	$20 - 7 = 13$
13	$12 - 11 = 1$	$14 - 11 = 3$
14	$(34 - 32) + (28 - 24) + (20 - 20) = 6$	$37 - 20 = 17$
15	$(32 - 28) + (24 - 23) = 5$	$34 - 23 = 11$

Average wait time = $\frac{1}{6}(0 + 8 + 4 + 1 + 6 + 5) \approx 3.7$

Priority with a priority aging of +1 every 8 ms while in the ready queue



PID	Wait Time	Turnaround Time
10	$(16 - 2) + (0 - 0) = 14$	$18 - 0 = 18$
11	$2 - 2 = 0$	$7 - 2 = 5$
12	$7 - 7 = 0$	$16 - 7 = 9$
13	$18 - 11 = 7$	$20 - 11 = 9$
14	$(29 - 23) + (20 - 20) = 6$	$37 - 20 = 17$
15	$23 - 23 = 0$	$29 - 23 = 6$

Average wait time = $\frac{1}{6}(14 + 0 + 0 + 7 + 6 + 0) \approx 4.5$

3 (10 pts) What is an atomic operation? Provide at least one detailed example of an atomic operation.

An atomic operation is an operation that must be executed fully uninterrupted. An example is `acquire()` for mutex lock. `acquire()` have two part: the busy wait part and the set unavailable part. The process will constantly check for availability of mutex lock and once it become available, it must set it to unavailable before it is acquired by other process. Therefore, it must set the lock unavailable immediately after the wait ends.

4 (15 pts) Recall the various deadlock detection and prevention algorithms we've discussed in class and consider the following snapshot of a system with five processes (P10, P11, P12, P13, P14) and four resources (R1, R2, R3, R4). R1, R2, R3, and R4 have a total of 4, 7, 2, and 11 resources, respectively. There are no current outstanding queued unsatisfied requests.

Table 1: Allocation

PID	R1	R2	R3	R4
10	1	0	1	8
11	0	2	0	1
12	2	0	0	0
13	0	1	1	1
14	1	3	0	1

Table 2: Max Need

PID	R1	R2	R3	R4
10	3	1	2	8
11	0	6	2	5
12	2	1	2	10
13	1	7	2	3
14	4	5	2	4

Is the system currently in a safe or unsafe state? If safe, provide the process execution order.

Table 3: Need

PID	R1	R2	R3	R4
10	2	1	1	0
11	0	4	2	4
12	0	1	2	10
13	1	6	1	2
14	3	2	2	3

$Available = (4, 7, 2, 11) - (1, 0, 1, 8) - (0, 2, 0, 1) - (2, 0, 0, 0) - (0, 1, 1, 1) - (1, 3, 0, 1) = (0, 1, 0, 0)$
Initialize: $Work = Available$, $Finish = (False, False, False, False, False)$
Check P10: $Finish[10] = False$, $Need_{10} = (2, 1, 1, 0) > (0, 1, 0, 0) = Work$
Check P11: $Finish[11] = False$, $Need_{11} = (0, 4, 2, 4) > (0, 1, 0, 0) = Work$
Check P12: $Finish[12] = False$, $Need_{12} = (0, 1, 2, 10) > (0, 1, 0, 0) = Work$
Check P13: $Finish[13] = False$, $Need_{13} = (1, 6, 1, 2) > (0, 1, 0, 0) = Work$
Check P14: $Finish[14] = False$, $Need_{14} = (3, 2, 2, 3) > (0, 1, 0, 0) = Work$
Not enough resources to finish any process, system in an unsafe state.