CS 471: Operating System Concepts

Spring 2009 **Lecture: T 1910-2150**

HW #1 Points: 20 Due: Jan 27, 2009

Question 1 [Points 10] Exercise 5.12 using the following data (with RR Quantum = 4 instead of 1 as in the textbook)

Process	Arrival time	Burst time	Priority
P1	10	10	2
P2	15	4	1
P3	20	12	4
P4	5	8	3
P5	25	6	5

Solution:
FCFS:

0-5	Idle
5-13	P4
13-23	P1
23-27	P2
27-39	P3
39-45	P5

Turnaround time = Process finish time – Arrival time
Waiting time = Turnaround time – CPU Burst time

Process	Arrival Time	Burst Time	Priority	Finish Time	Turnaround Time	Waiting Time
P1	10	10	2	23	23-10=13	13-10=3
P2	15	4	1	27	27-15=12	12-4=8
P3	20	12	4	39	39-20=19	19-12=7
P4	5	8	3	13	13-5=8	8-8=0
P5	25	6	5	45	45-25=20	20-6=14
Average					14.4	6.4

Round Robin:

0-5	Idle
5-9	P4
9-13	P4
13-17	P1
17-21	P2
21-25	P1
25-29	P3
29-31	P1*
31-35	P5
35-39	P3
39-41	P5
41-45	P3

*Assuming that P1 was preempted at 25^- and then P5 arrived at 25^+
(**Otherwise, 29-33 P5 and 33-35 P1)

Process	Arrival Time	Burst Time	Priority	Finish Time	Turnaround Time	Waiting Time
P1	10	10	2	31* 35**	21* 25**	11* 15**
P2	15	4	1	21	6	2
P3	20	12	4	45	25	13
P4	5	8	3	13	8	0
P5	25	6	5	41	16	10
Average					15.2* 16**	7.2* 8**

SJF (Non-preemptive):

0-5	Idle
5-13	P4
13-23	P1
23-27	P2
27-33	P5
33-45	P3

Process	Arrival Time	Burst Time	Priority	Finish Time	Turnaround Time	Waiting Time
P1	10	10	2	23	13	3
P2	15	4	1	27	12	8
P3	20	12	4	45	25	13
P4	5	8	3	13	8	0
P5	25	6	5	33	8	2
Average					13.2	5.2

SJF (Preemptive):

0-5	Idle
5-10	P4
10-15	P1
15-19	P2
19-24	P1
24-27	P4
27-39	P3
39-45	P5

Process	Arrival Time	Burst Time	Priority	Finish Time	Turnaround Time	Waiting Time
P1	10	10	2	24	14	4
P2	15	4	1	19	4	0
P3	20	12	4	39	19	7
P4	5	8	3	27	22	14
P5	25	6	5	45	20	14
Average					15.8	7.8

Non-Preemptive Priority:

0-5	Idle
5-13	P4
13-23	P1
23-27	P2
27-39	P3
39-45	P5

Process	Arrival Time	Burst Time	Priority	Finish Time	Turnaround Time	Waiting Time
P1	10	10	2	23	13	3
P2	15	4	1	27	12	8
P3	20	12	4	39	19	7
P4	5	8	3	13	8	0
P5	25	6	5	45	20	14
Average					14.4	6.4

d) Average waiting time:

Average Waiting Time	
FCFS	6.4
SJF(Preempt)	7.8
SJF(Non-Preempt)	5.2
Non-Preemptive	6.4
Round Robin	7.2* 8.0**

SJF (Non-preemptive) has the minimum average waiting time.

Question 2 [Points 2] Consider the exponential average formula used to predict the length of the next CPU burst. What are the implications of assigning the following values to the parameters used by the algorithm?
a. $\alpha = 0$ and $\tau_0 = 100$milliseconds
b. $\alpha = 0.99$ and $\tau_0 = 10$milliseconds

Answer: (a) the formula always makes a prediction of 100 milliseconds for the next CPU burst.
(b) The most recent behavior of the process is given much higher weight than the past estimated value. Consequently, the scheduling algorithm is almost memory-less, and simply predicts the length of the previous burst for the next quantum of CPU execution.

Question 3. Which of the following scheduling algorithms could result in starvation?
a. First-come, first-served
b. Shortest job first
c. Round robin
d. Priority

Answer: Shortest job first and priority-based scheduling algorithms could result in starvation.

Question 4 [Points 6] (Similar to Exercise 5.15) Consider a system running 2 (two) CPU-bound tasks and 4 (four) I/O-bound tasks. Each I/O bound task issues an I/O operation once every 1 millisecond of CPU. Each I/O operation takes 4 milliseconds. Assume that there is only one I/O device (so multiple I/O requests may have to queue). Assume that the context switch takes 0.2 milliseconds.

Assume that each CPU-bound requires 10 milliseconds of CPU to complete and each I/O-bound task requires 2 milliseconds of CPU time. Show through a Ganttt chart how the I/O and CPU are allocated and compute the average turnaround times for the CPU-bound and I/O bound tasks.

Assume that all jobs are in the ready queue at time 0. To be more specific, assume that the two CPU jobs are at the front and the I/O

jobs are at the back of the queue. Refer to 5.15 where it refers to two cases: RR with 1 millisecond quantum; RR with 10 milliseconds quantum;

Answer: With Quantum = 10 milliseconds; CPU bound processes: CPU1 and CPU2; IO processes: IO1-IO4

Time	CPU State
0-10	CPU1
10-10.2	CS
10.2-20.2	CPU2
20.2-20.4	CS
20.4-21.4	IO1
21.4-21.6	CS
21.6-22.6	IO2
22.6-22.8	CS
22.8-23.8	IO3
23.8-24.0	CS
24.0-25.0	IO4
25.0-25.2	CS
25.2-25.4	Idle
25.4-25.6	CS
25.6-26.6	IO1
26.6-26.8	CS
26.8-29.4	Idle
29.4-29.6	CS
29.6-30.6	IO2
30.6-30.8	CS
30.8-33.4	Idle
33.4-33.6	CS
33.6-34.6	IO3
34.6-34.8	CS
34.8-37.4	Idle
37.4-37.6	CS
37.6-38.6	IO4

Time	IO Device State
0-21.4	Idle
21.4-25.4	IO1
25.4-29.4	IO2
29.4-33.4	IO3
33.4-37.4	IO4
37.4-41.4	IO1
41.4-45.4	IO2

45.4-49.4	IO3
49.4-53.4	IO4

Process	Finish time	Turnaround time	Wait time
CPU1	10	10	0
CPU2	20.2	20.2	10.2
IO1	41.4	41.4	31.4
IO2	45.4	45.4	35.4
IO3	49.4	49.4	39.4
IO4	53.4	53.4	43.4

Average turnaround time for CPU task = 30.2/2 = 15.1 msec

Average turnaround time for I/O task = 149.6/4 = 37.4 msec.