CS471: Operating System Concepts
Fall 2007
(Lecture: TR 11:25-12:40 PM)
Homework #2
Points: 20
Due: September 14, 2007

Question 1 [Points 2] Exercise 5.5 (Briefly, explain your answer)
Solution: Priority and Shortest job scheduling suffer from starvation. (SJF is considered as the special case of priority scheduling algorithm). A stream of high priority processes can prevent a low priority processes from getting the CPU so eventually either processes will be running or the system will be crashed. So aging technique is used to avoid starvation.

Question 2 [Points 3] Exercise 5.7 with 5 I/O-bound and 2 CPU-bound tasks.
Solution:
a. This is rather a simple problem that appears to be complex. Since the jobs are assumed to be long term, and for every quantum either a CPU-bound job or an I/O-bound is always available, there is an overhead of 0.1 units for 1 unit of time. So utilization is 1.0/1.1 = 0.91 or 91%

b. Here, it is slightly different because an I/O job does not consume all its 10 units of CPU time. So for each I/O job, it consumes 1 unit with an overhead of 0.1 units. CPU jobs consume 10 units with an overhead of 0.1 units. Now the enxt step depends on whether or not there is queueing at the I/O (that is is there a parallel I/O or serial I/O. If we assume that there is no queueing time for I/O, then each cycle has a cycle length of 25.7 where 25 units for CPU and 0.7 units for I/O. So utilization is = 25/25.7 = 0.9727 or 97.27%. If we assume that all I/O operations content for the same device and they are queued, things become more complicated. WE will deal with this later on.

Question 3 [Points 12] Exercise 5.4 using the following data. SHOW YOUR WORK
Process Arrival time Burst time Priority

Process	Arrival Time	Burst Time	Priority
P1	5	10	3
P2	2	15	4
P3	9	5	5
P4	15	20	1
P5	12	4	2

Solution:
FCFS:

0-2	Idle
2-17	P2
17-27	P1
27-32	P3
32-36	P5
36-56	P4

Waiting time = Process start time – Arrival time
Turnaround time = Process finish time – Arrival time

Process	Arrival Time	Burst Time	Priority	Finish Time	Waiting Time	Turnaround Time
P1	5	10	3	27	12	22
P2	2	15	4	17	0	15
P3	9	5	5	32	18	23
P4	15	20	1	56	21	41
P5	12	4	2	36	20	24
Average					14.2	25

Round Robin:

0-2	Idle
2-5	P2
5-6	P1
6-7	P2
7-8	P1
8-9	P2
9-10	P1
10-11	P3
11-12	P2
12-13	P1
13-14	P3
14-15	P5
15-16	P2
16-17	P1
17-18	P3
18-19	P4
19-20	P5
20-21	P2
21-22	P1
22-23	P3
23-24	P4
24-25	P5
25-26	P2
26-27	P1
27-28	P3(STOP)
28-29	P4
29-30	P5 (STOP)
30-31	P2
31-32	P1

32-33	**P4**
33-34	**P2**
34-35	**P1**
35-36	**P4**
36-37	**P2**
37-38	**P1(STOP)**
38-39	**P4**
39-40	**P2**
40-41	**P4**
41-42	**P2**
42-43	**P4**
43-44	**P2(STOP)**
44-56	**P4(STOP)**

Process	Arrival Time	Burst Time	Priority	Finish Time	Waiting Time	Turnaround Time
P1	**5**	**10**	**3**	**38**	**23**	**33**
P2	**2**	**15**	**4**	**44**	**27**	**42**
P3	**9**	**5**	**5**	**28**	**14**	**19**
P4	**15**	**20**	**1**	**56**	**21**	**41**
P5	**12**	**4**	**2**	**30**	**14**	**18**
Average					**19.8**	**30.6**

SJF (Non-preemptive):

0-2	Idle
2-17	P2
17-21	P5
21-26	P3
36-36	P1
36-56	P4

Process	Arrival Time	Burst Time	Priority	Finish Time	Waiting Time	Turnaround Time
P1	5	10	3	36	21	31
P2	2	15	4	17	0	15
P3	9	5	5	26	12	17
P4	15	20	1	56	21	41
P5	12	4	2	21	5	9
Average					11.8	22.6

SJF (Preemptive):

0-2	Idle
2-5	P2
5-9	P1
9-12	P3
12-14	P3
14-18	P5
18-24	P1
24-36	P2
36-56	P4

Process	Arrival Time	Burst Time	Priority	Finish Time	Waiting Time	Turnaround Time
P1	5	10	3	24	9	19
P2	2	15	4	36	19	34
P3	9	5	5	14	0	5
P4	15	20	1	56	21	41
P5	12	4	2	18	2	6
Average					10.2	21

Non-Preemptive Priority:

0-2	Idle
2-17	P2
17-37	P4
37-41	P5
41-51	P1
51-56	P3

Process	Arrival Time	Burst Time	Priority	Finish Time	Waiting Time	Turnaround Time
P1	5	10	3	51	36	46
P2	2	15	4	17	0	15
P3	9	5	5	56	42	47
P4	15	20	1	37	2	22
P5	12	4	2	41	25	29
Average					21	31.8

b) Turnaround time:

Process	FCFS	SJF(Preemptive)	SJF(Non-preemptive)	Non-Preemptive priority	Round Robin
P1	22	19	31	46	33
P2	15	34	15	15	42
P3	23	5	17	47	19
P4	41	41	41	22	41
P5	24	6	9	29	19

c) Waiting time:

Process	FCFS	SJF(Preemptive)	SJF(Non-preemptive)	Non-Preemptive priority	Round Robin
P1	12	9	21	36	23
P2	0	19	0	0	27
P3	18	0	12	42	14
P4	21	21	21	2	21
P5	20	2	5	25	15

d) Average waiting time:

Average Waiting Time	
FCFS	14.2
SJF(Preempt)	10.2
SJF(Non-Preempt)	11.8
Non-Preemptive	21
RR	20

SJF (preemptive) has the minimum average waiting time when compared to rest of them.

Question 2 [Points 3] Consider the exponential average formula used to predict the length of the next CPU burst of a process. The initial estimate of the CPU burst time is $\tau 0 = 100$ milliseconds and $\alpha = 0.8$. The following are the actual CPU burst observed. t0=80 msec; t1=120 msec; t2=60 msec. Compute $\tau 1$, $\tau 2$, and $\tau 3$.
Solution:

Given:
t0=80msec
t1=120msec
t2=60msec
T0 = 100
$\alpha = 0.8$

Formula: $T(n+1) = \alpha\, t(n) + (1-\alpha)T(n)$

$T1 = \alpha\, t0 + (1- \alpha)\, T0$
$= 0.8 * 80 + (1 - 0.8)\, 100$
$= 84$

$T2 = \alpha\, t1 + (1-\alpha)\, T1$
$= 0.8*120 + (1- 0.8)84$
$= 96+16.8$
$=112.8$

$T3 = \alpha\, t2 + (1-\alpha)\, T2$
$= 0.8 * 60 + (1- 0.8)\, 112.8$
$=48 + 22.56$
$=70.56$