COP 4600 – Summer 2013

Introduction To Operating Systems

Final Exam Review

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Material Covered On Exam

- Material from exam #1 and exam #2. Review the exams.
- New material from:
  - Memory management – Parts 3 & 4 – Virtual memory (homework #3)
  - Distributed process management
  - Device Management (homework #4)
  - File Management
- A total of 58 points on the exam (14 T/F-MC problems at 2 points each plus 3 work problems) are from new material. A total of 44 points on the exam (17 T/F-MC problems at 2 points each plus one work problem) are from old material (see exams 1 & 2 and homework 1 & 2).

Format of the Exam

- The exam consists of 31 T/F – MC questions and 4 work problems.
- The work problem from the previous exams deals with processor scheduling.
- The work problems similar to those on Homework 3, deal with paging algorithms and determining page faults.
- The work problems similar to those on Homework 4, deal with disk scheduling algorithms.

Sample Questions:

1. Given the reference string shown below, determine the number of page faults that occur for this reference string when a FIFO page replacement policy is used with both a three and a four frame allocation.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

2. Given the reference string shown below, determine the number of page faults that occur for this reference string when a LRU page replacement policy is used with both a three and a four frame allocation.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

3. Given the reference string shown below, determine the number of page faults that occur for this reference string when the Optimal page replacement policy is used with both a three and a four frame allocation.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

Sample Questions:

4.

- A process has associated with it the following table.
- For each logical address shown indicate if the address is legal.
- If it is, compute the physical address.
- Addresses are in the form <p, d>.
- Assume each page/frame is 1000 bytes in size.

Page #	Frame #
0	32
1	18
2	3
3	45

Logical Address < 0, 321 > Is it legal? _____ Physical Address _____

Logical Address < 1, 3100 > Is it legal? _____ Physical Address _____

Logical Address < 4, 754 > Is it legal? _____ Physical Address _____

Logical Address < 2, 208 > Is it legal? _____ Physical Address _____

Logical Address < 3, 0 > Is it legal? _____ Physical Address _____

Sample Questions:

5. Given the following table of processes, their arrival times, processing times, and priority, construct Gantt charts for each of the following processor scheduling protocols and determine for each protocol, the average turnaround time, average normalized turnaround time, and the average waiting time. Do this for the protocols: (a) FCFS, (b) SPN, (c) RR with time quantum = 1, (d) non-preemptive priority, and (e) preemptive priority.

Process	Arrival Time	Processing Time	Priority
A	0	10	4
B	2	3	2
C	4	2	3
D	6	4	3
E	8	5	1

Sample Questions:

6. Given the following sequence of disk track requests, and assuming that the read/write head is current positioned on track 50 (tracks numbered 0-199) and moving toward larger track numbers (toward the center of the disk), determine the total number of tracks traversed in accommodating all of the requests using the (a) the SSTF disk scheduling algorithm and (b) the C-SCAN disk scheduling algorithm.

20, 44, 116, 98, 178, 35, 99, 122, 156

Sample Questions: ANSWERS

Question 1

FIFO

Ref. String		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	
frame	1	1	1	1	3	3	5	5	4	2	6	5	5	4	4	4	3	2	2	5	6	
	2		3	3	5	5	4	4	2	6	5	4	4	3	3	3	2	5	5	6	3	
	3			5	4	4	2	2	6	5	4	3	3	2	2	2	5	6	6	3	4	total faults
page fault		Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	14

FIFO

Ref. String		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	6	3	4	
frame	1	1	1	1	1	1	3	3	5	5	5	4	4	4	4	4	2	2	2	2	6	
	2		3	3	3	3	5	5	4	4	4	2	2	2	2	2	6	6	6	6	3	
	3			5	5	5	4	4	2	2	2	6	6	6	6	6	3	3	3	3	5	
	4				4	4	2	2	6	6	6	3	3	3	3	3	5	5	5	5	4	total faults
page fault		Y	Y	Y	Y	N	Y	N	Y	N	N	Y	N	N	N	N	Y	N	N	N	Y	9

Sample Questions: ANSWERS

Question 2

LRU

Ref. String		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	
frame	1	1	1	1	3	5	4	3	2	2	6	5	5	3	4	2	3	4	5	6	2	
	2		3	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	
	3			5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	total faults
page fault		Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	15

LRU

Ref. String		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	
frame	1	1	1	1	1	1	5	4	3	3	2	6	6	5	5	5	2	3	4	5	6	
	2		3	3	3	5	4	3	2	2	6	5	5	3	4	2	3	4	5	6	2	
	3			5	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	
	4				4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	total faults
page fault		Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	14

Sample Questions: ANSWERS

Question 3

Optimal

Ref. String		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	
frame	1	1	1	1	3	3	2	2	6	5	5	6	6	2	2	2	5	4	2	2	2	
	2		3	3	4	4	4	4	4	6	6	3	4	4	3	4	4	3	4	3	3	
	3			5	5	5	5	5	5	4	4	4	3	3	4	3	3	6	3	4	4	total faults
page fault		Y	Y	Y	Y	N	Y	N	Y	N	N	Y	N	Y	N	N	Y	Y	Y	N	N	11

Optimal

Ref. String		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4	
frame	1	1	1	1	1	1	2	2	6	6	6	6	6	2	2	2	2	5	2	2	2	
	2		3	5	4	3	3	3	3	5	5	5	5	5	3	4	5	4	6	6	6	
	3			3	5	4	4	4	4	3	4	4	4	4	5	3	4	3	4	3	3	
	4				3	5	5	5	5	4	3	3	3	3	4	5	3	6	3	4	4	total faults
page fault		Y	Y	Y	Y	N	Y	N	Y	N	N	N	N	Y	N	N	N	Y	Y	N	N	9

Sample Questions: ANSWERS

Question 4

- A process has associated with it the following table.
- For each logical address shown indicate if the address is legal.
- If it is, compute the physical address.
- Addresses are in the form <p, d>.
- Assume each page/frame is 1000 bytes in size.

Page #	Frame #
0	32
1	18
2	5
3	45

Logical Address < 0, 321 > Legal – physical address = (32 * 1000 + 321) = 32,321

Logical Address < 1, 3100 > Illegal - displacement of 3100 is larger than 1000 byte page size

Logical Address < 5, 754 > Illegal – process has no page 5 in the page table

Logical Address < 2, 208 > Legal – physical address = (5 * 1000 + 208) = 5208

Logical Address < 3, 0 > Legal – physical address = (45 * 1000 + 0) = 45,000

Sample Questions: ANSWERS

Question 5 - FCFS

Process	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	T_R	T_R / T_S	wait time	
A																										10	1	0	
B			w	w	w	w	w	w	w	w																11	3.666667	8	
C					w	w	w	w	w	w	w	w	w													11	5.5	9	
D							w	w	w	w	w	w	w	w	w											13	3.25	9	
E									w	w	w	w	w	w	w	w	w	w	w							16	3.2	11	
																										12.2	3.323333	7.4	average

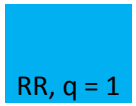
Sample Questions: ANSWERS

Question 5 - SPN

Process	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	T_R	T_R / T_S	wait time	
A																										10	1	0	
B			w	w	w	w	w	w	w	w	w	w														13	4.333333	10	
C					w	w	w	w	w	w																8	4	6	
D							w	w	w	w	w	w	w	w	w											13	3.25	9	
E									w	w	w	w	w	w	w	w	w	w	w							16	3.2	11	
																										12	3.156667	7.2	average

Sample Questions: ANSWERS

Question 5 – RR, q = 1



Process	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	T_R	T_R / T_S	wait time	
A			w		w	w	w		w	w	w	w	w		w	w		w	w		w					24	2.4	14	
B				w		w	w	w	w																	8	2.666667	5	
C					w		w	w	w	w																7	3.5	5	
D								w	w	w	w		w	w		w	w									12	3	8	
E										w	w	w		w	w		w	w		w						13	2.6	8	
																										12.8	2.833333	8	average

Sample Questions: ANSWERS

Question 5 – priority – non-preemptive

Process	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	T_R	T_R / T_S	wait time	
A																										10	1	0	
B			w	w	w	w	w	w	w	w	w	w	w	w	w											16	5.333333	13	
C					w	w	w	w	w	w	w	w	w	w	w	w	w	w								16	8	14	
D							w	w	w	w	w	w	w	w	w	w	w	w	w	w						18	4.5	14	
E									w	w																7	1.4	2	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	13.4	4.046667	8.6	average

Sample Questions: ANSWERS

Question 5 – priority – preemptive

Process	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	T_R	T_R / T_S	wait time	
A			w	w	w	w	w	w	w	w	w	w	w	w	w	w										24	2.4	14	
B																										3	1	0	
C					w																					3	1.5	1	
D							w		w	w	w	w	w													10	2.5	6	
E																										5	1	0	
																										9	1.68	4.2	average

Sample Questions: ANSWERS

Question 6(a) - SSTF

Next track accessed	Number of tracks traversed	Cumulative tracks traversed
44	6	6
35	9	15
20	15	30
98	78	108
99	1	109
116	17	126
122	6	132
156	34	166
178	22	188
Average number of tracks traversed = 20.89		

Sample Questions: ANSWERS

Question 6(b) – C-SCAN

Next track accessed	Number of tracks traversed	Cumulative tracks traversed
98	48	48
99	1	49
116	17	66
122	6	72
156	34	106
178	22	128
178-199, 199-0	221	349
20	20	369
35	15	384
44	9	393
Average number of tracks traversed = 43.67