CSE 120: Final

August 3, 2006

Name: _____

Student ID:_____

Write your test number on *all* pages because the pages will be separated for grading.

No books, no notes, but calculators are allowed. If you need to make an assumption to solve a problem, state the assumption.

Problem	Score
1	/10
2	/5
3	/5
4	/10
5	/5
6	/10
7	/10
8	/10
9	/5
10	/10
11	/10
12	/10
Extra Credit	/5
Extra Credit	/10
Total	/100

1. *10 pts.* Imagine a professor who has a laptop on which he has to run a very large number of student programs for grading. His goal is to get the entire set of programs completed in as short a time as possible.

   (a) Explain (in no more than two sentences) why running very few programs at a time can cause an overall slowdown.

   (b) Explain (in no more than two sentences) why running very many programs at a time can cause an overall slowdown.

2. *5 pts.* Consider a system where the free disk space is kept in an on-disk free-space list. If the pointer to the free page list is corrupted, can the system reconstruct the free-space list? Explain in no more than two sentences.

3. *5 pts.* Which of the following components of program state are shared across threads in a multithreaded process (Circle all that are correct).

   (a) Global variables.

   (b) Stack memory

   (c) Open-file table

   (d) Heap Memory

   (e) Register values

4. *10 pts.* Consider a demand-paging system with the following current utilizations:
   CPU utilization 20%
   Paging disk 97.8%
   Other I/O devices 5%

   For each of the following, say whether it is likely to improve CPU utilization. Explain your answers in no more than two sentences each:

   (a) Install a faster CPU

   (b) Install a bigger paging disk

   (c) Install more main memory

   (d) Increase the degree of multiprogramming.

   (e) Decrease the degree of multiprogramming.

5. *5 pts.* Consider a Unix-style filesystem with indexed allocation using i-nodes. What is the maximum number of disk I/O operations that could be required to read the (very small) file `/etc/rc/foo` assuming that no disk blocks are currently being cached?

6. *10 pts.* Assume we have a demand-paging system with the following characteristics

   - It takes 4 milliseconds to service a page fault if there is a free frame available or if the frame to be evicted is not modified. Forty percent of page faults fall into this category.
   - It takes 9 milliseconds to service a page fault if the frame to be evicted is modified. Sixty percent of page faults fall into this category.
   - Main-memory access time is 100 nanoseconds.

   What is the maximum page fault frequency (in faults/access) to obtain an effective memory access time of no more than 200 nanoseconds? You need not simplify your answer.

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7. *10 pts.* Consider a simple paging system with the following parameters: 2^{36} bytes of physical memory; page size of 2^{12} bytes; 2^{10} entries in the page table.

   (a) How many bytes in the virtual address space?

   (b) How many bits are in a logical address?

   (c) How many bytes in a frame?

   (d) How many bits in the physical address specify the frame?

   (e) How many bits in each page table entry (assume each page table entry includes a valid bit, a dirty bit, and a used bit)?

8. *10 pts.* Consider a system running ten I/O-bound tasks and one CPU-bound task. Assume that the I/O-bound tasks issue an I/O operation once every millisecond of CPU computing and that each I/O/ operation takes 10 milliseconds to compute. Also assume that the context-switching overhead is 0.1 milliseconds and that all processes are long-running tasks. What is the CPU utilization (percentage of CPU cycles used getting real work done) for a round-robin scheduler where:

   (a) The time quantum is 1 millisecond.

   (b) The time quantum is 10 milliseconds.

9. *5 pts.* Suppose a disk rotates at 7200 RPM. What is the average rotational latency in milliseconds? (You need not simplify).

10. *10 pts.* Assume a disk driver has requests for the following cylinders in its queue: 32 14 62 15 18 25 98 13. The disk just finished servicing a request for cylinder 40 and the previously-serviced request was for cylinder 60. Assume no new requests come in. In what order are the requests in the queue satisfied using the following disk scheduling algorithms?

    (a) Shortest Seek First

    (b) Look (Scan or elevator but doesn't move all the way to the outer or inner cylinder if not necessary)

    (c) C-Look (no servicing requests as the disk head moves from higher cylinders to lower cylinders)

11. *10 pts.* We have an architecture that uses both segmentation and paging A 24-bit virtual address consists of:

4-bit segment number	4-bit page number	16-bit offset

Here are the relevant tables for a specific process:

Segment Table

Segment #	Page Table
0	Page Table A
1	Page Table B
...	(Remainder invalid)

Page Table A

Page #	Frame number
0	DEAD
1	BEEF
2	ABCD
3	8282
...	(Remainder invalid)

Page Table B

Page #	Frame number
0	FEED
1	0105
2	DADA
...	(Remainder invalid)

Find the physical address corresponding to each of these virtual addresses (write "INVALID" if the virtual address is invalid):

(a) `11AABB`

(b) `000000`

(c) `DEADEE`

(d) `034567`

(e) `121314`

12. *10 pts.* Using the reference string <2 1 2 3 1 4 2 1 0 3 4>, fill in the table below (representing three page frames) using the LRU page replacement policy. How many page faults occur?

13. *5 pts. Extra credit.*

(a) What are three things you liked most about this class?

(b) What are three things you liked least about this class?

(c) What would you like to see changed?

14. *10 pts. Extra credit.* For speed, some operating systems do disk I/O directly into a buffer provided by the user program (rather than into an intermediate kernel buffer and then copied). The user program calls a `read` system call and provides the address of the buffer and length (which must be an even multiple of the disk block size). The `read` routine is blocking: it returns when the system call is complete.

    Note that the disk controller works with physical memory addresses, not virtual memory addresses.

    Joe suggests implementing this system call by converting the provided virtual address into a physical address, and then passing that address, along with the length to the disk controller.

    In no more than three sentences, describe why Joe's suggestion won't quite work.