CS140 Operating Systems and Systems Programming
Final Exam

December 11, 2003

(Total time = 165 minutes, Total Points = 165)

Name: (please print)_____

In recognition of and in the spirit of the Stanford University Honor Code, I certify that I will neither give nor receive unpermitted aid on this exam.

Signature:_____

This examination is closed notes and closed book. You may not collaborate in any manner on this exam. You have 165 minutes (2 hours and 45 minutes) to complete the exam. Before starting, please check to make sure that you have all 22 pages.

1		**12**	
2		**13**	
3		**14**	
4		**15**	
5		**16**	
6		**17**	
7		**18**	
8		**19**	
9		**20**	
10		**21**	
11		**Total**	

Name:_____

(1) (10 points) Assume you have a file system that uses write-ahead logging.
(a) Is it ever possible to have more bytes written to the log than are written to the data portion (i.e., the non-log portion) of the disk?
(b) Is it ever possible to have more bytes read from the log than are read from the data portion of the disk?
Justify your answers.

(2) (6 points) Explain why a hard link in Unix cannot span different file systems while a soft link can. (Hint: Think about what meta-data is stored for each type of link.)

(3) (10 points) Assume that you have a machine with a fixed amount of physical memory and demand-paged virtual memory system.
(a) Is it possible that doubling the page size can reduce the number of page faults? If so, describe how. If not, describe why.
(b) Is it possible that halving the page size can reduce the number of page faults? If so, describe how. If not, describe why.

(4) (8 points) A FIFO page replacement algorithm will replacement a page that was first referenced the longest time ago. Under a workload with locality of reference, choosing to replace a page accessed a long time ago seems like a good idea since it is not likely to be within the current locality being accessed. Does this mean that a FIFO replacement algorithm should approximate a LRU algorithm for workloads with strong locality? Justify you answer.

(5) (6 points) Is the heap free list management technique such as first fit or best fit relevant if you employ a compacting garbage collector? Justify your answer.

(6) (8 points) You overhear one of your classmates saying that any space considered internal fragmentation must not be on the free list while any external fragmentation must be on the free list. Is this statement correct? Justify your answer.

(7) (8 points) Explain how a mark and sweep garbage collector can handle circular data structures while a reference counting scheme doesn't.

(8) (10 points) Given a BSD Unix Fast File System that needs to support two types of workloads:

Workload A – Contains sequential access to many small files in the same directory.

Workload B – Contains sequential access to a few very large files in different directories.

For each workload, describe the effect of the following changes in disk technology (be sure to estimate how significant the change would be):

(a) A disk with twice the number of heads and platters.

(b) A disk that spins twice as fast.

(c) A disk with twice as many sectors per track.

(9) (6 points) Describe the advantages and disadvantages of a file system supporting multiple small files allocated from the same disk sector.

(10) (9 points) Which of the following conditions would likely represent a serious problem with a file system (Justify answer for each.)
(a) A write to a data block that contains no on-disk inodes pointing at it.
(b) A write to a data block that contains multiple on-disk inodes pointing at it.
(c) A write to a data block that is marked as free in the on-disk bitmap.

(11) (6 points) Explain what it meant when a "df" command on a BSD fast file system says the disk is 110% full? What can cause this condition? Why was it built this way?

(12) (6 points) (a) Is it possible with the BSD fast file system to have blocks from two different files in the same cylinder group? (b) How about files from two different directories in the same cylinder group? Justify your answers. If it is possible, describe what conditions would be necessary to make it occur.

(13) (8 points) Describe how a system can know if a password specified by a user is correct yet not know the user's actual password?

(14) (8 point) Would having a lock on every file that required a special software key to open be consider a capability or access control list-based system? Justify your answer.

(15) (8 points) It is not uncommon for a company to compute the value of a cryptographically secure checksum (such as SHA1) for a file and then encrypt this value with a private key whose corresponding public key is advertised by the company. What is the purpose of this sequence of operations? What can the resulting value be used for?

(16) (8 points) An Ethernet is an example of a link-level network protocol that must deal with multiple senders and multiple receivers on the same wire. (a) Describe how Ethernet deals with multiple receivers on the same link. (b) Describe how Ethernet handles multiple senders on the same link.

(17) (8 points) What purpose does IP fragmentation serve? Include in your answer an example of what condition would cause IP fragmentation to occur.

(18) (10 points) Describe the abstraction exported to the application programmer of the following protocols:
(a) UDP/IP
(b) TCP/IP
(Note: Your answer should discuss both the expected interface and protocol behavior.)

(19) (6 points) Describe why distributed consensus over unreliable networks is impossible.

(20) (8 points) Explain why a virtual machine monitor is sensitive to the performance of a processor's trap architecture.

(21) (8 points) Explain why a virtual machine cannot make a real I/O device do DMA into memory belonging to another virtual machine.