CIS 520 – Quiz #2 – Fall 2012 Name: _____

Date: Wed., Nov. 14, 2012
Total: 100 pts

1. (20 points) File Systems:

   (a) Suppose that a Berkeley Fast File System (FFS) contains one very large (4 GB) file, and a collection of 400,000 files of size 10 KB each, spread throughout the directories. You notice that you can process through the large file, reading the whole thing sequentially, in about 2 minutes. However, a process that traverses the file system and reads all of the small files takes about an hour to run, even though that traversal also involves only reading about 4 GB of data. Explain the difference in performance between the two workloads.

   (b) The original Unix File System (UFS) exhibited much better performance on sequential reads of large files when the file system was newly created than after it had been running for awhile and had many files added and deleted. Briefly, explain why.

   (c) Explain how it would be possible to append a few bytes of data to every file in a file system and yet have the file system report the same total amount of disk space in use.

   (d) Why is LRU usually not the best cache eviction strategy for a disk buffer cache? Hint: consider the sequential access of a very large file. Suggest an alternative that might be a better choice. Hint: consider how most large files are usually processed.

2. (20 points) Dynamic Memory Management: A dynamic memory allocator uses a linked list to track free blocks. Suppose that the free list contains just two blocks, of size 30 and 20 bytes, in that order. Ignore any space required for bookkeeping overhead.

   (a) List a sequence of malloc( ) calls that would succeed using worst-fit allocation, but fail with best-fit, or explain why such a sequence cannot exist.

   (b) Likewise, list a sequence of malloc( ) calls that would succeed on the original free list, with free blocks of size 30 and 20, using best-fit, but fail with worst-fit, or explain why such a sequence cannot exist.

   (c) In a pure segmentation system, processes are allocated the amount of memory requested. After several processes have executed, and several segments have been allocated and released, a subsequent request may not be able to be satisfied because no remaining free segment is large enough (even though the total amount of free memory is adequate). Is this an example of internal or external fragmentation? Explain briefly.

   (d) For dynamic memory management, if the process calls malloc( ) with a request for 18 bytes and the allocator is using the best-fit algorithm, the request for 18 bytes will be satisfied by breaking the block of size 20 into two parts, and returning the remaining 2 bytes to the free list. This small block of size 2 bytes is sometimes referred to as “sawdust” because it will probably never be used. Is this an example of internal or external fragmentation? Explain briefly.

3. (20 points) Paging and Page Replacement Algorithms:

   (a) If the page size is 2 KB (2048 bytes) in a 16-bit architecture, how many bits are used to denote the offset into each page? _____ How many **pages** exist in the virtual address space (assume that all 16 bits can be used for addressing)? _____ Hint: $2^{10} = 1024$.

   (b) Discuss situations in which the least recently used (LRU) page replacement algorithm generates fewer page faults than the first-in, first-out (FIFO) page replacement algorithm.

   (c) What is Belady's anomaly? Can the FIFO algorithm exhibit Belady's anomaly? Can the optimal algorithm exhibit Belady's anomaly? Explain briefly.

   (d) Does a pure paging system suffer from internal fragmentation or external fragmentation, or both? Explain briefly.

4. (20 points) File System Calls:

   a. None of the disk-scheduling disciplines (SSTF, SCAN, C-SCAN, etc.), except FCFS, is truly ***fair*** (starvation may occur in all other disciplines). Explain why this assertion is true.

   b. Briefly describe a way to modify algorithms such as SCAN to ensure fairness.

   c. Explain why fairness is an important goal in a time-sharing system.

   d. Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is: 86, 1470, 313, 1774, 248, 1509, 422, 130. Starting from the current head position, list the next three requests to be satisfied for each of the following disk-scheduling algorithms?

      i. FCFS: _____

      ii. SCAN: _____

5. (20 points) Virtual Address Mapping: Consider the page table shown below for a system with 16-bit virtual addresses and 4KB pages; that is, page offsets are represented using 12 bits.

   (a) How many bits are used to represent a virtual page number? _____ How many bytes can be addressed in virtual memory? _____

   (b) Convert the following virtual addresses to their equivalent physical addresses in hexadecimal. If the reference would cause a page fault to be generated, just write "page fault". Note that "--" indicates that a page is currently not loaded into the frame. Write all answers in hex format.

   - 4FFD → _____
   - CFFE → _____
   - 2FFF → _____

   (c) Also, compute the virtual address corresponding to the given physical addresses. If you are not able to determine, just write "N/A".

   - FFFF → _____
   - 12FF → _____
   - 3FFD → _____

Page	Page Frame
0	6
1	3
2	--
3	F
4	A
5	--
6	D
7	--
8	2
9	9
A	7
B	--
C	0
D	5
E	--
F	1