Sungkyunkwan University
School of Information and Communication Engineering

CSE3008: Operating Systems
Final Exam. (Fall 2009)

13:30 - 14:50, December 14, 2009. Instructor: Jin-Soo Kim

Student ID: _____

Name: _____

Codename: _____

Q1 (30)		Q5 (25)	
Q2 (20)		Q6 (25)	
Q3 (50)		Q7 (20)	
Q4 (50)		Q8 (30)	
		Total (250)	

- *Choose your codename with any combination of alphabets and numbers you can remember later. It will be used to post your final exam score in the web page without revealing your identity.*

1. Consider a demand-paging system with the following time-measured utilizations:

CPU utilization:	20%
Paging disk:	97.7%
Other I/O devices:	5%

For each of the following, say whether it will (or is likely to) improve CPU utilization. You should justify your answers. (5 points each)

(1) Install a faster CPU

(2) Install a bigger paging disk

(3) Increase the degree of multiprogramming

(4) Install more main memory

(5) Install a faster hard disk, or multiple controllers with multiple hard disks

(6) Increase the page size

2. Assume a processor with 32-bit virtual addresses. The page size of this processor is 256 bytes and the amount of the maximum physical memory size supported is 1GB. A page table entry (PTE) occupies 4 bytes. Answer the following questions. (10 points each)

(1) If the processor uses a single-level page table structure, what is the total size of page table needed for a process?

(2) We consider the use of multi-level page table structure for the processor. To make each page table fit into one page, how many levels of page tables are needed?

3. Answer the following questions on virtual memory.

(1) In virtual memory, each physical frame is normally pointed to by a single PTE. But in some cases, it is possible for two PTEs from different processes to point to the same physical frame. When does this happen? List at least three cases. (30 points)

(2) One of the goals of virtual memory is to allow the application program to use memory larger than the physical memory size, by utilizing the swap space in storage device. Even though many embedded systems (such as cellular phones, PDAs, etc.) have its own storage device consisting of NAND flash memory, it is common that they do not allocate any swap space in the storage. In this case, do we still need to use the virtual memory? Why or why not? (20 points)

4. The followings show some of data structures used in the FAT and Ext2 file systems.

A. Directory entry	E. Superblock
B. FAT (File Allocation Table)	F. Root directory
C. I-node	G. Data block bitmap
D. I-node bitmap	

(1) Where is the information on the file size is stored in the FAT file system? What about in the Ext2 file system? (10 points)

FAT file system: _____ Ext2 file system: _____

(2) If you want to know whether the cluster #100 is allocated to a file or not, what data structure you should look at in the FAT file system? (5 points)

Answer: _____

(3) Show two methods to identify whether the data block #100 is in use or free in the Ext2 file system. (15 points)

Method 1:

Method 2:

(4) How can you count the number of files in the FAT file system? (10 points)

(5) In the Ext2 file system, how many i-nodes should be read to process the following system call? Explain why. (10 points)

```
int fd = open ("/usr/bin/test.txt", O_RDONLY);
```

5. Assume that the following virtual pages are referenced in that order when we execute a certain program. Also assume that all the physical frames are initially empty.

1 2 3 2 1 4 1 3 1 4 2 5 2 4 2 1 2 4 1 3

(1) When we assume that the physical memory is infinite, what is the page fault rate? (5 points)

(2) When the number of available physical frames is 3, what is the page fault rate with the Belady's optimal replacement policy? (5 points)

(3) What is the page fault rate with the FIFO page replacement policy? (5 points)

(4) Under the LRU page replacement policy, how many physical frames are needed to have the page fault rate less than 40%? (10 points)

6. Which of the following scheduling algorithms could result in starvation? Explain why. (5 points each)

(1) First-come, first-served

(2) Shortest job first

(3) Round robin

(4) Priority

(5) Linux 2.4 scheduling

7. Assume that you are implementing virtual memory in Pintos as requested in Project #3. If you have a page fault for a valid memory address, you need to allocate a new physical frame. In may cases, the new physical frame is initialized with the data read from the executable file. But, in some cases it is just initialized to all zeroes. When does Pintos require such a physical frame? List all the possible cases. (20 points)

8. If there is no free frame in the physical memory, Pintos needs to find a victim page that should be evicted from the physical memory. The following shows the possible actions Pinto can take for the selected victim page, before it is reused for the new virtual page.

A. Do nothing. Just drop the page.
B. Write the contents into the corresponding file.
C. Write the contents into the free swap space.

For each of the following type of victim page, show what action should be taken. (5 points each)

Victim page type	Action
Clean code page	
Clean data page	
Dirty data page	
Stack page	
Clean memory-mapped page	
Dirty memory-mapped page	

THANK YOU AND HAVE A NICE VACATION!