ITP30002 Operating Systems, Spring 2023

Final Exam

Your name and student number: _____

- You have **80 minutes** to answer to **7 problems** (100 points).
- Check if you receive all **7 pages** including this cover page and last two blank pages.
- Write your answer **on the given box**. Writings outside the box will not be counted.
- Write answers **clearly and legibly**. No points for ambiguous or illegible writings.
- Read the following quote from *Handong CSEE Standard* and declare your agreement below.

> Examination
>
> 1. Examination is an educational act necessary for evaluation of the students' achievement and for encouraging the students to absorb the material in the process of preparation.
> 2. Student should do their best to prepare for exams in order to improve her/his own knowledge and skill and should fully engage in the test during examination hour.
> 3. Accessing or providing unauthorized information, including other students' answer sheets, is regarded as cheating. The use of electronic devices, including cell phones and computers, without permission is strictly prohibited.
> 4. Entering or leaving the classroom during the examination before the finish time without permission is regarded as cheating.

I uphold Handong Honor Code and Handong CSEE Standard in taking this exam.

Sign: _____

1. (18 points) Suppose that you have a system that installs Very Simple File System on a HDD of the following specification: Sector size: 4 KB, RPM: 7200, Average Seek: 12ms, and Max Transfer: 120 MB/s.

   How much time does it take to open `/home/user/project/program.c` and reads 10 KB from the file if we assume that no cache is working? Support your answer with details.

2. (16 points) Explain what kinds of architectural supports (not OS supports) are needed to extend memory to use swap spaces.

3. (12 points) Explain what open file table is, and how it is managed.

4. (16 points) Suppose that you are asked to implement a given concurrent algorithm.
Explain how to determine whether the algorithm is better implemented as a multi-process program, or a multi-threaded program.

5. (20 points) Suppose that you are given the following multithreaded program:

```
#include <pthread.h>
#include <stdio.h>

int cnt = 0 ;

void thread1 (void *) {
    while (1) {
        cnt++ ; printf("%d", cnt) ; } }

void thread2 (void *) {
    while (1) {
        cnt++ ; printf("%d", cnt) ; } }

int main () {
  pthread_t t1, t2 ;
  pthread_create(&t1, NULL, thread1, NULL) ; pthread_create(&t2, NULL, thread2, NULL) ;
  pthread_join(t1, NULL) ; pthread_join(t2, NULL) ;
}
```

Revise the program to add Pthread semaphores, such that `thread1` (thread `t1`) and `thread2` (thread `t2`) alternatively increment and print `cnt` (i.e., `thread1` prints only odd numbers, and `thread2` prints only even numbers).

6. (10 points) The following is the inode structure of the Ext-3 file system:

Name	Bytes	Description
File Mode	2	Permission flags and file type
User ID	2	Lower 16 bits of user ID
File Size	4	Lower 32 bits of size in bytes
ACMD Times	16	Most recent access, creation, mod., del. times
Group ID	2	Lower 16 bits of group ID
Link Count	2	Number of existing links to the file
Sector Count	4	Sector occupied by the file
Flags	4	Assorted flags
Unused	4	Unused bytes
Direct Pointers	48	12 direct pointers
Single Indirect Pointer	4	1 single indirect pointer
Double Indirect Pointer	4	1 double indirect pointer
Triple Indirect Pointer	4	1 triple indirect pointer
Misc. Information	8	NFS gen. number, extended attribute block
File Size	4	Upper 32 bits of size in bytes
Fragment Information	9	Address, count and size
Unused	2	Unused bytes
User ID	2	Upper 16 bits of user ID
Group ID	2	Upper 16 bits of group ID
Unused	2	Unused bytes

Note that (1) a single indirect pointer points to a block of direct pointers that point to data blocks, and (2) a double indirect pointer points a block of single indirect pointers, and (3) a triple indirect pointer points a block of double indirect pointers.

What is the maximum file size of a Ext-3 file system? Support your answers with details.

7. (8 points) Explain when trashing happens.

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