ITP30002 Operating Systems, Spring 2023

Midterm Exam

Your name and student number: _____

- You have **70 minutes** to answer to **7 problems** (100 points).
- Check you have total **7 pages** including this cover and last two blank pages.
- Write an answer **only in the given box**. Things outside the box will not be counted.
- Write answers **clearly and legibly**. No points for ambiguous and 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 agree to uphold Handong Honor Code and Handong CSEE Standard in taking this exam.

Signature: _____

1. (18 points) Suppose that we have a 16-bits computer architecture (i.e., word size is 16-bits) with frame size of 256-bytes. For this computer architecture, you want to implement segmented paging (i.e., combine segmentation and paging like Multics) with three segments (code, stack and heap).

   How much memory is needed for holding the page tables? Explain your answer with the assumption and/or the rationale behind the answer.

2. (12 points) Explain the cost of a context-switching.

3. (12 points) The ARM architecture provides pages of four different sizes (i.e., 4 KB, 64 KB, 1 MB, 16 MB). In which situations, an application would use a large-size pages? What would be the expected benefit of using a large-size page for that situation?

4. (16 points) Suppose that you administrate a server computer that runs multi-level feedback queue for process scheduling. Initially, you used default parameters for the scheduler.

   Since your service often suffers from long response time, you want to diagnose the problem and tune the scheduling parameters. What would you do for this situation?

5. (15 points) See a post from StackOverflow below (c.f., the text and the code are simplified):

Hi, I was writing the following C program to do "`cat inputs.txt | sort | uniq`", but the program seems to not run anything at all. I have no idea what is going on.

```
1    #include <stdlib.h>
2    #include <stdio.h>
3    #include <unistd.h>
4    int main() {
5        int pipe1[2];
6        int pipe2[2];
7
8        pipe(pipe1) ;
9        int process1 = fork();
10       if (process1 > 0){
11           close(pipe1[0]) ;
12           dup2(pipe1[1], 1) ;
13           close(pipe1[1]) ;
14           execlp("cat","cat","inputs.txt",NULL);
15       } else if (process1 == 0) {
16           pipe(pipe2) ;
17           process2 = fork() ;
18           if (process2 == 0) {
19               close(pipe2[1]) ;
20               dup2(pipe2[0], 0) ;
21               close(pipe2[0]) ;
22               execlp("uniq","uniq",NULL);
23           } else if (process2 > 0){
24               close(pipe1[1]) ;
25               close(pipe2[0]) ;
26               dup2(pipe1[0], 0) ;
27               dup2(pipe2[1], 1) ;
28               close(pipe1[0]) ;
29               close(pipe2[1]) ;
30               execlp("sort","sort",NULL);
31           }
32       }
33   }
```

Indicate the problems of this program and suggest solutions as much as you can (for simplicity, assume that all system library function calls do not fail).

Your name:

6. (12 points) Write a logic of the timer interrupt handler routine for the Linux Completely Fair Scheduler.

7. (15 points) Suppose that a process invokes `fork()`. Explain what will happen for executing this statement, as detailed as possible.

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