

Fall 2011 Operating Systems Qualifying Exam

This is an open book exam. Basic calculators are allowed, but no computers or other devices that have communication capability are allowed; this means that cell phones cannot be used as calculators. There are a total of 100 points on this exam. Be sure to show your work in case your answer may deserve partial credit, but do not add spurious or frivolous content in hopes that something you say might be right. Content in an answer that is irrelevant to the problem may cause point deductions.

[25pts] 1. Processes and Threads

Below are two programs, and the output of the programs when executed as shown. For this problem, you need to explain the output: why some numbers are the same and why some are different. (Hints: each line prints out three numbers; also carefully note the autoincrement operators in the print statements). You also need to state whether or not the output lines could have appeared in a different order, and explain why or why not.

<pre>#include <stdio.h> #include <unistd.h> int x=42; int main(int argc, char *argv[]) { int y=53; int pid = getpid(); sleep(3); printf("PID %d: address of x is %p, value is %d\n", pid, &x, x++); printf("PID %d: address of y is %p, value is %d\n", pid, &y, y++); sleep(3); return 0; }</pre>	<pre>#include <stdio.h> #include <unistd.h> #include <pthread.h> int x=42; void* run(void *p) { int y=53; int pid = getpid(); sleep(3); printf("PID %d: address of x is %p, value is %d\n", pid, &x, x++); printf("PID %d: address of y is %p, value is %d\n", pid, &y, y++); sleep(3); return; } int main(int argc, char *argv[]) { int i,s; pthread_t th[3]; for (i=0; i<3; i++) { s = pthread_create(&th[i],NULL,&run,NULL); printf("thread: %d %d\n",s,th[i]); } sleep(8); return 0; }</pre>
<pre>shell> ./a.out & ./a.out & ./a.out (note: these do run simultaneously) PID 5438: address of x is 0x804a01c, value is 42 PID 5438: address of y is 0xbfc19c00, value is 53 PID 5437: address of x is 0x804a01c, value is 42 PID 5437: address of y is 0xbfc27170, value is 53 PID 5439: address of x is 0x804a01c, value is 42 PID 5439: address of y is 0xbfc84ed0, value is 53 shell></pre>	<pre>shell> ./a.out PID 5138: address of x is 0x804a020, value is 42 PID 5138: address of y is 0xb76623b4, value is 53 PID 5138: address of x is 0x804a020, value is 43 PID 5138: address of y is 0xb6e613b4, value is 53 PID 5138: address of x is 0x804a020, value is 44 PID 5138: address of y is 0xb66603b4, value is 53 shell></pre>

[20pts] 2. Scheduling

Five batch jobs A-E arrive at a job queue according to the following table. Note that 5 is the highest priority and 1 is the lowest.

Job	Arrival Time	Compute Time	Priority
A	0	9	3
B	2	10	5
C	4	4	2
D	7	4	1
E	11	6	4

For each of the following scheduling algorithms in parts A-C, draw a process execution Gantt chart and determine the mean process turnaround time. Ignore process switching overhead.

[5pts] A) Shortest Remaining Time (preemptive version of Shortest Job First)

[5pts] B) Priority Scheduling (with preemption)

[5pts] C) Round Robin (quantum == 1 time unit)

[5pts] D) If you were developing the operating system for a smart phone (such as an iPhone or Android-type phone), what type of scheduling algorithm would you use, and why?

[20pts] 3. Paging and Virtual Memory

For this problem all of the questions are in the context of a computer system that has 26-bit virtual addresses and 20-bit physical addresses, and a page size of 2048 bytes.

[4pts] A) What is the role of the page table?

[4pts] B) Is the page table accessed on every single memory reference?

[5pts] C) How many bytes would a flat, single-level page table occupy?

[7pts] D) Design a page table scheme that you think would be best for this system.

[25pts] 4. Synchronization and Mutual Exclusion

A programmer has a program with two threads that need to both access a critical section of code. They hope that their solution satisfies all the desirable properties of critical sections. Their solution is:

```
// shared variable: int turn;
// private variables: int me, other;
// - in each thread, me is that thread's ID,
//   other is the other thread's ID

void doCriticalSection()
{
    turn = other;
    while (turn != me) {;}
    //
    // Code for critical section here
    // (no code in here modifies turn)
    //
    turn = other;
}
```

[5pts] A) Does this solution satisfy the requirement for mutual exclusion? Why or why not?

[5pts] B) Is this solution fair? Why or why not?

[8pts] C) Would you use it in your own program that contained a critical section? Why or why not?

[7pts] D) If your answer in B was no, how would you change the code to make it work? If your answer in B was yes, is there anything you could do to it to improve it?

[10pts] 5. Finishing Off

You have been hired as the CIO (chief information officer) of a university, and shortly after you are hired, a worker in the department comes in and says, "Some students have found out our algorithm for encrypting passwords and have posted it on the Internet!" What should you do?