CMPUT 480 - Operating Systems

FINAL EXAMINATION

Monday December 16, 15:00-17:00

Note: Marked out of 100

1) (20 marks)

Answer True of False to each of the following statements. Make sure you write your answers down in your exam booklet. **DO NOT GUESS. WRONG ANSWERS WILL BE SUBTRACTED FROM RIGHT.**

a) A zombie can be created by killing a parent process before its children processes die.

b) Page replacement strategies are only required when memory becomes completely filled.

c) Public Key Encryption Schemes make everything publicly available for encoding and decoding messages.

d) Shortest Remaining Time (SRT) is a preemptive scheduling algorithm.

e) *Getrusage* provides statistics on how often a process did not voluntarily give up the CPU.

f) The socket *select* operation selects the process you will next do a *read* from.

g) An interrupt is an asynchronous procedure call.

h) Multiprogramming is the use of multiple CPUs running in parallel.

i) In the MTS scheduler, as processes use up CPU time they drop into the lower priority queues but can return to higher priority queues depending on I/O wait times.

j) If a process-resource graph is irreducible, then there is no deadlock.

k) A 4 million byte program that executes 10 million instructions may run slower than a 1 million byte program executing 25 million instructions.

l) In UNIX, a user process has code, data, and stack segments.

m) Executing sequential, non-looping code exhibits spatial locality of reference.

n) First-come, first-served (FCFS) scheduling is equivalent to round-robin scheduling with an infinite time quantum.

o) Seek time is the amount of time required by a disk to rotate to the correct position.

p) The MTS file system uses an access control matrix.

q) Multiple computers connected via a network are said to be loosely coupled.

r) Load balancing can be achieved by migrating processes.

s) The interval timer could be set to interrupt every millionth of a second but on the VAX it is not allowed.

t) In UNIX, executing a read operation could have the side-effect of changing the process' state from BLOCKED to RUNNABLE.

Trivia question: On the Amdahl, what is the maximum number of pages that an instruction must have resident in memory for it to be executed? Answer later.

2) (15 marks)

The *ls* command does not distinguish between files and directories. Write a shell script that separates directories from files. Specifically, the command is called *lc* and optionally takes one parameter, a directory name. The command looks at the entries of the specified directory (default is the current directory) and outputs the heading "Directories" followed by the names of the directories, and then the heading "Files" followed by all the file names. If the current directory contains the following entries (as obtained by doing an *ls),*

afile bdir cfile dfile zdir

the *lc* command should produce the output

```
    Directories:
        bdir zdir
    Files:
        afile cfile dfile
```

You do not have to worry about neatly formatting the output. You may use whichever shell you prefer.

3) (10 marks)

The UNIX *cat* command lists a file. Assume that you know the *inode* of a file you wish to list and that the file is only 2,000 bytes long. Further, assume the system uses the standard UNIX file system; not the new Berkeley system.

a)   Give a pseudo-code algorithm that implements the routine

mycat(inode)

to print out a file given its inode number. Make sure your algorithm describes where it finds the appropriate information on disk.

b)   What changes would have to made to your answer in a) to accommodate arbitrary file sizes?

4) (10 marks)

Management at Hackers High School are upset because their GIGO (Garbage In, Garbage Out) computer does not seem to be running at full capacity. During the day, there are lots of users on the machine, but response seems uncomfortably slow. Most work done on the machine is editing and printing; Hacker High has a policy of not letting students hand in hand-written work. Joe Blough, systems programmer at Hacker High and a CMPUT 480 alumnus, was called in to investigate. He discovered that even during peak periods, the CPU was busy only 80% of the time - 20% of the time it was idle. The hardware consists of the GIGO computer with a megabyte of memory, disk drive, line printer, and 30 terminals. Joe needs some help in finding an explanation for the idle time. Give several possible explanations for the poor performance.

7) (5 marks)

In UNIX, there are many types of interrupts. In assignment 4, you should have used SIGALARM to catch the interval timer interrupts. Hitting break (or control-c) while a program is running generates a SIGINT interrupt. Write a C library routine called *catch()* that a user program can call to catch SIGINT interrupts. When a SIGINT occurs, the routine should ask the user whether to continue (ignore the interrupt) or abort (kill the program). Write your solution in C and remember to include comments.

Trivia question answer: 8. Eight?! What instruction could possibly require 8 pages resident in memory just to execute it?? Answer later.

8) (15 marks)

High in the Rocky Mountains, there are two circular railroad lines. One line is in Canada; the other in the United States. The lines share a small section of track where they cross a mountain pass on the international border. Unfortunately, the Canadian and American trains occasionally collide when simultaneously entering the mountain pass. The trouble is, alas, the drivers of both trains are blind and deaf, so they can neither see nor hear each other's train.

The drivers agree on the following method of preventing collisions. They set up a large bowl at the entrance to the pass. Before entering the pass, a driver stops his train, walks over to the bowl, and reaches into it to see if it contains a rock. If the bowl is empty, the driver finds a rock and drops it in the bowl, indicating that his train is entering the pass. Once his train has cleared the pass, he must stop the train, walk back to the bowl and remove the rock, indicating that the pass is no longer being used. If a driver arriving at the pass finds a rock in the bowl, he leaves the rock there. He then repeatedly takes a nap and re-checks the bowl until he finds it empty. Then he finds a rock, drops it into the bowl, and drives his train through the pass.

a)   A smart aleck CMPUT 480 graduate claimed that subversive train schedules made up by Americans could block Canadian trains from ever getting through the pass. Explain.

b)   The Americans just laughed and said this could not be true because it had never happened. Explain.

c)   Unfortunately, one day the two trains crashed. Explain.

Following the crash, our CMPUT 480 student was consulted on setting up an arrangement to guarantee that crashes did not occur. He explained that the bowl was being used in the wrong way. The American driver must wait at the pass entrance until the bowl is empty, drive through the pass, and then walk back and place a stone in the bowl. The Canadian driver must wait at the pass entrance until a stone is in the bowl, drive through the pass, and then walk back and remove the stone from the bowl.

d)   Does our former classmate's method work? Explain.

e)   Prior to this arrangement, American trains would use the pass twice as often as Canadian trains would. The Americans are unhappy with the new arrangement. Why?

f)   The mountain pass conflict is just a special case of what more general problem? Name an algorithm to solve this problem that will keep everyone happy.

Answer to trivia question. In a worst-case scenario, executing an MVC instruction could require 8 pages. The MVC instruction moves a maximum of 256 characters from location A to location B. The 256 bytes located at A could cross a page boundary, hence requiring 2 pages. Similarly, the 256 bytes at location B may also cross a page boundary requiring 2 more pages. The MVC instruction itself could cross a page boundary (2 more), and to make things worse, you could use an EXECUTE instruction to execute the MVC and it could be located on a page boundary. Hence 8 pages. Other instructions (such as moves of large amounts of data) may seem to require more pages, but these instructions are interruptible and are allowed to page fault in the middle of execution. Most instructions (including MVC) are not interruptible and once started, must be completed.