CSC 469H1 F
ADVANCED OPERATING SYSTEMS

UNIVERSITY OF TORONTO
Fall 2006

Term Test #1

NO AIDS ALLOWED

Please **PRINT** in answering the following requests for information:

Family Name: _____

Given Names: _____

Student Number: |_ _ _| |_ _ _| |_ _ _|

Login (@cdf): _____

Notes to students:

1. This test lasts for 110 minutes and consists of 80 marks. Budget your time accordingly.
2. This test has 7 questions and 9 pages (including this one); Check that you have all pages before starting.
3. **Write in pen. No pencils. Really, I mean it.**
4. Write your answers on this "question and answer" paper, in the spaces provided. Be concise. In general, the amount of space provided is an upper bound on the "size" of answer that is expected. If necessary, use space where available and provide explicit pointers.
5. State your assumptions and show your intermediate work, where appropriate.
6. Do **not** go beyond here until instructed to do so. Write your student number at the top of each succeeding page once you get going.

Question	Marks
1	/15
2	/12
3	/10
4	/12
5	/9
6	/10
7	/12
Total	/80

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1. [15 marks, 3 each] Definitions

Define the following terms, in the context of this course:

a) microkernel

b) interrupt

c) queuing lock

d) ABA problem

e) processor affinity

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2. [12 marks; 4 each] System Virtual Machines

a) Identify 2 architecture requirements for constructing a virtual machine, and briefly explain why each is needed.

b) What is the distinction between *sensitive* and *privileged* instructions, in the context of virtual machines?

c) The Intel Pentium is not *efficiently virtualizable*, meaning extra work is needed to create the illusion of a virtual machine, yet several VMs exist for this architecture. Identify the strategy used by VMWare and the strategy used by Xen, and identify the primary advantage of each approach.

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3.[10 points, 5 each] Signals

You are using a FreeBSD system, and your firefox browser window has completely stopped responding. Using the `ps` command from a shell, you have identified the pid of the browser as 1234.

a) You try to kill the browser by typing "`kill 1234`" at the shell prompt, but as far as you can tell, nothing happens. A quick check with "`man kill`" tells you that the default signal for kill is `SIGTERM`. Give two reasonable explanations for this behaviour.

b) You try again, this time explicitly sending `SIGKILL` with "`kill -SIGKILL 1234`" and the window disappears. A check with `ps` verifies that the process is gone. Outline the steps taken in the OS, from receiving the kill system call from the shell process, to the point where the browser process exits.

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4. [12 points; 4 each] Performance

You need to tune the performance of an application that you wrote. You have profiled the application and the OS and find that it spends 50% of its execution time executing application instructions, 36% handling page faults, and 14% handling TLB misses (the system uses a software TLB miss handler).

a) Where should you focus your code optimization efforts first, and why?

b) Suppose all the page fault time is due to I/O, and you do almost no I/O outside of page fault handling. What speedup do you expect if you buy a disk that is twice as fast? Show your calculations. You may express your final answer as a fraction.

c) Instead of spending a lot of time coding, you buy a new CPU with twice the clock speed. You find, however, that your speedup is much less than you were expecting. What is the most likely explanation?

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5. [10 points] Memory Reclamation

L.T. tries to implement quiescent-state-based memory reclamation. Assume that he has written a function `quiescent_state()` which announces to all other threads that the calling thread has gone through a *quiescent state*, and always detects a *grace period* if one exists. (L.T. sometimes writes brilliant code.)

However, L.T. has given each thread exactly one limbo list, which it empties on every grace period. (L.T. sometimes writes sloppy code.) **Show a simple schedule in which this causes a problem, and explain what the problem is**.

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6. [9 points, 3 each] Multiprocessors: Locking Issues

In the lectures, we looked at 4 ways to improve the performance of spinlocks on multiprocessors.

a) Why do we focus on spinlocks, rather than a lock with a sleep queue for waiting threads?

b) All four strategies address the main performance issue (which is not wasted CPU cycles in the spinning thread) in different ways. Explain the problem.

c) Pick any one of the improved spinlocks, and explain how it addresses the performance issue of (b).

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7. [12 points] Parallel Job Scheduling

At a particular point in time, all 4 CPUs on a space-shared multiprocessor become idle. The job scheduler queue is shown below. Show the scheduling decisions that result if we are using FCFS with the EASY backfilling algorithm, on the CPUxTime matrix below, up to the point where all jobs have run.

Write a 1-line description of how the scheduling decision was made for each job.

Scheduler Queue (Job ID, # CPUs, Time per CPU):

Queue head

empty	F, 2, 2	E, 1, 4	D, 3, 2	C, 4, 4	B, 2, 3	A, 1, 8

Schedule:

CPU_0															
CPU_1															
CPU_2															
CPU_3															

Time

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Extra space. Please indicate clearly which question(s) you are answering here, if any.

Total marks = (80)

End of test

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