

# MCS-378 Final Exam

Serial #:

This exam is closed-book and mostly closed-notes. You may, however, use a single 8 1/2 by 11 sheet of paper with *hand-written* notes for reference. (Both sides of the sheet are OK.)

Please write your name only on this page. Do not turn the page until instructed, in order that everyone may have the same time. Then, be sure to look at all problems before deciding which one to do first. Some problems are easier than others, so plan your time accordingly. **You have 120 minutes to work.**

Write the answer to each problem on the page on which that problem appears. You may also request additional paper, which should be labeled with your test number and the problem number.

Printed name: \_\_\_\_\_

Problem	Page	Possible	Score
1	2	10	
2	3	10	
3	4	10	
4	5	10	
5	6	10	
6	7	10	
7	8	10	
8	9	10	
9	10	10	
10	11	10	
<b>Total</b>		100	

1. [ **10 Points** ] Each of the following statements is false. For each one, write a brief explanation of why it is false.
  - (a) A computer that is only used by a single user has no need for a scheduler, because the computer's computational resources don't need to be divided up.
  - (b) No scheduler is needed on a computer that has multiple processors, because computations can take place simultaneously on different processors rather than needing to take turns using a single processor.
  - (c) Preempting thread A in order to run thread B delays A's completion just as much as it hastens B's completion, so the average time to completion is unaffected.
  - (d) Mutual exclusion locks (mutexes) are used to prevent two threads from running their critical sections concurrently, and so are only relevant on multiprocessor systems.
  - (e) The Linux and OS X schedulers are essentially identical (for non-real-time processes) because both allow the user to set a niceness level for each process.

2. [ 10 Points ] On the first test, you helped write the following class:

```
public class Semaphore {
    private int value;

    public Semaphore(int value) {
        this.value = value;
    }

    public synchronized void up() {
        value++;
        notifyAll();
    }

    public synchronized void down()
        throws InterruptedException
    {
        while (value == 0)
            wait();
        value--;
    }
}
```

Indicate whether each of the following changes would be valid:

- (a) replacing `notifyAll();` with `notify();`
- (b) replacing `notifyAll();` with `if (value == 1) notifyAll();`
- (c) replacing `notifyAll();` with `if (value == 1) notify();`
- (d) replacing `while` with `if`
- (e) replacing `wait();` with `Thread.sleep(1);`

3. [ **10 Points** ] Write down five different two-phase histories that would be possible for a transaction,  $T_1$ , that first reads  $x$ , then writes  $y$ , then writes  $z$ . In at least two of your five histories, avoid grouping all the unlock operations together at the end of the history.

4. [ **10 Points** ] Each of the following statements is false. For each one, write a brief explanation of why it is false.
- (a) Virtual memory uses disk as a partial substitute for RAM, and so is irrelevant on a system with enough RAM.
  - (b) For a virtual memory page containing instructions, if the page is initially stored on disk, the first time an instruction on that page is executed, the process will need to be delayed long enough to fetch the page from disk.
  - (c) The size of a virtual memory page table is proportional to the size of the virtual address space.
  - (d) If a virtual memory page is marked as read-only in the page table, then any attempt to write into it is a fatal error that will cause the operating system to terminate the offending process.
  - (e) Unless the number of physical memory page frames is greater than or equal to the sum of the active processes' working set sizes (measured in pages), the working sets won't all be able to fit in physical memory and hence paging to disk will be necessary.

5. [ 10 Points ] The following C++ program makes use of the `fork`, `getpid`, and `getppid` system calls. You should remember what `fork` does. The other two return process ID numbers; `getpid` returns the current process's ID number and `getppid` returns its parent's process ID number.

```
#include <unistd.h>
#include <stdio.h>
#include <iostream>
using namespace std;

int main(){
    fork();
    fork();
    cout << "Process ID " << getpid() << " with parent " << getppid() << endl;
    sleep(1);
    return 0;
}
```

Assume that when this program is run, the `fork` procedure does not encounter any error condition, all processes have time to print their output before any of them finishes its one second sleep, and each line of output appears as an atomic unit. (To restate this last assumption: you will not see part of one process's output line mixed together with part of another process's output line.)

Write down one plausible set of output lines that might result from the processes.

6. [ **10 Points** ] Enough of you did poorly on this problem that I'm giving you another chance at it. On a POSIX system (such as Linux or Mac OS X), a file with name `/foo/bar` has wide open permissions (`rw-rw-rw-`), but the directory `/foo` has much more restrictive permissions, `rw-r-x---`. The directory is owned by user 32 and group 49. List five different ways in which it could happen that a program run by user 87 modifies the contents of the file, despite the restrictive permissions on the directory. (Do not consider such complete evasions of the protection system as stealing user 32's password or exploiting a bug in the system.)

7. [ **10 Points** ] When opening a network connection, a port number is typically specified, such as port 80 for connecting to a web server or port 25 for connecting to an email server.
- (a) Which layer in the protocol stack provides this feature of specifying port numbers? You may give your answer either as the general name for the layer (not a specific protocol) or as layer number within the OSI Reference Model.
  - (b) Which specific widely-used protocol at this layer is generally used for the communication that underlies web browsing and email transmission?
  - (c) Give at least one other feature of this protocol, beyond the provision of port numbers.
  - (d) Suppose a server with a single IP address is communicating over two different open sockets, both on port 80. What features of arriving packets allow incoming data to be delivered to the appropriate socket?
  - (e) Even if communication is happening with port 80, that doesn't guarantee it entails web browsing. What higher-level protocol must be used for web browsing?



## 8. [ 10 Points ]

- (a) What illusion does RMI provide for the application programmer?
- (b) How does it provide this illusion?
- (c) In the example we used, how does the publisher obtain a remote reference to the topic server?
- (d) In the example we used, how does the topic server obtain a remote reference to the subscriber?
- (e) Why do remotely accessed methods always need to be declared as potentially throwing an exception?

9. [ **10 Points** ] Suppose you use a non-networked desktop computer for your work, and that several co-workers have keys to the office you share with them, which would allow any one of them to obtain physical access to your computer when no one else is around. The co-workers do not have administrative privileges on your computer system and they should not be able to read some sensitive data that you have stored on the hard drive. You use a secret password to log into the computer; this password is not stored on the computer's disk or elsewhere in the office.
- (a) Suppose the data is not encrypted, but it has permission settings that only allow you to read it. You shut down your computer before leaving; when you boot it back up, you need to log in with your secret password. How might one of your co-workers use their physical access to obtain the stored data in a single visit?
  - (b) Suppose that to avoid the preceding situation, you store the data in encrypted form. Your secret password is needed to decrypt the data. How might one of your co-workers use their physical access to obtain the data?
  - (c) Suggest two ways to improve the data's security, short of eliminating the co-workers' ability to have physical access to the office with no one else around.
  - (d) Given that your secret password is not stored on disk, how can the computer check that you have entered the correct password when you log in?

10. [ **10 Points** ] Choose five security principles from the following list. For each of the five you choose, give a brief explanation of the principle and a concrete example of its application.
- (a) Economy of mechanism
  - (b) Fail-safe defaults
  - (c) Complete mediation
  - (d) Open design
  - (e) Separation of privilege
  - (f) Least privilege
  - (g) Psychological acceptability
  - (h) Work factor
  - (i) Compromise recording
  - (j) Defense in depth
  - (k) Alignment of authority and control