COSC 6360 Second Midterm Examination March 24, 2004

This exam is **closed book**. You can have one sheet (i.e., two pages) of notes.

1. Consider the following CSP program fragment:

```
n : integer;
n := 0;
*[n > 0; p ? message -> n := n - 1 || q ? message -> n:= n + 1]
```

   a) When will this fragment terminate? (5 points)

When _ either both processes p and q terminate or q terminates and n >0. _____

   b) What are the possible values for the variable **n**? (5 points)

_All positive integer values _____

2. Consider a hypothetical cache replacement policy X operating in the following fashion: X divides the cache C into two equal-size lists C_1 and C_2. List C_1 contains all pages that have been referenced only once since they were brought into the cache while list C_2 contains all pages that have been referenced more than once. Both C_1 and C_2 are managed according to an LRU policy.

   a) Is this policy scan-tolerant? (5 points)

Yes, as the contents of C_2 will not be altered by a scan.

   b) What is its major drawback? (5 points)

The sizes of lists C_1 and C_2 are fixed. A better policy should automatically adjust the sizes of the lists according to their success rates.

3. The authors of Nooks state that they have chosen to "occupy the design space between 'unprotected' and 'safe.'" What do they mean by that? (10 points)

Nooks protects the kernel against buggy extensions but can be circumvented by a malicious extension.

4. What are the four techniques used by Spin to achieve its objectives of performance, safety and extensibility? (4×5 points)

a) Co-location: OS extensions are dynamically linked into the kernel address space.

b) Enforced modularity: Extensions are written in Modula-3. They cannot access the kernel memory or execute privileged instructions unless they have been given explicit access through an interface.

c) Logical protection domains: Extensions exist within logical protection domains, that is, kernel name spaces that contain code and export interfaces.

d) Dynamic call binding: Extensions execute in answer to system events declared in the interfaces.

5. How does Spring ensure that there will always be a server thread ready to service each incoming call? (10 points)

To allow target domains to create new threads whenever needed, Spring includes a system call that blocks until no available threads can be found in the domain.

6. According to the authors of Nooks, which are the two mean reasons for the poor reliability of kernel extensions? (2×5 points)

a) First mean reason: they are often written by less experienced programmers.

b) Second mean reason: they are not completely tested.

7. Give two examples of *covert channel*. (2×5 points)

a) A rogue server program can leak data in the bill rendered for the service.

b) It can transmit information by locking and unlocking some shared files.

c) It can transmit information by varying its ratio of computing to input/output or its paging rate.

8. What is the function of Xok *software abstraction*s? (5 points) Give one example. (5 points)

Software abstractions bind hardware resources together, such as disk blocks and the memory pages caching them.

9. According to Lamport, which two conditions must be satisfied by *true physical clocks*? (2×5 points)

True physical clocks verify the two physical clock conditions:

a) There is a constant $\kappa \ll 1$ such that for all i:

$$|d\,C_i(t)/dt - 1| < \kappa,$$

which means that the clocks are reasonably accurate, and

b) There is a constant ε such that for all i, j:

$$|C_i(t) - C_j(t)| < \varepsilon,$$

which means that the clocks are not too far apart from each other.