

**C1. Operating Systems (25 points) Answer all questions.**

- 1) (3 points) What is a race condition?
- 2) (3 points) Give one example to illustrate a race condition.
- 3) (3 points) What is the fundamental approach to avoiding race conditions?
- 4) (3 points) Disabling interrupt is one approach to achieving mutual exclusion. Describe the drawbacks of disabling interrupt on uniprocessor and multiprocessor systems, respectively.
- 5) (13 points) Suppose that processes in a system are one of two types (A or B). All processes want to execute a critical section, CS. We would like to enforce 'strict alternation' on the execution of CS by A-type processes and B-type processes. That is, accesses should be permitted in the order A-type, B-type, A-type, B-type, etc. Thus, if an A-type process finishes CS and another A-type process wants to execute CS, the second A-type process should wait until after a B-type process executes CS.
  - (a) Give the code for an A-type and B-type process using the P and V operations of semaphores to enforce the proper synchronization.
  - (b) Give the code for the monitor to enforce the synchronization. Give the code for the A-type and B-type processes as well.

Be sure to include initialization code.

## **C2. Operating Systems (25 points) Answer all questions.**

We define the portion of a process that is actually in main memory at any time to be the 'resident set' of the process. In paged virtual memory management, there are two aspects with respect to resident set, size and replacement scope. For resident set size, there exist two policies, fixed allocation and variable allocation. A fixed allocation policy gives a process a fixed number of frames in memory within to execute; a variable allocation policy allows the number of page frames allocated to a process to be varied over the lifetime of the process. For resident set replacement scope, there are two policies, local replacement policy and global replacement policy. A local replacement policy chooses only among the resident pages of the process that generated the page fault in selecting a page to replace; a global replacement policy considers all unlocked pages in main memory as candidates for replacement, regardless of which process owns a particular page.

- 1) (5 points) What is the Working Set Model?
- 2) (4 points) What specific problem(s) does the Working Set Model address/solve?
- 3) (6 points) What is the principle behind the Working Set Model?
- 4) (5 points) With respect to the size and replacement policies described above, there exist four combinations, fixed-local, fixed-global, variable-local, and variable-global. Which combination does the Working Set Model belong to? Which combination is NOT possible?
- 5) (5 points) Discuss the pros and cons of pure paging and pure segmentation memory management systems?

**C3. Operating Systems (25 points) Answer all questions.**

- 1) (6 points) Describe an instance of an Operating System providing a synchronous I/O abstraction on top of an underlying asynchronous mechanism. Provide details about how the driver and/or general I/O layers in the system would implement this.
- 2) (7 points) Name 2 inter-process communication (IPC) mechanisms provided by operating systems and describe how the kernel implements them.
- 3) (7 points) Compare and contrast programmed IO and DMA and describe operating system design considerations for each.
- 4) (5 points) Describe how a buffer cache can be used to improve file access performance, and describe the architecture of a typical implementation including algorithms and logical organization.

**C4. Operating Systems (25 points) Answer all questions.**

1. (25 points) Describe the steps involved when two processes communicate over a network using "sockets." Provide as much detail as you can (library code, system calls, device drivers, interrupt handling, etc.)