Carleton UNIVERSITY

Fall 2017 MIDTERM
EXAMINATION

DURATION: 1.5 HOURS **No. Of Students: 138**

Department Name & Course Number: Systems and Computer Engineering SYSC 4001A

Course Instructor: Thomas Kunz

AUTHORIZED MEMORANDA:

William Stallings, *Operating Systems: Internals and Design Principles*, 9th edition, Pearson 2018, ISBN-9780134670959 (as physical book, no ebook) or earlier versions of that same book. Also, a non-programmable calculator is allowed.

Students MUST count the number of pages in this examination question paper before beginning to write, and report any discrepancy to a proctor. This question paper has 5 pages + cover page = 6 pages in all.

This examination question paper MAY NOT be taken from the examination room.

In addition to this question paper, students require: an examination booklet: NO
Scantron Sheet: NO

Name: _____

Student Number: _____

Question 1: _____ /10

Question 2: _____ /10

Question 3: _____ /10

Question 4: _____ /10

Total: _____/40

Exam questions will not be explained, and no hints will be given. If you think that something is unclear or ambiguous, make a reasonable assumption (one that does not contradict the question), write it at the start of the solution, and answer the question.

Question 1: Processes and Threats (10 marks)

a. Two advantages of using multiple thread within a process are that (1) less work is involved in creating a new thread within the existing process than creating a new process and (2) communication among threads within the same process is simplified. Is it also the case that a mode switch between two threads within the same process involves less work than a mode switch between two threads in different processes?

b. In the discussion of ULT versus KLT, it was pointed out that a disadvantage of ULTs is that when a ULT executes a system call, not only is that thread blocked, but also all of the threads within the process are blocked. Why is that so?

c. Consider an environment in which there is a one-to-one mapping between user-level threads and kernel-level threads that allows one or more threads within a process to issue blocking system class while other threads continue to run. Explain why this model can make multithreaded programs run faster than their single-threaded counterpart on a uniprocessor computer.

Question 2: Concurrency: Mutual Exclusion and Synchronization (10 marks)

A file is to be shared among different threads, each of which has its own unique ID number (for simplicity, assume that a thread i's ID number is i). The file can be accessed by several threads at the same time as long as the sum of the thread ID numbers is less than a constant k. Write pseudocode for Thread(i) that coordinates access to the file using semaphores while ensuring the above synchronization requirement.

Note: it is tempting to redefine the semaphore operations, which would potentially make this question quite simple to solve. However, that is not how things work in real life: semaphores have a fixed and well-defined set of operations and you should limit yourself to using only those.

Question 3. Deadlocks (10 marks)

1. A computer has six tape drives, with n processes competing for them. Each process may need two drives. For which values of *n* is the system deadlock free?

2. In a real computer system, neither the resources available nor the demands of processes for resources are consistent over long periods (months). Resources break or are replaced, new processes come and go, new resources are bought and added to the system. If deadlock is controlled by the banker's algorithm, which of the following changes can be made safely (without introducing the possibility of deadlock), and under what circumstances?
    - Increase Available (add new resources)
    - Decreases Available (remove resources permanently from system)
    - Increase Max for one process
    - Decrease Max for one process
    - Increase the number of processes
    - Decrease the number of processes

Question 4. Memory Management (10 marks)

A pure paging system (no segmentation) has a page size of 512 words, a virtual memory of 512 pages numbered 0 through 511, and a physical memory of 10 frames numbered 0 through 9. The current content of physical memory is as follows:

Physical Address	Content
0	…….
…	…….
1536	start of Page 34
2048	start of Page 9
…	…
3072	start of Page Table
3584	start of Page 65
…	…….
4608	start of Page 10
…	…….

a) Assuming that page tables contain frame numbers (rather than physical memory addresses), show the current content of the page table.

b) Show the content of the page table after page 49 is loaded at location 0 and page 34 is replaced by page 12.

c) What physical address is referenced by the virtual address 4613?