CSCE 5640: Operating System Design

Topics to be covered on Final Exam

The final exam will cover everything we have discussed from Chapter 6 – 10 and some sections of Chapters related to I/O and File System (11-14) in the text and all the presented materials (including further reading sections). The exam will be very flexible, possibly consisting of filling in the blanks, true/false with justification, multiple choice questions, short answers, and numerical questions. There will be about 50 – 60 questions in total. The exam period will be 120-minutes and will be *closed book* and *closed notes*.

A brief outline of the topics we have covered is described below. This list is intended to be as complete as possible but may not be all inclusive.

- ***Synchronization Tools:*** Critical-section problem and race condition. Peterson's solution. Hardware solutions to the critical-section problem using memory barriers, compare-and-swap operations, and atomic variables. Solve critical-section problem using mutex locks, semaphores, monitors, and condition variables.

- ***Deadlocks:*** Reason for occurring deadlock when mutex locks are used. Four necessary conditions that characterize deadlock. Identifying a deadlock using a research allocation graph. Methods for handling deadlocks. Deadlock prevention, avoidance, and detection. Banker's algorithm for deadlock avoidance. Deadlock detection algorithm. Recovery from deadlock.

- ***Main Memory:*** Logical and physical address. Role of memory management unit (MMU) in translating addresses from logical to physical. Strategies for contiguous memory allocation: first-, best-, and worst-fit. Difference between internal and external fragmentation. Paging system that includes a translation look-aside buffer (TLB) for translating logical to physical addresses. Hierarchical paging, hashed paging, and inverted page tables.

- ***Virtual Memory:*** Demand paging and how pages are loaded into memory. Page replacement algorithms: FIFO, Optimal, and LRU. Working set of process and its relation to program locality. Allocation of frames. Thrashing and its prevention. Allocating kernel memory.

- ***I/O and File-System:*** Overview of mass storage structure. Disk structure. HDD Scheduling algorithms: FCFS, SCAN, C-SCAN. File management, file concept, and its attributes. Directory structure: Single-Level, Two-Level, Tree-Structured, Acyclic-Graph, General Graph. File system structure. Directory implementation. Allocation methods: Contiguous, Linked, and File Allocation Table (FAT).

Sample questions:

1. A(n) _____ refers to the section of the code which is accessing data that may be modified by another process executing concurrently.

2. _____ is the time required for the disk arm to move to the desired cylinder on an HDD device.

3. True or False. Justify your answer in either case. If a resource-allocation graph has a cycle, the system must be in a deadlock.

4. One necessary condition for deadlock is ____, which states that a process must be holding one resource and waiting to acquire additional resources.
    a) hold and wait
    b) mutual exclusion
    c) no preemption

5. A logical address space of size 2^32 with a page size of 2^12 requires ____ bits for the page number and _____ bits for the page offset.
    a) 12, 20
    b) 20, 12
    c) 10, 22

6. Consider a disk queue holding requests to the following cylinders in the listed order: 116, 22, 3, 11, 75, 185, 100, 87. Using the SCAN scheduling algorithm, what is the order that the requests are serviced, assuming the disk head is at cylinder 88 and moving upward through the cylinders?
    a. 116 - 22 - 3 - 11 - 75 - 185 - 100 – 87
    b. 100 - 116 - 185 - 87 - 75 - 22 - 11 – 3
    c. 100 - 116 - 185 - 3 - 11 - 22 - 75 - 87

7. List five different page replacement algorithms.

8. What is the effective memory access time with a TLB hit ratio of 85% and 15ns memory access time?

9. Assume a 32-bit single-level paging system with an 8 KB page size. How many page table entries are required for the paging system?

10. Consider the following snapshot of a system:

	Allocation				***Max***			
	A	*B*	*C*	*D*	*A*	*B*	*C*	*D*
T_0	1	2	0	2	4	3	1	6
T_1	0	1	1	2	2	4	2	4
T_2	1	2	4	0	3	6	5	1
T_3	1	2	0	1	2	6	2	3
T_4	1	0	0	1	3	1	1	2

Using the banker's algorithm, determine whether or not each of the following states is unsafe. If the state is safe, illustrate the order in which the threads may complete. Otherwise, illustrate why the state is unsafe.

a) ***Available*** = (4, 4, 1, 1)
b) ***Available*** = (3, 0, 1, 4)

11. Consider the following page reference string:

2, 6, 9, 2, 4, 2, 1, 7, 3, 0, 5, 2, 1, 2, 9, 5, 7, 3, 8, 5

Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms?

a) FIFO replacement
b) Optimal replacement
c) LRU replacement