Name:

CSCI 2310: Operating Systems
Sample Final Exam

General instructions:

- This examination booklet has 10 pages.

- Don't forget to put down your name on the exam books.

- The exam is closed book and closed notes.

- Explain your answers clearly and be concise. Do not write long essays.

- You have 180 minutes to complete the exam. Be a smart test taker, if you get stuck on one problem go on to the next. Don't waste your time giving details that the question does not request.

- Show your work. Partial credit is possible, but only if you show intermediate steps.

- Good luck!

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1. **Short Answer** (20 pts)

   (a) (4pts) Explain the difference between compile-time, load-time, and execution-time binding in memory management.

(b) (4pts) Explain briefly why second chance page replacement approximates the least recently used (LRU) page replacement policy.

(c) (6pts) Explain the difference between sequential and random access to a file. Give an example of an application that uses sequential file access and one that uses random access.

(d) (6pts) Explain why hard links to directories are disallowed in most file systems. How do soft-links address this problem?

2. **Memory Management** (35 pts)

(a) (12pts) What data structures (tables) do you need to maintain to implement segmented paging? What are the components of a virtual address in this scheme?

(b) (10pts) What is a translation look-aside buffer (TLB)? Do you need a TLB for a segmentation scheme where the segment table is stored in registers?

(c) (8pts) In a demand paged system with a 100 nanosecond memory access time and a 10 millisecond page fault time, what must be the page fault rate to incur a 10% slowdown in the effective memory access time?

(d) (5pts) Explain what is meant by a process' *working set* and why this is important in memory management.

3. **Disks and File Systems** (20 pts)

   (a) (4pts) What is the seek and rotational latency overhead incurred during a disk I/O?

(b) (5pts) How many disk accesses are incurred to read block i of a file when each of the following file system organization is used on disk: (i) linked list, (ii) indexed, (iii) contiguous.

(c) (6pts) Draw a figure to show the multi-level indexed organization for storing file meta-data in a file system. Be sure to label all key parts of your figure.

(d) (5pts) Consider a disk with tracks numbered 1 to 100. Assume that the disk head is positioned on track 20 and traversing to outer tracks. Using the SCAN scheduling, calculate the total seek incurred for the following requests: 50, 25, 65, 13.

4. **I/O Devices and Device Drivers** (15 pts)

(a) (5pts) Explain the steps that must be performed by a device driver when writing 1 byte to an I/O device using the *polling* method.

(b) (5pts) Why is the interrupt-based I/O more efficient than the polling method?

(c) (5pts) Why is direct memory access (DMA)-based I/O more efficient than interrupt-based I/O when reading or writing a block of data?

5. **Virtualization**   (10 pts)

    (a) (6pts) Explain why a data center operator might be interested in using virtualization on their machines.

    (b) (4pts) True or false: an application running in a virtual machine (VM) cannot be impacted in any way by another application running in a different virtual machine on the same physical machine. Explain.

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