

Your name:

## **CSE 30341 Operating Systems: Final Exam**

*OPEN BOOK, OPEN NOTES, CLOSED ELECTRONIC SEARCHES  
INDIVIDUAL EFFORT*

*DURATION: TWO HOURS*

There are eight questions in this exam. All questions carry equal weight. Ockham's Razor principles (or Keep It Simple, Stupid: KISS principles) hold. *Make no more assumptions than is needed.* Write down any assumptions to support your answer. Find a contiguous two hour slot to take the exam. By turning in the exam, you certify that you followed the instructions, that this is your own work and that you did not collaborate with others (in any form).

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1. Suppose a file system uses bit vectors to manage its free space. Let us denote the free space bit vector at time  $t$  as  $b_t$ . Similarly, let us denote the state of the file system at time  $t$  as  $S_t$ . Now suppose that the system crashes leaving  $b_i, S_j$  in the stable storage. Describe what happens when
  - a. time  $i$  was before time  $j$ .
  - b. time  $j$  was before time  $i$ .Given a choice, would you prefer condition a) or condition b)? Why?

2. Suppose your genius friend tells you that she can write a utility in 10 minutes that will free up the available memory in your laptop by up to 50%. Explain how you would respond to your friend.

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3. Outline your design for a file allocation mechanism for a iPOD device. Your target iPOD will use a disk based storage, use a sector size of 512 bytes and store files whose sizes vary from 5 megabytes to 20 megabytes each. The iPOD is optimized for playing songs from start to finish (meaning, applications will open files and read all the data from offset 0 to the *filesize*).

4. Your friend is in the market for a new desktop and seeks your advise. He wants to store and watch high definition movies from his desktop. You calculate the throughput required to play these high definition movies and find that you could satisfy the requirements by using a disk head that is spinning at 14,000 rpm. You price the desktop hard drives and find that the cost of one 15000 rpm hard disk equals three 7200 rpm hard disks or five 4200 rpm hard disks (each of these disks have equal storage capacity, i.e. three 7200 rpm disks have three time the raw storage capacity of one 15000 rpm disk). Which hard disk combination would you advise your friend to purchase, why and how would you organize the recommended disk?

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5. Your friend is in the market for a new desktop and seeks your advise. Her hardware choices (cost wise) are:
  - a. one 3 GHz processor or one 2.1 GHz dual core processor (think of it as two 2.1 GHz processors)
  - b. 1 GB of main memory that can store data at 400 MB/s or 2 GB of main memory that can store data at 100 MB/s
  - c. one 200 GB disk spinning at 7200 rpm or one 400 GB disk spinning at 4200 rpm

For each of the design choices, describe what factors would help you decide on the alternatives that will leave your friend satisfied? (make reasonable assumptions on what an OS would do with this hardware)

6. Suppose that you profile you desktop and note that your system never requires more than 2 GB of main memory at any one time. You upgrade your desktop to hold 2 GB of main memory. Should you now remove the paging disk? Explain your decision.

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7. How can a OS kernel allocate the total physical memory among different processes? Is this mechanism fair? If it is fair, can you think of an unfair allocation policy that is advantageous to the fair policy? On the other hand, if your original mechanism was unfair, what are its advantages over a fair policy?

8. The kernel memory protection boundary prevents dangerous access to kernel data by user-mode threads. Similarly, mutexes prevent dangerous accesses to shared data by concurrent threads. However, kernel memory protection is mandatory, whereas the protection afforded by mutexes is voluntary. Explain this statement. [chase01]