Important: This is an open book test. You can use any books, notes, or paper but no electronic device. *Do not log into the computer during the test, or use any electronic or communications device. Switch off your cell phones*. Any calculations and rough work can be done on the back side of the test pages. If there is a syntax error in any program segment, just write it down and you will get full credit for the problem. You will lose five points for not writing your name.

1. [10 pt] Consider a machine with the memory access time of 100ns. You are running processes that, on an average, have 1 page fault in 4000 memory accesses. Out of these page faults, 1 in 4 pages turnup with their dirty bit set. The disk has a seek time of 30ms and is spinning at 7200 rpm. Consider about 1 ms of transfer time. At any time, there are 2 processes in the device queue. Compute the effective memory access time for this system.

2. [8 pt] In the page table, we have valid bit, refer bit, dirty bit, shared bit, and protection bits. Explain the function of each of them. Do we need to add a bit to indicate the presence of reentrant code? Explain why would you do so, or why you would not do so.

3. [6 pt] Most of the modern operating systems do not have sophisticated storage systems for the files. Instead, they try to provide more flexibility to the user by allowing the user to access the file as a stream of bytes. This structure is very good for sequential access to file contents. How do they account for random access to file contents? Can a user have indexed sequential access to file contents in such a system? How will he do that?

4. [6 pt] In Unix, we may have a file such that the `gid` of the file points to a group that is different from the set of groups in which the file's `uid` belongs. That is, we have a situation where the `uid` and `gid` suggest different ownership. Give an example to illustrate where such a scheme is relevant.

5. [6 pt] Explain the difference between stateful and stateless file access systems. Give an advantage of each over the other.

6. [10pt] A machine has a memory of 64 frames, with each frame being 1K bytes. Current free-frame list is: 0x1B, 0x06, 0x08, 0x3A, 0x3F, 0x09, 0x21, 0x15, 0x2B, 0x00, 0x20, and 0x3E. You just scheduled a process that requires 8 frames. Show the resulting page table. Show the translation of logical address 0x292B and 0x3A10 into physical addresses using your page table.

7. [18 pt] Consider a disk with 256 cylinders, indexed from 0 to 255, with 0 being the innermost and 255 being the outermost cylinder. The system receives disk requests on the following tracks in the specified order

$$88 \; 62 \; 179 \; 93 \; 225 \; 32 \; 98 \; 43 \; 26 \; 83 \; 238$$

The head is currently on cylinder 36, and is moving towards outer cylinder. The head requires a total of 128ms to move from innermost to outermost track. Give the time required to service the given requests using each of the following algorithms.

(a) FCFS scheduling

(b) SSTF scheduling

(c) SCAN scheduling

(d) C-SCAN scheduling, servicing requests as head moves outwards

(e) LOOK scheduling

(f) C-LOOK scheduling, servicing requests as head moves outwards