

**Important:** This is an open book test. You can use any books, notes, or paper. If there is a syntax error in any program segment, just write it down and you will get full credit for the problem. The test is 75 minutes long.

1. [6 pt] Why is the principle of locality crucial to the use of virtual memory?
2. [6 pt] What is the distinction between use bit, valid bit, and dirty bit in a page table?
3. [10pt] A machine has a memory of 64 frames, with each frame being 1K bytes. Current free-frame list is: 0x2E, 0x27, 0x37, 0x25, 0x0C, 0x04, 0x0E, 0x09, 0x1D, 0x14, 0x16, 0x07, 0x22, 0x3E, and 0x30. You just scheduled a process that requires 10 frames. Show the resulting page table. Show the translation of logical address 0x240B and 0x5A32 into physical addresses using your page table. Express your result in hex.
4. [6 pt] What is the use of memory arbiter in the x86 architecture?
5. [6 pt] Why is the average search time to find a record in a file less for an indexed sequential file than for a sequential file?
6. [6 pt] Every user in Linux has complete access to the directory named /tmp. User `john` creates a file in this directory and forgets to remove it. Can he ask user `jim` to remove it? Why cannot `jim` remove it even when he has write permission on the directory?
7. [6 pt] Ignoring overhead for directories and file descriptors, consider a file system in which files are stored in blocks of 16K bytes. For each of the following file sizes, calculate the percentage of wasted file space due to incomplete filling of the last block: 41,600 bytes, 640,000 bytes, 4,064,000 bytes.
8. [6 pt] What is the different between block-oriented devices and stream-oriented devices from the perspective of kernel? Give a couple of examples of each.
9. [6+10 pt] I have a floppy disk with 1.44MB [unformatted] capacity. The data blocks are 256 bytes each.
  - (a) The OS keeps track of free space by using a bit vector approach. What is the size of the bit vector for this floppy? If the OS stores the bit vector on the floppy for recovery, how many blocks are left over to be used to store data.
  - (b) Now, consider that the same floppy is formatted using UFS, with an empty boot block of size 1 block. Consider 1 block to be allocated for super block. Let each inode require 1024 bytes. What can be the maximum formatted capacity of the floppy? What is the maximum file size that can be stored on this floppy if the system uses 12 direct blocks, 1 single indirect block, and 1 double indirect block?