

# Problem Set 19

CS 311

Due at the beginning of class the following Monday in hardcopy.  
Sections 9.1–3

1. A certain computer provides its users with a virtual memory space of  $2^{32}$  bytes. The computer has  $2^{22}$  bytes of physical memory. The virtual memory is implemented by paging, and the page size is 4,096 bytes. A user process generates the virtual address `0x11123456`. Explain how the system establishes the corresponding physical location. Distinguish between software and hardware operations.
2. Assume that we have a demand-paged memory. The page table is held in registers. It takes 8 milliseconds to service a page fault if the replaced page is not modified, and 20 milliseconds if the replaced page is modified. Memory access time is 100 nanoseconds.  
Assume that the page to be replaced is modified 70% of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 200 nanoseconds?
3. When a page fault occurs, the process requesting the page must block while waiting for the page to be brought from disk into physical memory. Consider a process with five user-level threads with a one-to-one mapping between user-level and kernel-level threads. If one user thread incurs a page fault while accessing its stack, would the other user threads belonging to the same process also be affected by the page fault — that is, would they also have to wait for the faulting page to be brought into memory? Explain.