

Problem 1. Consider a virtual memory system that uses a single-level page map to translate virtual addresses into physical addresses. Each of the questions below asks you to consider what happens when one of the design parameters of the original system is changed.

- A. If the physical memory size (in bytes) is doubled, how does the number of bits in each entry of the page table change?
- B. If the physical memory size (in bytes) is doubled, how does the number of entries in the page map change?
- C. If the virtual memory size (in bytes) is doubled, how does the number of bits in each entry of the page table change?
- D. If the virtual memory size (in bytes) is doubled, how does the number of entries in the page map change?
- E. If the page size (in bytes) is doubled, how does the number of bits in each entry of the page table change?
- F. If the page size (in bytes) is doubled, how does the number of entries in the page map change?
- G. The following table shows the first 8 entries in the page map. Recall that the valid bit is 1 if the page is resident in physical memory and 0 if the page is on disk or hasn't been allocated.

Virtual page	Valid bit	Physical page
0	0	7
1	1	9
2	0	3
3	1	2
4	1	5
5	0	5
6	0	4
7	1	1

If there are 1024 (2^{10}) bytes per page, what is the physical address corresponding to the decimal virtual address 3956?

Problem 2. Consider two possible page-replacement strategies: LRU (the least recently used page is replaced) and FIFO (the page that has been in the memory longest is replaced). The merit of a page-replacement strategy is judged by its hit ratio.

Assume that, after space has been reserved for the page table, the interrupt service routines, and the operating-system kernel, there is only sufficient

room left in the main memory for *four* user-program pages. Assume also that initially virtual pages 1, 2, 3, and 4 of the user program are brought into physical memory in that order.

- A. For each of the two strategies, what pages will be in the memory at the end of the following sequence of virtual page accesses? Read the sequence from left to right: (6, 3, 2, 8, 4).
- B. Which (if either) replacement strategy will work best when the machine accesses pages in the following (stack) order: (3, 4, 5, 6, 7, 6, 5, 4, 3, 4, 5, 6, 7, 6, ...)?
- C. Which (if either) replacement strategy will work best when the machine accesses pages in the following (repeated sequence) order: (3, 4, 5, 6, 7, 3, 4, 5, 6, 7, ...).
- D. Which (if either) replacement strategy will work best when the machine accesses pages in a randomly selected order, such as (3, 4, 2, 8, 7, 2, 5, 6, 3, 4, 8, ...).