Operating Systems and Systems Programming (15B11CI412)
Tutorial - 8 Virtual Memory

Q1. a) If the no of pages in a 32 bit machine is 8KB then what is the size of the page table?
b) In a 64 bit machine, with 256 MB RAM, and a 4KB page size, how many entries will there be in the page table if it is inverted?

Q2 Assuming a page size of 1 KB and that each page table entry takes 4 bytes, how many levels of page tables would be required to map a 34-bit address if every page table fits into a single page? Explain.

Q3. Assume a page reference string has length p with n distinct page numbers occurring in it. For any page replacement algorithms,
a. What is a lower bound on the number of page faults?
b. What is an upper bound on the number of page faults?

Q 4. Suppose we have a demand-paged memory. The page table is held in registers. It takes 8 milliseconds to service a page fault if an empty page is available or 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 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 200 nanoseconds?

Q 5. Consider the following page reference string:
1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6.
How many page faults would occur for the following replacement algorithms, assuming one, two, three, four, five, six, or seven frames? Remember all frames are initially empty, so your first unique pages will all cost one fault each.
_ LRU replacement
_ FIFO replacement
_ Optimal replacement

Q 6. What is the cause of thrashing? How does the system detect thrashing? Once it detects thrashing, what can the system do to eliminate this problem?

Q 7. Given references to the following pages by a program:
0,9,0,1,8, 1,8,7,8,7, 1,2,8,2,7, 8,2,3,8,3,

What is the working set $W(t,\Delta)$, with t equal to the time between the 15th and 16th references, and equal to 6 references?

Q8. Given following page table

Valid/Invalid bit	Frame No
V	20
I	22
V	200
V	150
I	30
I	50
V	120
V	101

Which of the following virtual addresses would generate a page fault? For those that do not generate a page fault, to what physical address would they translate?(Page Size=2000 Bytes)
(a) 10451
(b) 5421
(c) 14123
(d) 9156