Assignment 5
(**Due date: Tuesday, 11/16/2009, in class**)

Your name:	Date:

Provide **brief solutions** (see the ***important notes*** at the end of the assignment) to the following OS questions related to the textbook Chapters 8 and 9—questions marked **no submission are not required but may appear in the final exam**:

8.1 (No Submission, check course website for the solution) Name two differences between logical and physical addresses.

8.3 (No Submission, check course website for the solution) Why are page sizes always powers of 2?

8.4 (No Submission, check course website for the solution) Consider a logical address space of 64 pages of 1,024 words each, mapped onto a physical memory of 32 frames.

a) How many bits are there in the logical address?
b) How many bits are there in the physical address?

8.5 (No Submission, check course website for the solution) What is effect of allowing two entries in a page table to point to the same page frame in memory? Explain how this effect could be used to decrease the amount of time needed to copy a large amount of memory from one place to another. What effect would updating some byte on the one page have on the other page?

8.9 Explain the difference between internal and external fragmentation.

8.11 Given five memory partitions of 100 KB, 500 KB, 200 KB, 300 KB, and 600 KB (in order), how would each of the first-fit, best-fit, and worst-fit algorithms place processes of 212 KB, 417 KB, 112 KB, and 426 KB (in order)? Which algorithm makes the most efficient use of memory?

8.17 Assuming a 1 KB page size, what are the page numbers and offsets for the following address references (provided as decimal numbers):

a. 2375
b. 19366
c. 30000
d. 256
e. 16385

8.20 Consider a paging system with the page table stored in memory.

a) If a memory reference takes 200 nanoseconds, how long does a paged memory reference take?
b) If we add associative registers, and 75 percent of all page-table references are found in the associative registers, what is the effective memory reference time? (Assume that finding a page-table entry in the associative registers takes zero time if the entry is there.)

8.23 Consider the following segment table:

Segment	Base	Length
0	219	600
1	2300	14
2	90	100
3	1327	580
4	1952	96

What are the physical addresses for the following logical addresses?

a. 0,430
b. 1,10
c. 2,500
d. 3,400
e. 4,112

9.1 (No Submission, check course website for the solution) Under what circumstances do page faults occur? Describe the actions taken by the operating system when a page fault occurs.

9.2 (No Submission, check course website for the solution) Assume that you have a page-reference string for a process with ***m*** frames (initially all empty). The page-reference string has length ***p***; ***n*** distinct page numbers occur in it. Answer these questions 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?

9.6 (No Submission, check course website for the solution) An operating system supports a paged virtual memory, using a central processor with a cycle time of 1 microsecond. It costs an additional 1 microsecond to access a page other than the current one. Pages have 1,000 words, and the paging device is a drum that rotates at 3,000 revolutions per minute and transfers 1 million words per second. The following statistical measurements were obtained from the system:

- One percent of all instructions executed accessed a page other than the current page.
- Of the instructions that accessed another page, 80 percent accessed a page already in memory.
- When a new page was required, the replaced page was modified 50 percent of the time.

Calculate the effective instruction time on this system, assuming that the system is running one process only and that the processor is idle during drum transfers.

9.8 (No Submission, check course website for the solution) 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, and seven frames? Remember that all frames are initially empty, so your first unique pages will cost one fault each.

- LRU replacement
- FIFO replacement
- Optimal replacement

9.20 A certain computer provides its users with a virtual-memory space of $\mathbf{2^{32}}$ bytes. The computer has $\mathbf{2^{18}}$ bytes of physical memory. The virtual memory is implemented by paging, and the page size is **4096** bytes. A user process generates the virtual address **11123456Hex**. Explain how the system establishes the corresponding physical location. Distinguish between software and hardware operations.

9.21 Assume 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?

9.23 Consider the page table for a system with 12-bit virtual and physical addresses with **256**-byte pages. The list of free page frames is **D, E, F** (that is, **D** is at the head of the list, **E** is second, and **F** is last.)

Page	Frame
0	-
1	2
2	C
3	A
4	–
5	4
6	3
7	–
8	B
9	0

Gonvert the following virtual addresses to their equivalent physical addresses in hexadecimal. All numbers are given in hexadecimal. (A dash for a page frame indicates the page is not in memory.)

- 9EF
- 111
- 700
- 0FF

9.28 Consider a demand-paging system with the following time-measured utilizations:

CPU utilization	20%
Paging disk	97.7%
Other I/O devices	5%

For each of the following, say whether it will (or is likely to) improve CPU utilization.

a. Install a faster CPU.
b. Install a bigger paging disk.
c. Increase the degree of multiprogramming.
d. Decrease the degree of multiprogramming.
e. Install more main memory.

==========**Important Notes**==========

- Solutions must be **typewritten** (The question text ***is not*** required).
- Have all your solutions **in the same order** as the above questions.
- Your answers must be succinct and brief: using keywords/phrases is encouraged and no complete sentences are required. For each of the above questions (accept those for coding/pseudo-coding questions), **your answer must be limited within 30 words**—otherwise, your score for that question will be 0.