Homework 1

Due Date : April 15, 1999 **Points** : 100

Short-Answer Questions

These can be answered in a sentence or two, and are intended to reinforce important points.

1. (*3 points*) What is *multiprogramming*? (Tanenbaum, problem 1.2)
2. (*6 points*) Name the layers of the THE operating system, and *briefly* describe the function of each.
3. (*4 points*) Why was time-sharing not widespread on second generation computers? (Tanenbaum, problem 1.5)

Long-Answer Questions

These questions require some thought and longer answers than the short-answer questions. They are intended to have you use the concepts discussed in class, to be sure you understand them and can work with them.

4. (*14 points*) Protecting the resident monitor is crucial to a correctly operating computer system. Providing this protection is the reason behind multiple mode operation, memory protection, and the timer. To allow maximum flexibility, however, we would also like to place minimal constraints upon the user. The following is a list of operations which are normally protected. What is the *minimal* set of instructions which must be protected?
   a. Change to user mode.
   b. Change to monitor mode.
   c. Read from monitor memory.
   d. Write into monitor memory.
   e. Instruction fetch from monitor memory.
   f. Turn on timer interrupt.
   g. Turn off timer interrupt.
5. (*15 points*) Some early computers protected their operating systems against destruction by placing it in memory locations from which all programs (including the operating system itself) could read, but into which no program could write. What problem does this protection scheme create?
6. (*20 points*) Three conventions for communicating the arguments of a service call to the kernel are to place them on a stack, in registers, or right after the call. What are the advantages and disadvantages of these three strategies?
7. (*18 points*) The classical batch processing system completely ignores the cost of increased waiting time for users. Consider a single batch characterized by the following parameters:

M	average mounting time
T	average service time per job
N	number of jobs
S	unit price of service time
W	unit price of waiting time per user

   Show that the optimal batch size minimizing the cost of service time and waiting time per user within a single batch is $N_{opt} = \sqrt{\frac{MS}{TW}}$.
8. (*20 points*) In the example of virtual machines, with a compiler above an operating system above two levels of virtualizing kernel, how many privileged instructions would be executed at each level if the instruction executed by the compiler can be emulated without use of privileged instructions by the operating system?

Extra Credit

9. (*5 points*) In class I used CPU utilization to illustrate how successive generations made more effective use of the computer. How meaningful is the CPU utilization to the users? What other question (or questions) would users like to know the answer to?

10. (*10 points*) In MINIX, why is the CHROOT system call limited to the super-user? (*Hint*: think about protection problems.) (Tanenbaum, problem 1.14)