Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science
6.826 *Principles of Computer Systems*

February 24, 2000 **Due: Thursday, March 2, 2000**

Problem Set 4

Instructions: There are **5** *problems in this problem set;* **please turn in each problem on a separate sheet of paper with your name at the top, or you will run the risk of your solutions being lost**. *Also give the amount of time you spend on each problem.*

Problem 1

Consider the following specification for a reliable FIFO buffer:

```
MODULE Buffer [M] EXPORTS {put, get} = % M = message
  TYPE Q = SEQ M

  VAR q := {}

  APROC put(m) = << q := q + {m} >>
  APROC get() -> M = << VAR m | m = q.head => q := q.tail; RET m >>
END Channel
```

Assume that `M` is one byte in size.

(a) Write an implementation for this buffer that enforces *upper* time bounds of 15 ms and 150 MB/s respectively on the buffer latency and throughput.

(b) Write an implementation for this buffer that enforces *lower* time bounds of 5 ms and 50 MB/s respectively on the buffer latency and throughput.

(c) Give an abstraction function from each of your implementations to `Buffer`.

Problem 2

Ben Bitdiddle has quit MIT and started a .com selling widgets to an eager marketplace. His web server is a 500 MIPS machine, with a hard disk bandwidth of 40 MB/s and latency of 6 ms. Each widget transaction requires 200K instructions, and writes a total of 2 KB of data to disk.

(a) Ben wishes to balance the speed of the processor with the speed of the disks. How many disks should Ben use to accomplish this if the load on the disks is perfectly balanced?

His e-business online and thriving, Ben modifies his server to batch the transactions' disk I/O in groups of 10. Batched transactions are read and written sequentially to disk.

(b) Now how many disks does Ben require to balance the speed of the processor with the speed of the disks?

(c) At what rate can Ben's modified web server handle widget transactions in the steady state?

Problem 3

A web server services transactions at the rate of 100 per second; it also has internal buffer space for 100 transactions, and no more buffer space.

(a) Over any given four second period, we are guaranteed that at most 400 transactions are submitted to the server. How much external buffer storage must we add so that no transactions are lost?

(b) Now add the additional stipulation that the maximum arrival rate for transactions is 200 transactions per second. How much external buffer storage must we add so that no transactions are lost?

Problem 4

This problem refers to the *semantic file system* described by Gifford et. al.

Suppose a virtual directory has more than one file with the same last name, and you want them all to appear in the virtual directory, rather than just one chosen at random. Describe in English a reasonable convention for naming them.

Problem 5

Consider the `MemNames` and `ObjNames0` specs given in Handout 12. Write an abstraction function from `MemNames` to `ObjNames0`.