ECES 338 Assignment #4 Due: March 1, 2001
(100 points)

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In this assignment, you will write concurrent programming algorithms with (conditional) critical region statements and monitors.

(40 pts) **(1) The UniSex Bathroom Problem**. Suppose there is a bathroom with n stalls (a compartment with a toilet, or, as the British say, "a water closet") in the Thwing Center. The bathroom can be used by both men and women (i.e., processes), but not at the same time. Using critical region statements (with or without conditions), write a solution that controls the use of the bathroom. The bathroom entry is FIFO—except for the provision below. After entering the bathroom successfully, individuals use a stall. If all stalls are in use then they wait (there is enough space in the bathroom). After using a stall, each individual exits the bathroom for others to use it.

Your solution must be fair in the following sense. Assume that, at a given point in time, the bathroom is in use by x individuals of one sex (some using stalls and some waiting—referred to as O(riginal) sex), and the first individual, say N(ext), from the opposite sex arrives. Then

- N enters the bathroom immediately after the bathroom exit of those x individuals of sex O.
- When N is waiting, if other individuals of the same sex with N arrive, they use the bathroom concurrently with N.
- When N is waiting, if individuals of sex O arrive to use the bathroom, they enter the bathroom after N (and the company, if any) exit.
- When N (and the company) is using the bathroom and individuals of sex F are waiting, if individuals of the same sex with N arrive then they wait until those of the sex O (and waiting to enter) get to use the bathroom.

Explain your algorithms, and explicitly specify any assumptions you make about the model.

(30 pts) **(2) The Four-of-a-Kind Problem.** Develop a solution to the four-of-a-kind problem using critical region statements (with or without conditions): There is a deck of 24 cards, split into 6 different kinds, 4 cards of each kind. There are 4 players (processes); each player can hold 4 cards. Between each pair of adjacent (i.e., seated next to each other) players, there is a (possibly empty) pile of cards. Each player behaves according to the following program.

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while ((hand does not contain four of a kind) and (no one has won))
    begin
        Discard a card into the left-hand pile;
        Pick up a card from the right-hand pile;
    endwhile;
if  hand contains four of a kind then claim victory;
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There are no ties; when a player has claimed victory, all other players stop. The game begins by dealing four cards to each player and putting two cards on the pile between each pair of adjacent players. Explain your algorithm, and explicitly specify any assumptions you make about the model.

(30 pts) **(3) Searchers/Inserters/Deleters Problem**. Three kinds of processes share access to a singly linked list: searchers, inserters, and deleters. Searchers merely examine the list; hence they can execute concurrently with each other. Inserters add new items to the end of the list; insertions must be mutually exclusive to preclude two inserters from inserting new items at about the same time. However, one insert can proceed in parallel with any number of searches. Finally, deleters remove items from anywhere in the list. At most one deleter process can access the list at a time, and deletion must also be mutually exclusive with searches and insertions. You are to specify a monitor to synchronize searcher, inserter and deleter processes. Explicitly specify any additional assumptions you make about either the model or the monitor.