ECES 338: Intro to Operating Systems

Assignment #4

Due: February 26, 1999   100 Points

Late assignments are not accepted; I will post the solutions on Feb. 26.

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1. **(The Four-of-a-Kind Problem)** Develop a solution to the four-of-a-kind problem **using a monitor**: 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.

```
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;
```

   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 either the model or the monitor.

2. **(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, but not at the same time. Write a **monitor** that controls the use of the bathroom. The bathroom entry is by the monitor procedure *EnterBathroom.* After entering the bathroom successfully, individuals use the monitor procedure *getstall* to get to a stall. If all stalls are in use then they wait (there is enough space in the bathroom). After using a stall, each individual calls *ReleaseStall* for others to use it.

   The monitor is 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), and the first individual, say P, from the opposite sex arrives. Then

   (i) P enters the bathroom immediately after the bathroom exit of those x individuals,

   (ii) when P is waiting, if other individuals of the same sex arrive, they use the bathroom concurrently with P,

   (iii) when P is waiting, if individuals of the opposite sex arrive for bathroom use, they enter the bathroom after P (and the company, if any) exit,

(iv) when P (and the company) is using the bathroom, if individuals of the same sex arrive then they wait until those of the opposite sex with P and waiting get to use the bathroom.

Explain your algorithm, and explicitly specify any assumptions you make about either the model or the monitor.

3. **(The Printer Daemon Problem)** Consider an OS environment where processes have priorities. The printer daemon (a service routine) controls the allocation of three identical laser printers directly to processes: processes *GetPrinter*, use it for a while to print, and then *ReleasePrinter*. Write a **monitor** (as the printer daemon) where, if two processes execute *GetPrinter* and wait until a printer becomes available then, regardless of the order of their *GetPrinter* procedure call, the one with the higher priority gets the printer. **Assume** that

   - for condition variables, you do not have the *conditional* wait primitive; you can only use the basic *wait* and *signal* primitives for condition variables.
   - All processes have different priorities.
   - The monitor does not know the number (or the maximum number) of processes that exists within the system at any given time.
   - The monitor does not use lists that dynamically increase in size (because they may become arbitrarily large and create performance problems).

   Explain your algorithm, and explicitly specify any assumptions you make about either the model or the monitor.