

ECES 338 Assignment #3  
(100 points)

Due: February 22, 2001

Spring 2001  
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In this assignment, you will write concurrent programming algorithms with semaphores. Please **start** the assignment right away, as the algorithms are not trivial.

(30 pts) **(1) The Sleeping Barber Problem.** A barbershop has a single room with one barber chair and  $n$  customer chairs. Customers (i.e., independent processes) enter the waiting room one at a time if empty chairs are available, otherwise they go elsewhere. Each time the barber (i.e., an independent process) finishes a haircut the customer leaves to go elsewhere, and, among the waiting customers, the one who has been waiting the longest (i.e., a FIFO waiting queue) moves to the barber's chair to get a haircut. If the barber discovers that the waiting room is empty, (s)he falls asleep in the waiting room. An arriving customer finding the barber asleep wakes the barber (i.e., a rendezvous takes place) and has a haircut; otherwise the arriving customer waits. Using semaphores and shared variables only (but not critical region statements or monitors), give two algorithms, one for the barber, and another for an arbitrary customer, that implement the sleeping barber problem. Explain your algorithms, and explicitly specify any assumptions you make about the model.

(40 pts) **(2) The Sleeping Barber Problem With Multiple Barbers:** Revise the above problem into the following version (this is a real example from my barbershop): There are two barbers (Tina and Judy) and two barber chairs. Customers entering the shop declare three preferences: Tina, Judy or "don't-care". Waiting customers will still be serviced FIFO (i.e., the system satisfies the fairness and the liveness properties) with the exception of (a) those waiting for Tina will decline when Judy is available and wait for Tina in a FIFO order, and (b) those waiting for Judy will decline when Tina is available and wait for Judy in a FIFO order. Using semaphores and shared variables only (but not critical region statements or monitors), give five algorithms, one for each barber, and three for each customer type, that implement the sleeping barber problem with two barbers. Explain your algorithms, and explicitly specify any assumptions you make about the model.

Note: This is a significantly more difficult algorithm than the first one.

(30 pts) **(3) The Savings Account Problem.** A savings account is shared by several people (i.e., processes). Each person may deposit or withdraw funds from the account. The current balance in the account is the sum of all deposits to date minus the sum of all withdrawals to date. The balance must never become negative, and withdrawals are serviced First-Come-First-Serve with one twist: Those who want to withdraw money from the account are desperate (students?) to get their money; so, if the balance is not sufficient, they wait (in a FIFO order) until somebody else deposits enough money for them to make their withdrawals. Note that those waiting for others to deposit (so that they can withdraw) are serviced strictly FIFO. For example, suppose the current balance is 200 dollars, and customer A is waiting to withdraw 300 dollars. Assume another customer, say B, arrives with the request of withdrawing 200 dollars. Customer B must wait until customer A is serviced. Using semaphores (but not conditional critical region statements, critical region statements or monitors), give the algorithms for customers to withdraw or deposit funds. Explain your algorithms, and explicitly specify any assumptions you make about the model.