1998 Paper 11 Question 6

Operating System Foundations

A barber provides a hair-cutting service. He has a shop with two doors: an entrance and an exit. He spends his time serving customers one at a time. When none are in the shop, the barber sleeps in the barber's chair. When a customer arrives and finds the barber sleeping, the customer awakens the barber and sits in the barber's chair to receive his haircut. After the cut is done, the barber sees the customer out through the exit door. If the barber is busy when a customer arrives, the customer waits in one of the chairs provided for the purpose. If all the chairs are full he goes away. After serving a customer the barber looks to see whether any are waiting and if so proceeds to serve one of them. Otherwise, he sleeps again in his chair.

In this question we represent the barber and his customers as synchronising processes.

A solution for the barber using only semaphores is:

```
waiting : integer      := 0;  % customers waiting to be cut
guard : semaphore      := 1;  % delimits a critical region to protect waiting
customers : semaphore  := 0;  % counting semaphore of customers
barber : semaphore     := 0;  % barber waiting for a customer (1) or not (0)?
```

The barber executes the following program:

```
WAIT (customers);              % sleeps if there are none
WAIT (guard);
  waiting := waiting −1;       % otherwise changes waiting under exclusion
  SIGNAL (barber);             % and indicates his readiness to cut hair
SIGNAL (guard);
cut hair;
```

(*a*) Give the corresponding code for a customer. [6 marks]

(*b*) Give the corresponding solution using a monitor. [10 marks]

(*c*) To what extent are the difficulties of semaphore programming alleviated by the provision of monitors? [4 marks]