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Please write on each paper the date and the name of the course as well as your name and signature.

NOTE: Please, use separate papers for each solution!

1. SEMAPHORES (14 p)

A hostel has only one bathroom, which is used by both boys and girls. The usage has to be exclusive: only boys or only girls may use it at a time. Here is the code for boy-processes:

```
process Boy[i=1 to M]
{
  while (true) {
    P(mutex);
    count++;
    if (count == 1) P(proceed);
    V(mutex);

    use_bathroom();

    P(mutex);
    count--;
    if (count == 0) V(proceed);
    V(mutex);
  }
}
```

a) Write the code for the girl-processes, define all needed variables and explain the purpose and usage of each variable.

b) Assume that the bathroom is reserved for girls, and three boys want to use it. Explain how the solution prevents boys from executing the routine use_bathroom().

c) Change the solution so that only 4 girls or 4 boys may be using the bathroom at a time. Give reasons that your solution is correct.

2 MONITOR (12p)

A group of bees are feeding a bear in a trap. The life of the bear is simple: it just eats and sleeps. The bees carry small honey portions into a pot. When the pot is full (capacity of H portions), the bees awaken the bear, and wait until the bear has eaten all portions. When the pot is empty again, the bear goes to sleep.

Write the pot usage functions into a monitor and show the code for bee processes (N) and for the bear process. Explain the cases where synchronization and mutual exclusion is needed and how did you handle them in your solution.

3 MESSAGE PASSING (13p)

There are 5 barbers working in a barbershop, and they serve customers (N) in FCFS order. If there are no customers, the barbers have to wait. When a customer arrives, one of the barbers serves him. If there are no free barbers, the customer has to wait. When the barber is cutting the hair, the customer waits until the barber says that the work is done and it is time to pay. The barber cannot take a new customer until the previous customer has paid X euros, and the barber has added the amount to barbers common balance.

Use message passing for the communication, and semaphores for the mutual exclusion. Give the definitions for the communication channels and other variables and show the customer processes and the client processes.

4 DEADLOCK AVOIDANCE (12 p)

The system contains three types of resources: there are 9 units of resource A, 3 units of resource B and 6 units of resource C. The predefined maximum needs fofr4 the processes are P1: (3, 2, 2), P2: (6, 1, 3), P3: (3, 1, 4) and P4: (4, 2, 2). The resources allocated to the processes are P1: (1, 0, 0), P2: (5, 1, 1), P3: (2, 1, 1) and P4: (0, 0, 2).

a) Explain the ideas of the banker's algorithm.

b) Process P2 requests for one additional unit of A and one additional unit of C. Is it possible to grant the requests? Use the banker's algorithm step by step to solve the problem.

c) Same as b), but the requests come from process P1?

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