*This exam is **closed book**. You can have **one page** of notes.   Be specific.*

1. *Advantages and disadvantages* (5 points each).

   a) What is the main advantage of *DMA controllers*?

   They move data between the main memory and the disk without any CPU intervention, thus reducing the number of context switches.

   b) What is the main advantage of *delaying writes* to the disk?

   It reduces the number of disk accesses.

   c) What is the main advantage of *dual-mode* CPU architectures?

   They prevent user processes from accessing directly disk drives and other peripherals, forcing them to go through the kernel.

   d) What is the main advantage of *vectorized interrupts*?

   They assign different priority levels to different types of interrupts depending on their emergency level.

   e) What is the main advantage of *multithreaded servers*?

   They can process several client requests in parallel.

   f) What is the main advantage of *timer interrupts*?

   They notify the kernel that the running process has run for so many milliseconds, thus preventing a process from monopolizing the CPU when other processes are waiting.

2. How many lines will the following program print out? (5 points)

```
main() {
     int pid;
     if ((pid =fork())  == 0) {
          fork();
     }
     printf("Hello!\n");
}
```

The program will print out exactly   _three_   lines.

3. What is the *default action* taken by a UNIX process that receives a *signal*? (5 points)

It terminates.

What should the process do if it wants to do something else? (5 points)

It should issue beforehand a signal() system call to "catch" the signal..

Is this always possible? (5 points)

No, the SIGKIL signal cannot be caught.

4. Complete the following code fragment to ensure that (a) **stdout** in redirected to the file **output.txt** and (b) **stderr** is redirected to **errorlog.txt**? (4×5 points)

```
int fda, fdb;
fda = open("output.txt", O_WRONLY | O_CREAT, 0640);
fdb = open("errorlog.txt", O_WRONLY | O_CREAT, 0640);

close(1) _____;
dup(fda) _____;
close(2) _____;
dup(fdb) _____;
```

5. Both *microkernels* and *modular kernels* allow to extend kernel functionality without having to recompile it. What are the respective main advantages of each approach over the other? (2×5 points):

a) Microkernels are _ more secure _ than modular kernels because
__ kernel extensions are separate server processes that cannot access the kernel address space. _____

b) Modular kernels are _ faster _ than microkernels because
_ kernel extensions run in the kernel address space. _____

6. Give one example of

a) A real-time process with hard deadlines? (5 points)

Any process control application _____

b) A real-time process with soft deadlines (5 points)

Watching a DVD on your PC _____

7. Explain why a good multiprocessor operating system should :

a) Have a symmetric organization. (5 points)

Otherwise the processor on which the kernel run could become a bottleneck.

b) Support kernel-level threads. (5 points)

To be able to allocate several processors to a multithreaded process.