Exam guide: The exam consists of 15 questions spread across two pages. The exam has in total 100 points, you must achieve more than 50 points to pass the exam. The exam duration is 150 minutes. Questions with less than 3 point shouldn't take you more than 1 minute to answer; this leaves about 12 minutes for each question with more than 2 points.

1. What material did you use to prepare for the final? There only exist correct answers to this question. Please list a selection of (or specify other): Stalling's book, another book, lecture slides, own notes, nothing. *[1p]*

2. Are both of the following two context-switch routines useful for hard real-time systems? Justify your answer clearly or provide a counter example. Switch routine 1 always uses exactly 13us to complete the context switch. Switch routine 2 on average requires 666ms, sometimes only needs 422ms, but never uses more than 672ms. *[1p]*

3. Draw the seven state diagram for process state transitions. Explain the nature of all transitions that leave the Running state in one sentence each. *[10p]*

4. Explain the difference between user-level threads and kernel-level threads and explain the advantages of user-level threads over kernel-level threads. *[8p]*

5. Explain the term *race condition*. Provide a pseudo code example and an execution trace that demonstrates the problem. *[10p]*

6. Specify a set of tasks with their periods and execution times, so the task set is not schedulable with rate-monotonic scheduling but it is schedulable with earliest deadline first scheduling. *[12p]*

7. Explain a buffer overflow attack and explain two run-time defenses implementable by the operating system. *[5p]*

8. Buffering:

   (a) What is the use of buffers when communicating with I/O devices? *[5p]*

   (b) What is the advantage of circular buffers over double buffering? *[3p]*

9. It should be clear that disk striping can improve the data transfer rate when strip size is small compared to the I/O request size. It should also be clear that RAID 0 provides improved performance relative to a single large disk, because multiple I/O requests can be handled in parallel. However, in this latter case,

is disk striping necessary? That is, does disk striping improve I/O request rate performance compared to a comparable disk array without striping? *[5p]*

10. The disk just served the requests: 94, 100. The read buffer in the disk has requests listed in this chronological order: 184, 38, 150, 160, 90, 18, 39, 58, 55. Describe the order in which the disk executes these requests using the following scheduling algorithms:

    (a) Last in First Out *[2p]*

    (b) Shortest Service Time First *[3p]*

    (c) SCAN *[4p]*

11. SCAN typically performs as well as shortest service time first. Describe a scenario when SCAN performs poorly compared to shortest service time first. *[8p]*

12. Assume a clock page replacement algorithm with a 1 bit use flag and the OS monitors the movement of the pointer in [increments per ms].

    (a) If the rate is below a given lower threshold, what does this mean? *[9p]*

    (b) If the rate is below this threshold, should the OS increase or decrease the multiprogramming level. *[1p]*

13. How are the working set size and the principle of locality linked together? *[7p]*

14. What is the main problem with a global replacement, fixed allocation strategy for virtual memory management? *[2p]*

15. Questions specific for the lab project:

    (a) What is the command to download the .s19 file to the physical board ? *[1p]*

    (b) Is "RTE" a supervisor mode instruction or user mode instruction? *[1p]*

    (c) How many UARTs does the MCF5307 contain? *[1p]*

    (d) Why do you need to compile the RTX project with the "-nostdlib" flag? *[1p]*

End of exam. Total points: 100