

## T-106.4150 Operating systems and concurrent programming

The exam contains six questions. The maximum points for each question are listed in the beginning of the questions. Read the questions carefully. Give clear and compact answers. Remember to write the name of the course and your own personal information on each of the papers that you return.

- 1 (10p) Answer *shortly*. (One point per question.)
  - a) What is DMA?
  - b) What is starvation?
  - c) What is double buffering?
  - d) What is polling?
  - e) What is spooling?
  - f) What is priority inversion?
  - g) What is TLB?
  - h) What is gang scheduling?
  - i) What is binary semaphore?
  - j) What is NUMA?
- 2 (6p) Explain in detail the operation of a RMS scheduler and the principles that RMS scheduling is based on. What kind of tasks are suitable for RMS scheduling? What kind of tasks are not suitable?
- 3 (6p) Considering the readers-writers problem, give a solution that implements mutual exclusion by using a *monitor*. Present the code for both the producers and the consumers.
- 4 (4p) How is the address translation from virtual addresses to physical addresses done in a modern operating system? What kind of hardware is available to support such translations in modern systems?
- 5 (4p) What conditions must be satisfied by a system in order for a deadlock to be able to occur?
- 6 (6p) An operating system kernel can share address space with applications or have a separate address space. Write an essay that is not longer than a page discussing the benefits and the problems of different approaches.