

## T-106.4155 Operating systems

The exam contains five 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 your answer papers.

- 1 (10p) Give short definitions for the following. (One point per question.)
  - a) What is DMA?
  - b) What is TLB?
  - c) What is double buffering?
  - d) What is priority inversion?
  - e) What is starvation?
  - f) What is a system call?
  - g) What is a virtual machine?
  - h) What is NUMA?
  - i) What is a socket?
  - j) Where the SCAN algorithms are being used?

Note that long explanations (several sentences) are *not allowed*.

- 2 (6p) Considering the dining philosophers problem (assume five philosophers), give a solution that implements mutual exclusion by using *semaphores*. Present your solution as a piece of pseudo code and give a short explanation.
- 3 (4p) List four criteria for scheduling. Explain the listed criteria compactly (using up to three sentences per criterium).
- 4 (6p) Consider a single processor real-time system with three tasks, whose periods are 9ms, 11ms, and 13ms. The required processor times for the tasks are 4ms, 2.7ms, and 0.3ms, respectively. Can the system be schedulable if static priorities are used? Explain why or why not. (Hint: if you do not have a calculator, use inequations – the cube root of  $2 > 34/27$ .)
- 5 (6p) Write an one-page essay on kernel and user space threads.