## Coursework Part 2, 2018-2019

Please consult the module web page and the links therein about deadlines, late submission and plagiarism before submitting your solutions.

Your answers to these problems should contain explanations of the computations and calculations. If you make additional assumptions, state them explicitly and provide justifications for them.

1. There are three independent jobs, i.e., they are not constrained by dependencies on each other and they have different I/O needs. They need $20 \mathrm{~s}, 30 \mathrm{~s}$ and 40 s CPU time, respectively, and during their executions each of them spends one minute waiting for I/O. Compute the optimal (i.e., minimal) overall runtime of these jobs when they are processed
(a) in a uniprogrammed
(b) in a multiprogrammed
system.
Subtotal: [10 marks]
2. A computer uses virtual memory implemented by paging. The TLB lookup takes 100 ns and the update takes 200 ns . The PT lookup takes $1 \mu \mathrm{~s}$ and the update takes $2 \mu \mathrm{~s}$. Loading a word from main memory onto the CPU takes $10 \mu$ s and loading a page from the disk into main memory takes 10 ms . The TLB hit ratio is 0.4 and the main memory hit ratio is 0.3. Compute the average access time for a referenced word: i.e., the time it takes

- to find out the physical address
- to load the referenced word onto the CPU and
- to perform the necessary updates to the page tables.
[Hint: Compute the access time for the possible scenarios (TLB-hit, etc.) and take the weighted average according to the hit ratios.]

Subtotal: [20 marks]
3. In a computing center there are four types of jobs according to their arrival times (in seconds), their priorities and their run times (in seconds); see the table below:

|  | Type 1 | Type 2 | Type 3 | Type 4 |
| :--- | :---: | :---: | :---: | :---: |
| arrival time | 40 | 50 | 40 | 0 |
| priority | 1 | 1 | 0 | 0 |
| run time | 1 | 2 | 1 | 2 |

There are 20 Type 1 jobs, 30 Type 2 jobs, 20 Type 3 jobs and 80 Type 4 jobs. Compute the average turnaround time using the multilevel queues (round robin on every priority level - the higher the priority, the sooner they run) scheduling algorithm.
[Use a quantum that provides short response time. You can ignore the overhead of process switches.]

Subtotal: [20 marks]
Total: [50 marks]

