

Written examination

Operating Systems

July 22nd 2019

Last name: _____

First name: _____

Student number: _____

I confirm with my signature that I will process the written examination alone and that I feel healthy and capable to participate this examination.
I am aware, that from the moment, when I receive the written examination, I am a participant of this examination and I will be graded.

Signature: _____

- Use the provided sheets. Own paper must *not* be used.
- You are allowed to use a *self prepared, single sided DIN-A4 sheet* in the exam. Only *handwritten originals* are allowed, but no copies.
- You are allowed to use a non-programmable calculator.
- Do *not* use a red pen.
- The time limit ist *90 minutes*.
- Turn off your mobile phones!

Result:

Question:	1	2	3	4	5	6	7	8	9	10	11	Σ	Grade
Maximum points:	8	14	8	4	10	8	4	8	10	9	7	90	—
Achieved points:													

1.0: 90.0-85.5, **1.3:** 85.0-81.0, **1.7:** 80.5-76.5, **2.0:** 76.0-72.0, **2.3:** 71.5-67.5,
2.7: 67.0-63.0, **3.0:** 62.5-58.5, **3.3:** 58.0-54.0, **3.7:** 53.5-49.5, **4.0:** 49.0-45.0, **5.0:** <45

Last name:

First name:

Student number:

Question 1)

Points:

Maximum points: $1+1+2+2+2=8$

- a) At any given moment, only a single program can be executed. What is the technical term for this operation mode?

- b) What is the name of the quasi-parallel program or process execution?

- c) Describe the structure of a monolithic kernel.

- d) Describe the structure of a microkernel.

- e) Describe the structure of a hybrid kernel.

Last name:

First name:

Student number:

Question 2)

Points:

Maximum points: $1+2+2+3+6=14$

- a) Name the two groups of Input/Output devices for computer systems that are distinguished according to their minimum transfer unit.
- b) Describe the different operating principles of the groups of subtask a).
- c) Name two examples for each group from subtask a).
- d) Name three possible ways for processes to read data from Input/Output devices.
- e) Name a benefit and a drawback for each possible way from subtask d).

Last name:

First name:

Student number:

Question 3)

Points:

Maximum points: 2+2+2+2=8

A hard disk drive provides these information:

IBM Travelstar	MODEL: DBCA-204860 E182115 T
RATED: 5V 500mA	MADE IN THAILAND BY IBM STORAGE
P/N: 21L9510 4090 MB	16NOV99
FRU: 22L0018 MLC:F41941	(7944 CYL. 16 HEADS. 63 SEC/T)

- a) Calculate the capacity of one side of one disk of the hard disk drive.
(Provide the calculation steps!)

Note: The number of cylinders (CYL) is equal to the number of tracks per disc. The size of the sectors (SEC) is 512 Byte.

- b) Calculate the capacity of one track of the hard disk drive.
(Provide the calculation steps!)

- c) Calculate the total capacity of the hard disk drive.
(Provide the calculation steps!)

- d) How many disks does the hard disk drive have? *Note: Each disk has two sides.*
(Explain your answer!)

Last name:

First name:

Student number:

Question 4)

Points:

Maximum points: 4

Please mark for each one of the following statements, whether the statement is true or false.

a) Real mode is suited for multitasking systems.

☐ True

☐ False

b) In protected mode, each process is executed in its own copy of the physical address space, which is protected from other processes.

☐ True

☐ False

c) When static partitioning is used, internal fragmentation occurs.

☐ True

☐ False

d) When dynamic partitioning is used, external fragmentation cannot occur.

☐ True

☐ False

e) With paging, all pages have the same length.

☐ True

☐ False

f) One advantage of long pages is little internal fragmentation.

☐ True

☐ False

g) A drawback of short page table can become huge.

☐ True

☐ False

h) When paging is used, the MMU translates the logical memory addresses into physical memory addresses.

☐ True

☐ False

Last name:

First name:

Student number:

Question 5)

Points:

Maximum points: 10

- a) Describe which information inodes store.
- b) Name three examples of metadata in the file system.
- c) Describe what a cluster in the file system is.
- d) Describe how a UNIX file system (e.g. ext2/3), which does not implement extents, can address more than 12 clusters.
- e) Describe how directories in the Linux file systems are technically implemented.
- f) Most operating systems operate according to the principle...
 - ☐ write-back ☐ write-through
- g) `/home/<username>/Mail/inbox/` is an/a...
 - ☐ absolute path name ☐ relative path name
- h) Describe what information the boot sector of a file system stores.
- i) Describe what information the super block of a file system stores.
- j) Explain why some file systems (e.g. ext2/3) do combine the clusters of the file system to block groups.

Last name:

First name:

Student number:

Question 6)

Points:

Maximum points: $2+1+1+3+1=8$

- a) Describe what the File Allocation Table (FAT) is and describe the information it stores.

- b) Describe the objective of the journal in a journaling file system.

- c) Describe a benefit of using a journaling file system compared with using a file system without a journal.

- d) Name the three values that are required to store an extent.

- e) Describe the benefit of using extents compared with direct addressing of the clusters.

Last name:

First name:

Student number:

Question 7)

Points:

Maximum points: 4

- a) Describe the result of defragmenting a file system.

- b) Describe the sort of data processing that is maximum accelerated by defragmenting.

- c) Describe the scenario where defragmenting is useful.

- d) Does defragmenting SSDs make sense? (*Explain your answer!*)

Last name:

First name:

Student number:

Question 8)

Points:

Maximum points: 8

- a) Describe the effect of calling the system call `fork()`.
- b) Describe the effect of calling the system call `exec()`.
- c) Describe what `init` is and what its task is.
- d) Name the differences of a child process from the parent process shortly after its creation.
- e) Describe the effect, when a parent process is terminated before the child process.
- f) Describe what data the Text Segment contains.
- g) Describe what data the Heap contains.
- h) Describe what data the Stack contains.

Last name:

First name:

Student number:

Question 9)

Points:

Maximum points: $6+2+2=10$

- a) Explain how multilevel feedback scheduling works.
(*An illustration can be useful here.*)

- b) Name four scheduling strategies that are fair.

- c) Name four scheduling strategies that do not need to know the *execution time* of the processes.
(*Note: Only those scheduling procedures are searched, that can be used under realistic conditions.*)

Last name:

First name:

Student number:

Question 10)

Points:

Maximum points: 2+7=9

- a) Mark four conditions that must be fulfilled at the same time as precondition that a deadlock can occur.

- | | |
|---|--|
| <input type="checkbox"/> Recursive function calls | <input type="checkbox"/> Hold and wait |
| <input type="checkbox"/> Mutual exclusion | <input type="checkbox"/> > 128 processes in blocked state |
| <input type="checkbox"/> Frequent function calls | <input type="checkbox"/> Iterative programming |
| <input type="checkbox"/> Nested for loops | <input type="checkbox"/> Circular wait |
| <input type="checkbox"/> No preemption | <input type="checkbox"/> Queues |

- b) Does a deadlock occur?

Perform the deadlock detection with matrices.

Existing resource vector = $(4 \ 8 \ 6 \ 6 \ 5)$

Current allocation matrix = $\begin{bmatrix} 0 & 2 & 1 & 0 & 0 \\ 2 & 3 & 1 & 0 & 4 \\ 1 & 0 & 2 & 1 & 1 \end{bmatrix}$

Request matrix = $\begin{bmatrix} 3 & 3 & 2 & 4 & 5 \\ 0 & 3 & 1 & 4 & 0 \\ 0 & 2 & 3 & 5 & 4 \end{bmatrix}$

Last name:

First name:

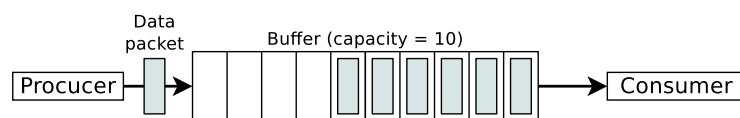
Student number:

Question 11)

Points:

Maximum points: 7

- A producer writes data into a buffer and the consumer removes it.
- Mutual exclusion is necessary in order to avoid inconsistencies.
- If the buffer has no more free capacity, the producer must be blocked.
- If the buffer is empty, the consumer must be blocked.



For synchronizing the two processes, create the required semaphores, assign them initial values and insert semaphore operations.

```
typedef int semaphore;           // semaphores are of type integer

void producer (void) {
    int data;
    while (TRUE) {               // infinite loop
        createDatapacket(data);  // create data packet

        insertDatapacket(data);   // write data packet into the buffer

    }
}

void consumer (void) {
    int data;
    while (TRUE) {               // infinite loop

        removeDatapacket(data);   // pick data packet from the buffer

        consumeDatapacket(data);  // consume data packet
    }
}
```