Written examination in Operating Systems

November 24th 2015

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: _____

- Provide on all sheets (including the cover sheet) your *last name*, *first name* and *student number*.
- Use the provided sheets. Own paper must *not* be used.
- Place your *ID card* and your *student ID card* on your table.
- 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.
- Answers, written with pencil or red pen are *not* accepted.
- Time limit: *90 minutes*
- Turn off your mobile phones!

Result:

Question:	1	2	3	4	5	6	7	8	9	10	11	12	**Σ**	Grade
Maximum points:	10	5	5	7	5	7	6	10	9	10	9	7	90	—
Achieved points:														

Last name: First name: Student number:

Question 1)

Points: .....

Maximum points: 1+1+2+2+1+1+1+1=10

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

b) What are half multi-user operating systems?

c) Name one advantage and one drawback of monolithic kernels.

d) Name one advantage and one drawback of microkernels.

e) Describe, what an administrator can do with the command `whoami`.

f) Describe, what an administrator can do with the command `chmod`.

g) Describe, what an administrator can do with the command `head`.

h) Describe, what an administrator can do with the command `touch`.

Last name: First name: Student number:

Question 2)

Points: .....

Maximum points: 1+1+1,5+1+0,5=5

a) Name two rotating magnetic digital data storages.

b) Name two non-rotating magnetic digital data storages.

c) Name three benefits of data storage without moving parts compared with data storage with moving parts.

d) What is random access?

e) Name one non-persistent data storage.

Last name: First name: Student number:

Question 3)

Points: .....

Maximum points: 1+1+2+1=5

- Draw the structure of a hard disk drive schematically. Explain with your drawing(s) the meaning of the following terms:
  a) Sector (= Block)
  b) Track
  c) Cylinder
  d) Cluster

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Question 4)

Points: .....

Maximum points: 2+2+1+1+1=7

a) Why is it wrong to call SSDs Solid State Disks?

b) Describe the difference between NAND memory of the categories Single-Level Cell (SLC), Multi-Level Cell (MLC) and Triple-Level Cell (TLC).

c) What is the objective of wear leveling algorithms?

d) With which memory management methods do internal fragmentation occur?

- ☐ Static partitioning
- ☐ Dynamic partitioning
- ☐ Buddy memory allocation

e) With which memory management methods do external fragmentation occur?

- ☐ Static partitioning
- ☐ Dynamic partitioning
- ☐ Buddy memory allocation

Last name: First name: Student number:

Question 5)

Points: .....

Maximum points: 0,5+0,5+2+2=5

a) Which command is used to modify the priority of an existing process?

b) Which command is used to create a link?

c) Can hard links be copied over file system boundaries?
(Explain your answer!)

d) Can symbolic links be copied over file system boundaries?
(Explain your answer!)

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Question 6)

Points: .....

Maximum points: 1+1+1+1+1+1+1=7

a) Describe the functioning of the real mode.

b) Describe the functioning of the protected mode.

c) What causes a page fault exception to occur?

d) What causes a general protection fault exception to occur?

e) What is the consequence (effect) of a general protection fault exception?

f) What contains the kernelspace?

g) What contains the userspace?

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Question 7)

Points: .....

Maximum points: 6

Please mark for each statement about file systems, whether the statement is true or false.

Statement	**true**	**false**
Inodes store all metadata of files.		
File systems address clusters and not blocks of the storage medium or storage drive.		
The smaller the clusters are, the more overhead for large files occur.		
The bigger the clusters are, the lesser capacity is lost due to internal fragmentation.		
Absolute path names describe the complete path from the root to the file.		
An advantage of block groups is that the inodes are physically located close to the clusters, they address.		
For each cluster in the file system, an entry exists in the FAT.		
A journal in the file system reduces the number of write operations.		
Journaling file systems narrow down the data, which need to be checked during the consistency check.		
When using journaling file systems, a loss of data is impossible.		
If metadata and file contents are journaled both, all write operations are carried out twice.		
Extents cause lesser overhead compared with block addressing.		

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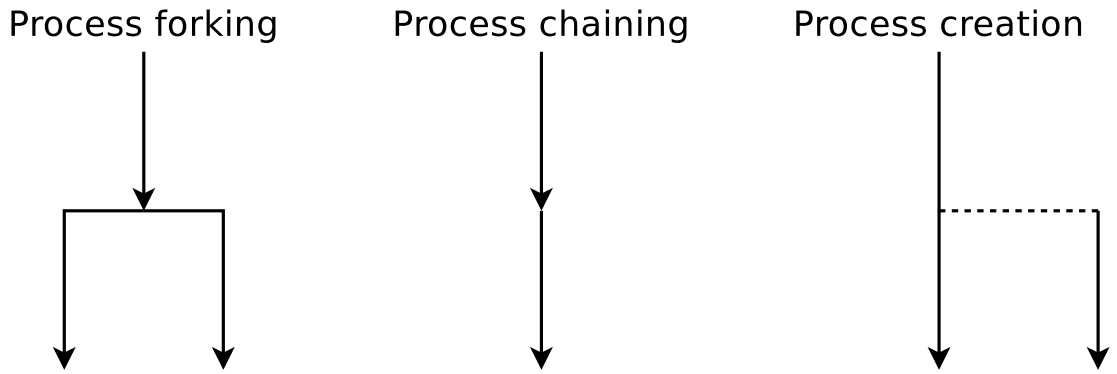
Question 8)

Points: .....

Maximum points: 1+3+1+1+4=10

a) What happens if a new process should be created, but the operating system has no more free process IDs (PID) left?

b) The three diagrams below show all existing ways of creating a new process. Specify for each diagram, which system call(s) are required to implement the illustrated way of process creation.



c) What differentiates a child process from the parent process shortly after the creation?

d) What happens, when a parent process is terminated before the child process?

e) A parent process (PID = 102) with the characteristics, described in the table below, creates a child process (PID = 103) by using the system call `fork()`. Enter the four missing values into the table.

	Parent Process	**Child Process**
UID	100	
PID	102	103
PPID	101	
Return value of `fork()`		

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Question 9)

Points: .....

Maximum points: 1+2+3+1+1+1=9

a) What data contains the text segment?

b) What data contains the heap?

c) What data contains the stack?

d) What are interrupts?

e) What is the interrupt vector?

f) What are exceptions?

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Question 10)

Points: .....

Maximum points: 2+3+2+1+1+1=10

a) How does static multilevel scheduling work?

b) How does multilevel feedback scheduling work?

c) Name four scheduling strategies, that are fair.

d) What is a critical section?

e) What is a race condition?

f) How can race conditions be avoided?

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Question 11)

Points: .....

Maximum points: 1+1+0,5+0,5+1+1+3+1=9

a) What must be considered, when inter-process communication via shared memory segments is used?

b) What is the impact of a restart (reboot) of the operating system on the existing shared memory segments?

☐ The shared memory segments are created new during boot and the contents are restored.
☐ The shared memory segments and their contents are lost.
☐ The shared memory segments are created new during boot, but they remain empty. This means, only the contents are lost.
☐ Only the shared memory segments are lost. The operating system stores the contents in temporary files inside the folder `\tmp`.

c) According to which principle operate message queues?

☐ Round Robin ☐ LIFO ☐ SJF ☐ FIFO ☐ LJF

d) How many processes can communicate with each other via a pipe?

e) What is the effect, when a process tries to write data into a pipe without free capacity?

f) What is the effect, when a process tries to read data from an empty pipe?

g) Which three sorts of inter-process communication operate bidirectional?

h) For which sort of inter-process communication guarantees the operating system the synchronization?

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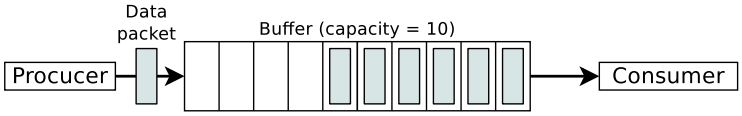
Question 12)

Points: .....

Maximum points: 7

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



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

```
typedef int semaphore;



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


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


  }
}

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


    removeDatapacket(data);       // remove data packet from buffer


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