Written examination

Operating Systems

July 25th 2016

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	Σ	Grade
Maximum points:	6	5	6	6	9	7	8	7	18	5	13	90	—
Achieved points:													

Question 1)

Maximum points: 1+1+1+1+2=6

a) For which tasks is batch processing especially well suited

b) What is the purpose of memory protection?

c) What is the difference between 8 bit, 16 bit, 32 bit and 64 bit operating systems?

d) Name the two types of real-time operating systems.

e) Your colleague recommends you to relocate frequently used server daemons, such as web server, email server, SSH server and FTP server, from the user mode to the kernel mode. What is your opinion about this idea? Give reasons for your answer. Name at least one benefit and a drawback.

Question 2)

Maximum points: 2+3=5

a) Explain the two file entries „.“ and „..“ in the output of `ls`?

```
$ mkdir new_directory
$ cd new_directory
$ ls -l --all --size --human-readable
insgesamt 8,0K
4,0K drwxr-xr-x   2 bnc users 4,0K Jul 12 11:03 .
4,0K drwxr-xr-x 119 bnc users 4,0K Jul 12 11:03 ..
```

b) Explain the permissions of the file `convert_script.py`.

```
$ ls -l --all --size --human-readable
insgesamt 16K
4,0K drwxr-xr-x   2 bnc users 4,0K Jul 12 09:14 .
4,0K drwxr-xr-x 119 bnc users 4,0K Jul 12 09:13 ..
8,0K -rwxr-xr--   1 bnc users 7,0K Jul 12 09:22 convert_script.py
```

(*Note: Describe which operations the different users/groups are allowed to carry out with the file.*)

Question 3)

Maximum points: 1+0,5+0,5+1+1+1+1=6

a) Name the two basic cache write policies.

b) With which cache write policy of subtask a) may inconsistencies occur?

c) With which cache write policy of subtask a) is the system performance lower?

d) With which cache write policy of subtask a) are so called dirty bits used?

e) For what reason are dirty bits used?

f) Which factors influence the access time of HDDs?

g) Describe the factors of subtask f).

Question 4)   Points: . . . .

Maximum points: 1+1+1+1+1+1=6

a) Please comment the statement: „A RAID array can be used to replace the regular backup of important data".

b) Why is it not useful to store all parity information on a single drive, but to distribute the parity information on all drives?

c) What is the net capacity of a RAID 0 array?

d) What is the net capacity of a RAID 1 array?

e) What is the net capacity of a RAID 5 array?

f) How are the parity information of a RAID 5 array calculated?

Question 5)   Points: ....

Maximum points: 3+1+1+1+1+0.5+0.5+1=9

a) What is virtual memory?

b) Explain, why virtual memory helps to better utilize the main memory.

c) What is mapping?

d) What is swapping?

e) Name the two different virtual memory concepts.

f) With which concept of subtask e) does internal fragmentation occur?

g) With which concept of subtask e) does external fragmentation occur?

h) What causes a page fault exception to occur?

Question 6)

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

a) What is an absolute path name?

b) What is a relative path name?

c) What is the File Allocation Table (FAT) and what information does it store?

d) What is the objective of the journal in journaling file systems?

e) Name an advantage of journaling file systems compared with file systems without a journal.

f) What sort of data processing is maximum accelerated by defragmenting?

Question 7)

Maximum points: 1.5+0.5+1+1+1+1+1+1=8

a) Which three sorts of process context information stores the operating system?

b) Which process context information are not stored in the process control block?

c) Why does the process control block not store all process context information?

d) What is the task of the dispatcher?

e) What is the task of the scheduler?

f) What is the effect of calling the system call `fork()`?

g) What is the effect of calling the system call `exec()`?

h) What is a `cron` job?

Question 8)   Points: ....

Maximum points: 6+1=7

a) Enter the names of the states in the diagram of the process state model with 6 states.

Creation   Termination
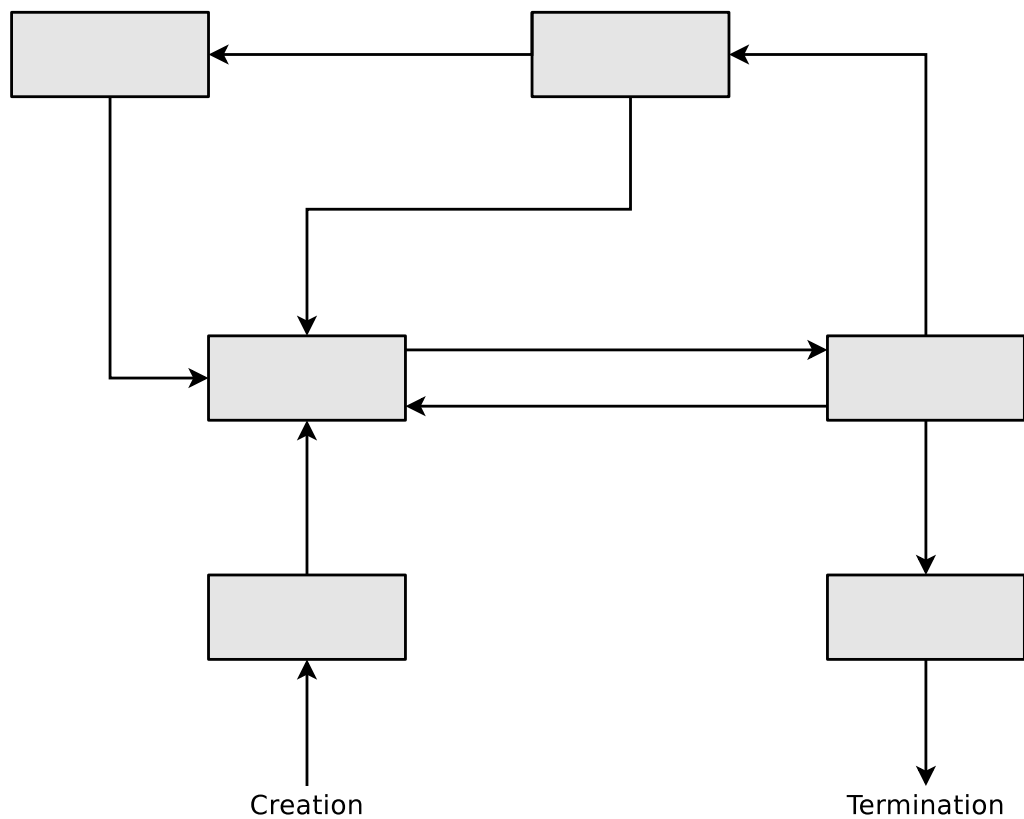
b) What is a zombie process?

Question 9)

Maximum points: 5+5+2+2+2+2=18

a) Six processes with different creation times shall be executed on a single CPU system.

Process	CPU runtime [ms]	Creation time [ms]
A	10	0
B	8	4
C	2	6
D	5	11
E	4	13
F	1	15

Draw the execution order of the processes with a Gantt chart (timeline) for...
- Shortest Remaining Time First and
- Longest Remaining Time First.
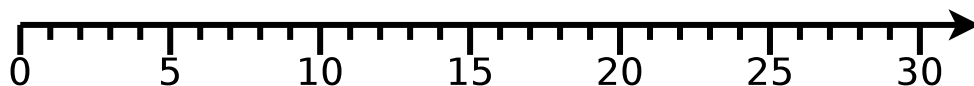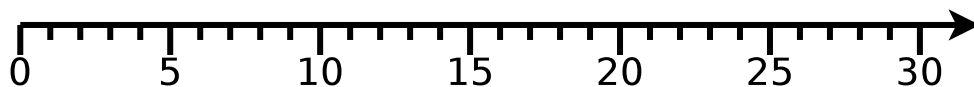
b) Calculate the average runtimes of the processes.

c) Calculate the average waiting times of the processes.

Question 10)   Points: . . . .

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

a) What is the advantage of signal and wait compared with busy waiting?

b) What is a barrier?

c) Which two problems can arise from blocking?

d) What is the difference between signaling and blocking?

Question 11)

Maximum points: 13

In a warehouse, packages are delivered constantly by a supplier and picked up by two deliverers. The supplier and the deliverers need to pass through a gate. The gate can always be passed only by a single person. The supplier brings three packages with every shipment to the incoming goods section. One of the deliverers can pick two packages with every pickup from the outgoing goods section. The other deliverer can pick only a single package per pickup from the outgoing goods section.

Exactly one process `Supplier`, one process `Deliverer_X` and one process `Deliverer_Y` exist.

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

These conditions must be met:

- Only a single process can pass through the gate.
  It is impossible that multiple processes pass though the gate simultaneously.

- Only one of both existing deliverers can access the outgoing goods section.
  It is impossible that both deliverers access the outgoing goods section simultaneously.

- It should be possible that the supplier and one of the deliverers can simultaneously unload and pick goods.

- The capacity of the warehouse is 20 packages.

- No deadlocks are allowed.

- At the beginning, the warehouse contains no packets and the gate, as well as the incoming goods section and the outgoing goods section are free.

Source: TU-München, Übungen zur Einführung in die Informatik III, WS01/02

Question 11 – Continuation)

```
Supplier                    Deliverer_X                 Deliverer_Y
{                           {                           {
  while (TRUE)                while (TRUE)                while (TRUE)
  {                          {                           {

    <Pass through gate>;        <Pass through gate>;        <Pass through gate>;



    <Enter incoming             <Enter outgoing             <Enter outgoing
    goods section>;             goods section>;             goods section>;



    <Unload 3 packets>;         <Pick 2 packets>;           <Pick 1 packet>;



    <Leave incoming             <Leave outgoing             <Leave outgoing
    goods section>;             goods section>;             goods section>;



    <Pass through gate>;        <Pass through gate>;        <Pass through gate>;


  }                          }                           }
}                           }                           }
```