

Written examination in Operating Systems

February 05, 2023

Last name: _____

First name: _____

Student number: _____

Signature: _____

MOCK EXAM

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Please write only your student number — but **not your name** — on this or any of the following sheets. By omitting your name a pseudonymized correction of your exam can be achieved. The first page with your name will be removed before correction and consequently the corrector cannot be biased when correcting your exam. By putting your student number on all pages you make sure that even in the case the stapling gets lost each page can be attributed to your exam.

Student number: _____

Result:

Question:	1	2	3	4	5	6	7	8	9	10	11	12	Total
Points:	10	6	7	8	8	6	9	6	6	10	6	8	90
Score:													

1.0: 90-85.5, **1.3:** 85-81, **1.7:** 80.5-76.5, **2.0:** 76-72, **2.3:** 71.5-67.5,
2.7: 67-63, **3.0:** 62.5-58.5, **3.3:** 58-54, **3.7:** 53.5-49.5, **4.7:** 49-45, **5.0:** <45

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Question 1

Points:(max. 10 points)

Decide whether the following statements are correct or wrong and explain shortly why.

- (a) Since operating systems based on a micro-kernel architecture are more robust, basically all relevant modern operating systems are based on this architecture. True Wrong

- (b) In some scenarios a singletasking computer system can execute programs faster than a multitasking system. True Wrong

- (c) A fork bomb is a problem for computers with very little resources, e.g., embedded systems. True Wrong

- (d) The kernel of an operating system may implement more than one scheduling algorithm. True Wrong

- (e) Semaphores can be used to implement mutexes. True Wrong

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- (f) Interrupts are used to simplify debugging. True Wrong

- (g) Every x86 compatible CPU starts in Real Mode. True Wrong

- (h) The rotational speed of a hard disk drive (HDD) is the only limiting factor of its performance. True Wrong

- (i) The block size of the storage devices defines an lower bound for the cluster size of a file system. True Wrong

- (j) The File Allocation Table of a VFAT file system grows over time when more files are created. True Wrong

Question 2

Points: (max. 6 points)

Give a command that can be used to...

- (a) print out the path of the present working directory in the shell.

- (b) concatenate the content of different files or print out the content of a file.

- (c) modify the cron jobs for the current user.

- (d) modify a certain pattern in a file.

- (e) print out lines from the beginning of a file in the shell.

- (f) list the content of the current directory.

- (g) sort the lines of a text file.

- (h) create an archive file.

- (i) delete files or directories.

- (j) output a string in the shell.

- (k) create a hard link.

- (l) modify the permissions of files or directories.

Question 3

Points:(max. 7)

- (a) Explain why it is impossible to implement the optimal replacement strategy OPT. (1)

- (b) Discuss whether the random strategy is a good or a bad choice for finding the next free block of memory compared to first fit, next fit, or best fit. (2)

- (c) Name one advantage and one drawback for larger page sizes. (1)

- (d) Explain in which situations a page fault exception occur. (1)

- (e) Explain in which situations an access violation exception or general protection fault exception occur. (1)

- (f) Explain in which situations the use of an SSD may be a bad choice. (1)

Question 4

Points: (max. 8 points)

- (a) Name the three sorts of process context information the operating system stores.

- (b) Explain the task of the dispatcher.

- (c) Explain the task of the scheduler.

- (d) Explain what the PID is.

- (e) Explain what the PPID is.

- (f) Describe the effect of calling the system call `fork`.

- (g) Describe the effect of calling the system call `exec`.

- (h) Explain why some operating systems have one or more system idle processes.

Question 5

Points: (max. 8 points)

- (a) Explain the advantage of using the operations signal and wait compared with busy waiting.

- (b) Name two problems that can arise from locking.

- (c) Explain the difference between signaling and locking.

- (d) Mark the scheduling method that is implemented by message queues.
 - Round Robin
 - LIFO
 - S.JF
 - FIFO
 - L.JF
- (e) Specify how many processes can communicate with each other via a pipe.

- (f) Explain the effect, when a process tries to write data into a pipe without free capacity.

- (g) Explain the effect, when a process tries to read data from an empty pipe.

- (h) Name the two different types of pipes.

- (i) Name the two different types of sockets.

Question 6

Points:(max. 6)

- (a) What are possible (direct or indirect) sources for an interrupt? (2)
- System Calls
 - Program Error
 - E-mail reception
 - Hardware Failure
 - Button press
- (b) What is the name of the data structure the OS uses to lookup which handler to run upon interrupt? (1)
- ISR
 - IVT
 - IRQ
 - PIC
- (c) Describe two different approaches to handle concurrent interrupts. (2)
- (d) Name the bus that contains the line to signal the occurrence of an interrupt. (1)

Question 7

Points:(max. 9)

- (a) Show Belady's anomaly by performing the access sequence with the replacement strategy FIFO once with a cache with a capacity of 3 pages and once with 4 pages. Also calculate the hit rate and the miss rate for both scenarios. (8)

Requests: 3 2 1 0 3 2 4 3 2 1 0 4

Page 1:											
Page 2:											
Page 3:											

Hit rate:

Miss rate:

Requests: 3 2 1 0 3 2 4 3 2 1 0 4

Page 1:											
Page 2:											
Page 3:											
Page 4:											

Hit rate:

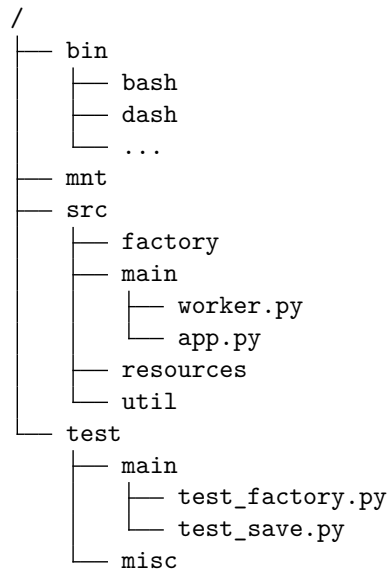
Miss rate:

- (b) Explain why fragmentation in memory management is irrelevant for modern operating systems. (1)

Question 8

Points: (max. 6 points)

Take a look at the given file system tree.

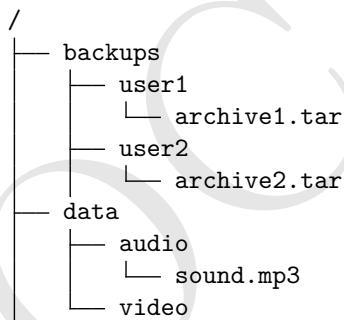


- (a) Write down the absolute path to the file `test_save.py`:

- (b) Write down the relative path from `src` to the file `app.py`:

- (c) Write down the relative path from the `factory` directory to the file `test_save.py`:

- (d) Another file system gets *mounted* at `/mnt`. The tree of this file system looks like this:



Write down the absolute path to the file `archive1.tar`:

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- (e) A symbolic link to `sound.mp3` shall be created in the directory `resources`. Describe the information that needs to be added to the file system.

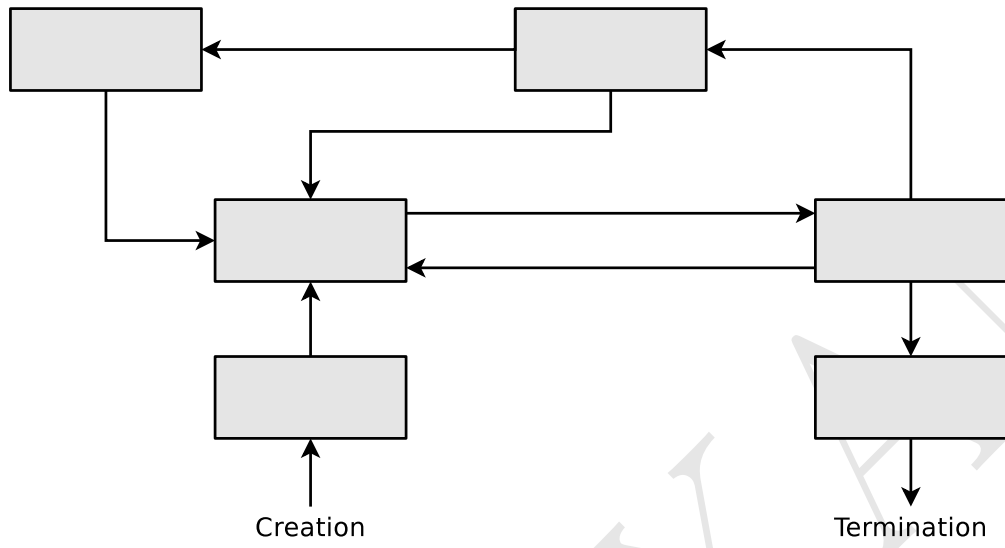
- (f) A hard link to `sound.mp3` shall be created in the directory `resources`. Describe the information that needs to be added to the file system.

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Question 9

Points: (max. 6 points)

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



Question 10

Points: (max. 10)

(a) Explain which problem may occur when static priorities are used for scheduling. (1)

(b) Some systems implement one or more idle process. Explain what idle processes are good for. (1)

(c) The two processes P_A (4 ms CPU time) and P_B (26 ms CPU time) are both in state **ready** at time point 0 and are to be executed one after the other. (6)

Fill the table with correct values. (*Hint: Runtime = Lifetime*)

Execution order	Runtime		Average runtime	Waiting time		Average waiting time
	P_A	P_B		P_A	P_B	
P_A, P_B						
P_B, P_A						

(d) Explain what can be observed from the values you filled into the table in (c). (2)

Question 11**Points:** (max. 6)

- (a) Explain what the following code is doing and whether it is correct and complete. State the value of the variable `ret` and explain its meaning. (3)

```
1 #include <stdio.h>
2 #include <unistd.h>
3 #include <stdlib.h>
4
5 void main() {
6     int ret = fork();
7
8     if (ret > 0) {
9         printf("Parent.\n");
10        exit(0);
11    }
12    else {
13        printf("Child.\n");
14        exit(0);
15    }
16 }
```

- (b) Describe what will be printed when executing the following program (after compiling and linking it). State the return value of the program. Explain your expectations. (3)

```
1 #include <unistd.h>
2 #include <stdio.h>
3
4 int main(void)
5 {
6     printf("Execute ls...\n");
7     execlp("/bin/echo", "/bin/echo", "now", NULL);
8     printf("done.\n");
9     return 5;
10 }
```

Question 12**Points:**(max. 8 points)

- (a) Perform the deadlock detection with matrices and check if a deadlock occurs.

Existing resource vector = (9 6 8 7 6 7)

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

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