Exercise Sheet 5

Exercise 1 (Memory Management)

1. Mark memory management methods that cause internal fragmentation to occur.

   ☐ Static partitioning
   ☐ Dynamic partitioning
   ☐ Buddy memory allocation

2. Mark memory management methods that cause external fragmentation to occur.

   ☐ Static partitioning
   ☐ Dynamic partitioning
   ☐ Buddy memory allocation

3. Explain how external fragmentation can be fixed.

4. Mark the memory management method that searches for the block, which fits best.

   ☐ First Fit ☐ Next Fit ☐ Best fit ☐ Random

5. Mark the memory management concept that searches for a free block, starting from the beginning of the address space.

   ☐ First Fit ☐ Next Fit ☐ Best fit ☐ Random

6. Mark the memory management concept that fragments quickly the large area of free space at the end of the address space.

   ☐ First Fit ☐ Next Fit ☐ Best fit ☐ Random

7. Mark the memory management concept that selects randomly a free and appropriate block.

   ☐ First Fit ☐ Next Fit ☐ Best fit ☐ Random

8. Mark the memory management concept that searches for a free block, starting from the latest allocation.

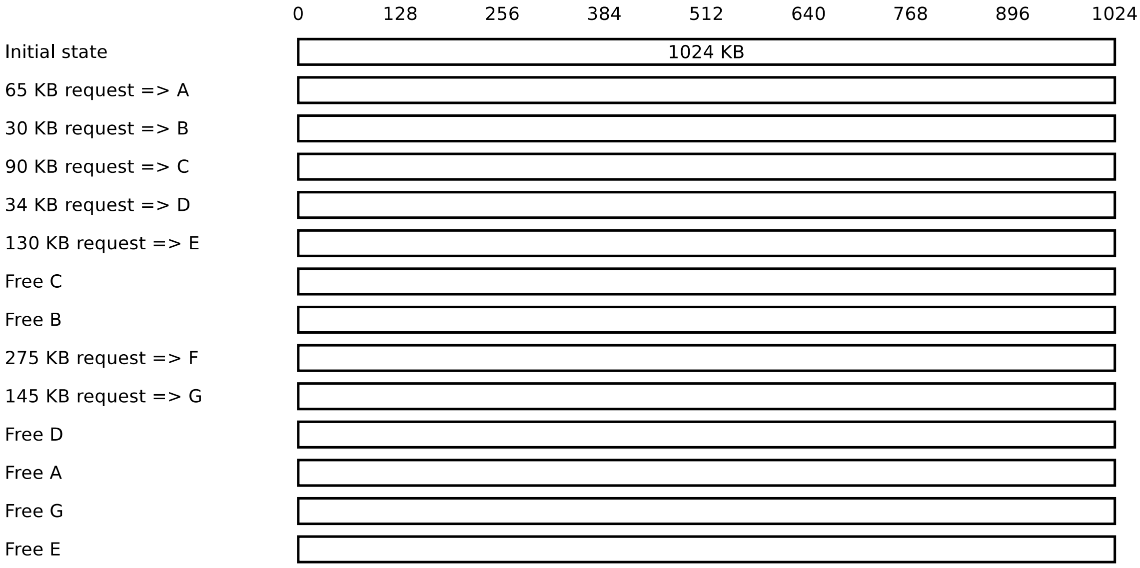
   ☐ First Fit ☐ Next Fit ☐ Best fit ☐ Random

9. Mark the memory management concept that produces many mini-fragments and is slow.

   ☐ First Fit ☐ Next Fit ☐ Best fit ☐ Random

Exercise 2 (Buddy Memory Allocation)

The Buddy method for allocating memory to processes shall be used for a memory with a capacity of 1024 kB. Perform the provided operations and give the occupancy state of the memory after each operation.



Exercise 3 (Real Mode and Protected Mode)

1. Describe the functioning of the real mode.
2. Explain why it is impossible to use real mode for multitasking operation mode.
3. Describe the functioning of the protected mode.
4. Describe what virtual memory is.
5. Explain, why virtual memory helps to better utilize the main memory.
6. Describe what mapping is.
7. Describe what swapping is.
8. Name the component of the CPU that is used to implement virtual memory.
9. Describe the function of the component from subtask 8.
10. Name a virtual memory concept.
11. Name the sort of fragmentation that does occur with the concept of subtask 10.
12. Explain the purpose of the Page-Table Base Register (PTBS).

13. Explain the purpose of the Page-Table Length Register (PTLR).
14. Explain what a page fault exception causes to occur.
15. Describe the reaction of the operating system when a page fault exception occurs.
16. Explain what an access violation exception or general protection fault exception causes to occur.
17. Describe the consequence (effect) of an access violation exception or general protection fault exception.
18. Describe the content of the kernelspace.
19. Describe the content of the userspace.

Exercise 4 (Memory Management)

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

1. Real mode is suited for multitasking systems.

   ☐ True ☐ False

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

   ☐ True ☐ False

3. When static partitioning is used, internal fragmentation occurs.

   ☐ True ☐ False

4. When dynamic partitioning is used, external fragmentation cannot occur.

   ☐ True ☐ False

5. With paging, all pages have the same length.

   ☐ True ☐ False

6. One advantage of long pages is little internal fragmentation.

   ☐ True ☐ False

7. A drawback of short pages is that the page table gets bigger.

   ☐ True ☐ False

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

   ☐ True ☐ False

9. Modern operating systems (for x86) operate in protected mode and use only paging.

   ☐ True ☐ False

Exercise 5 (Page Replacement Strategies)

1. Why is it impossible to implement the optimal replacement strategy OPT?

2. Perform the access sequence with the replacement strategies Optimal, LRU, LFU and FIFO once with a cache with a capacity of 4 pages and once with 5 pages. Also calculate the hit rate and the miss rate for all scenarios.

   Optimal replacement strategy (OPT):

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Hit rate:
Miss rate:

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Page 5:																								

Hit rate:
Miss rate:

Replacement strategy Least Recently Used (LRU):

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Queue:

Hitrate:
Missrate:

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Queue:

Hitrate:
Missrate:

Replacement strategy Least Frequently Used (LFU):

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Hit rate:
Miss rate:

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Hit rate:
Miss rate:

Replacement strategy FIFO:

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Page 4:																								

Hit rate:
Miss rate:

Requests:	**1**	**3**	**5**	**4**	**2**	**4**	**3**	**2**	**1**	**0**	**5**	**3**	**5**	**0**	**4**	**3**	**5**	**4**	**3**	**2**	**1**	**3**	**4**	**5**
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Hit rate:
Miss rate:

3. What is the key message of Laszlo Belady's anomaly?

4. 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.

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:

Exercise 6 (Time-based Command Execution, Sorting, Environment Variables)

1. Create in your home directory a directory `NotImportant` and write a cron job, which erases the content of the directory `NotImportant` every Tuesday at 1:25 clock am.

   The output of the command should be appended to a file `EraseLog.txt` in your home directory.

2. Write a cron job, which appends a line at a file `Datum.txt` with the following format (but with the current values) every 3 minutes between 14:00 to 15:00 clock on every Tuesday in the month of November:

```
Heute ist der 30.10.2008
Die Uhrzeit ist 09:24:42 Uhr
****************************
```

3. Write an at-job, which outputs at 17:23 today a list of the running processes.

> *You may have to install the command line tool* `at` *first.*
> *With Debian/Ubuntu this works with:*
> `$ sudo apt update && sudo apt install at`
> *With CentOS/Fedora/RedHat this works with:*
> `$ sudo yum install at`

4. Write an at-job, which outputs at December 24th at 8:15 am the text „It's christmas!“

5. Create in your home directory a file `Kanzler.txt` with the following content:

```
Willy     Brandt    1969
Angela    Merkel    2005
Gerhard   Schröder  1998
KurtGeorg Kiesinger 1966
Helmut    Kohl      1982
Konrad    Adenauer  1949
Helmut    Schmidt   1974
Ludwig    Erhard    1963
```

6. Print out the file `Kanzler.txt` sorted by the first names.

7. Print out the file `Kanzler.txt` sorted by the third letter of the last names.

8. Print out the file `Kanzler.txt` sorted by the year of the inauguration.

9. Print out the file `Kanzler.txt` backward reverse sorted by the year of the inauguration and redirect the output into a file `Kanzlerdaten.txt`.

10. Create with the command `export` an environment variable `VAR1` and assign it the value `Testvariable`.

11. Print out the value of `VAR1` in the shell.

12. Erase the environment variable `VAR1`.