### Exercise Sheet 5

# Exercise 1 (Memory Management)

1.	. With which memor	ry management	t methods do ir	nternal fragmentation occur?
	☐ Static partitionin☐ Dynamic partitio☐ Buddy memory	oning		
2.	. With which memor	ry management	t methods do ex	xternal fragmentation occur?
	☐ Static partitionin☐ Dynamic partitio☐ Buddy memory	oning		
3.	. How can external f	ragmentation l	be fixed?	
4.	. Which memory ma	anagement met	hod searches fo	r the block, which fits best?
	$\square$ First Fit $\square$	Next Fit	Best fit	$\square$ Random
5.	. Which memory ma	~	-	or a free block, starting from
	$\square$ First Fit	Next Fit	Best fit	$\square$ Random
6.	Which memory maspace at the end of	_		quickly the large area of free
	$\square$ First Fit	Next Fit	Best fit	$\square$ Random
7.	. Which memory ma block?	anagement con	cept selects rai	ndom a free and appropriate
	$\square$ First Fit $\square$	Next Fit	Best fit	$\square$ Random
8.	Which memory ma	~	cept searches fo	or a free block, starting from
	$\square$ First Fit $\square$	Next Fit	Best fit	$\square$ Random
9.	Which memory masslow?	anagement con	cept produces	many mini-fragments and is
	$\square$ First Fit	Next Fit	Best fit	☐ Random

Content: Topics of slide set 5 Page 1 of 8

#### 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.

	0	128	256	384	512	640	768	896	1024
Initial state					1024 KB				
65 KB request => A									
30 KB request => B									
90 KB request => C									
34 KB request => D									
130 KB request => E									
Free C									
Free B									
275 KB request => F									
145 KB request => G									
Free D									
Free A									
Free G									
Free E									

#### Exercise 3 (Real Mode and Protected Mode)

- 1. Describe the functioning of the real mode.
- 2. Why is it impossible to use real mode for multitasking operation mode?
- 3. Describe the functioning of the protected mode.
- 4. What is virtual memory?
- 5. Explain, why virtual memory helps to better utilize the main memory.
- 6. What is mapping?
- 7. What is swapping?
- 8. Which component of the CPU is used to implement virtual memory?
- 9. Describe the function of the component from subtask 8.
- 10. Name a virtual memory concept.
- 11. What soft of fragmentation does occur with the concept of subtask 10?
- 12. What causes a page fault exception to occur?

Content: Topics of slide set 5 Page 2 of 8

- 13. What is the reaction of the operating system, when a page fault exception occurs?
- 14. What causes an access violation exception or general protection fault exception to occur?
- 15. What is the consequence (effect) of an access violation exception or general protection fault exception?
- 16. What contains the kernelspace?
- 17. What contains 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.	-	node, each process is executed in its own copy of the physical which is protected from other processes.
	$\square$ True	☐ False
3.	When static p	partitioning is used, internal fragmentation occurs.
	$\square$ True	☐ False
4.	When dynami	c partitioning is used, external fragmentation cannot occur.
	$\square$ True	☐ False
5.	With paging,	all pages have the same length.
	$\square$ True	☐ False
6.	One advantag	e of long pages is little internal fragmentation.
	$\square$ True	☐ False
7.	A drawback o	f short page page table can become huge.
	$\square$ True	☐ False
8.	When paging physical memory	is used, the MMU translates the logical memory addresses into bry addresses.

Content: Topics of slide set 5

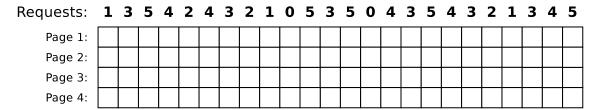
Page 3 of 8

	☐ True	$\square$ False		
9.	Modern of paging.	operating systems (for x86)	operate in protected n	node and use only
	$\square$ True	$\square$ False		

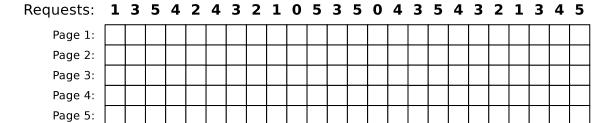
### Exercise 5 (Page Replacement Strategies)

- 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.

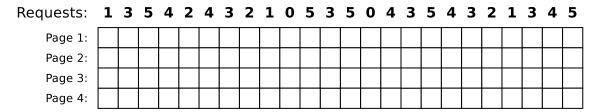
Optimal replacement strategy (OPT):



Hit rate: Miss rate:

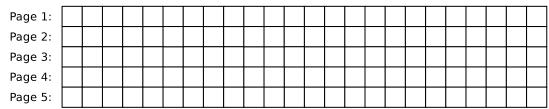


Hit rate: Miss rate: Replacement strategy Least Recently Used (LRU):



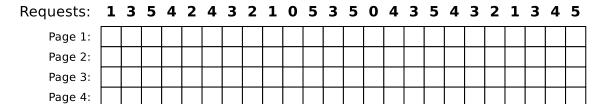
Hit rate: Miss rate:

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



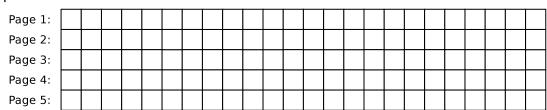
Hit rate: Miss rate:

Replacement strategy Least Frequently Used (LFU):



Hit rate: Miss rate:

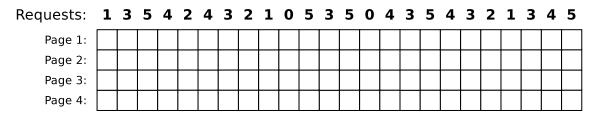
Requests: 1 3 5 4 2 4 3 2 1 0 5 3 5 0 4 3 5 4 3 2 1 3 4 5



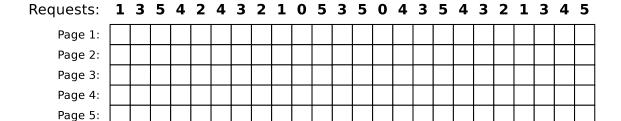
Hit rate: Miss rate:

Content: Topics of slide set 5 Page 5 of 8

Replacement strategy FIFO:



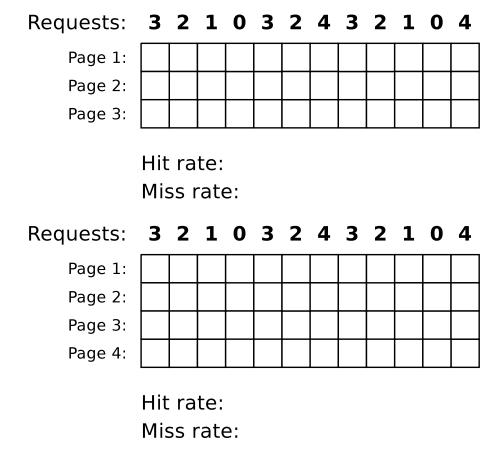
Hit rate: Miss rate:



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.

Content: Topics of slide set 5 Page 6 of 8



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.

5. Calculate for both scenarios of subtask 4 the hit rate and 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

- 3. Write an at-job, which outputs at 17:23 today a list of the running processes.
- 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
${\tt KurtGeorg}$	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.

Content: Topics of slide set 5