8-hour Take-Home Exam in Computer Systems

Department of Computer Science, University of Copenhagen (DIKU)
Date: January 27, 2021

1 Machine architecture (about 33 %)

1.1 Assembler programming (about 13 %)

Question 1.1.1:

(Maximum 30 lines.)

Exam number:

Question 1.1.2:

(Maximum 20 lines.)

Question 1.1.3:

(Maximum 10 lines.)

1.2 Performance / Pipeline (about 10 %)

Question 1.2.1:

(Maximum 20 lines.)

Exam number:

Question 1.2.2:

	Code	Timing
	`.L3:`	
1	`movq (%r14), %rax`	
2	`cbe %rax, %rsi, .L1.`	
3	`.L4:`	
4	`leaq (%rdi, %rax, 8), %r11`	
5	`movq (%r11), %r8.`	
6	`movq (%rdx), %r10`	
7	`cbae %r10, %r8, .L3`	
8	`movq %r8, (%rdx)`	
9	`movq %rax, (%rcx)`	
10	`jmp .L3`	
11	`.L3:`	
12	`addq $1, %rax`	

(Maximum 15 lines.)

Exam number:

Question 1.2.3:

(Maximum 15 lines.)

1.3 Data Cache (about 10 %)

Question 1.3.1:

(Maximum 15 lines.)

Question 1.3.2:

(Maximum 15 lines.)

Exam number:

Question 1.3.3:

Reference	Hit/Miss
0x000	
0x001	
0x01F	
0x102	
0x203	
0x304	
0x10C	
0x705	
0x002	
0x10F	
0x210	
0x010	

Exam number:

Question 1.3.4:

Reference	Hit/Miss
0x000	
0x001	
0x01F	
0x102	
0x203	
0x304	
0x10C	
0x705	
0x002	
0x10F	
0x210	
0x010	

Question 1.3.5:

(Maximum 10 lines.)

2 Operating Systems (about 33 %)

2.1 Multiple Choice Questions (about 6 %)

In each of the following questions, you may put one or more answers. Use the lines to argue for your choices.

Question 2.1.1:

a) Crashed

b) Running

c) Reaped

d) Stopped

e) Waiting

f) Zombie

(Maximum 5 lines.)

Question 2.1.2:

a) To download RAM from the Internet

b) So processes can use more memory than will fit in RAM

c) Protecting a process's memory from being accessed by the kernel

d) Protect a process's memory from being accessed by another process

e) More efficient use of RAM

f) Because otherwise `malloc()` could not be implemented.

(Maximum 5 lines.)

Question 2.1.3:

a) Avoiding unneeded disk writes

b) Marking the page as read-only.

c) Maintains LRU information for page replacement stragies.

d) Whether the entry is valid.

(Maximum 5 lines.)

2.2 Short Questions (about 12 %)

Question 2.2.1:

(Maximum 10 lines.)

Exam number:

Question 2.2.2:

Virtual address: `14e5`

1. Bits of virtual address

13	12	11	10	9	8	7	6	5	4	3	2	1	0

2. Address translation

Parameter	Value
VPN	
TLB index	
TLB tag	
TLB hit? (Y/N)	
Page fault? (Y/N)	
PPN	

3. Bits of phys. (if any)

12	11	10	9	8	7	6	5	4	3	2	1	0

Virtual address: `87`

1. Bits of virtual address

13	12	11	10	9	8	7	6	5	4	3	2	1	0

2. Address translation

Parameter	Value
VPN	
TLB index	
TLB tag	
TLB hit? (Y/N)	
Page fault? (Y/N)	
PPN	

3. Bits of phys. (if any)

12	11	10	9	8	7	6	5	4	3	2	1	0

Exam number:

Virtual address: `14df`

1. Bits of virtual address

13	12	11	10	9	8	7	6	5	4	3	2	1	0

2. Address translation

Parameter	Value
VPN	
TLB index	
TLB tag	
TLB hit? (Y/N)	
Page fault? (Y/N)	
PPN	

3. Bits of phys. (if any)

12	11	10	9	8	7	6	5	4	3	2	1	0

(Maximum 15 lines.)

2.3 Long Questions (about 15 %)

Question 2.3.1:

Address	Original value	After `free`	After `realloc`
0x500c028	0x00000013		
0x500c024	0x500c611c	0x500c611c	0x500c611c
0x500c020	0x500c512c	0x500c512c	0x500c512c
0x500c01c	0x00000013		
0x500c018	0x00000013		
0x500c014	0x500c511c	0x500c511c	0x500c511c
0x500c010	0x500c601c	0x500c601c	0x500c601c
0x500c00c	0x00000013		
0x500c008	0x00000013		
0x500c004	0x500c601c	0x500c601c	0x500c601c
0x500c000	0x500c511c	0x500c511c	0x500c511c
0x500bffc	0x00000013		

(Maximum 10 lines.)

Exam number:

Question 2.3.2:

(Maximum 20 lines.)

3 Computer Networks (about 34 %)

3.1 Application layer (about 6 %)

Question 3.1.1:

(Maximum 15 lines.)

Question 3.1.2:

(Maximum 10 lines.)

3.2 Reliable Data Transfer (about 8 %)

Question 3.2.1:

(Maximum 15 lines.)

Question 3.2.2:

(Maximum 10 lines.)

Exam number:

Question 3.2.3:

(Maximum 10 lines.)

3.3 Network Layer (about 10 %)

Question 3.3.1:

(Maximum 10 lines.)

Question 3.3.2:

(Maximum 10 lines.)

Question 3.3.3:

(Maximum 15 lines.)

Question 3.3.4:

(Maximum 15 lines.)

Exam number:

3.4 Network Security (about 10 %)

Question 3.4.1:

(Maximum 15 lines.)

Question 3.4.2:

(Maximum 15 lines.)

Exam number:

Question 3.4.3:

(Maximum 20 lines.)