

# Tentamen i Datorarkitektur

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## Cover Sheet

This sheet should be handed in together with the exam.  
Each problem must be solved on a separate sheet. Write your name on each sheet. Indicate below which questions you have answered.

Problem no.	Solution provided	Max	Your points
1		9	
2		14	
3		15	
4		22	
Total:		60	

Name : .....

Pers.no. : .....



# Exam Rubric

All answers should be written in English or Swedish. The pass mark for this exam is 50%.

## Hjälpmedel:

Pen,pencil, ruler,rubber, dictionary. You are not allowed a calculator.

1. Question on MIPS coding.

- (a) Code the following fragment of code in MIPS assembly language:

```
for(i = 0 ; i<100 ; i++) {
  A[i] = A[i]+1; }
for(i=0; i<100 ; i++ ) {
  B[i] = B[100 - i] + A[i] + 1;
}
```

Assume that register `$s0` holds `i`, register `$s1` holds the address of `A[0]` and `$s2` holds the address of `B`. Assume all arrays are integer arrays. **(points 5)**.

- (b) In designing the MIPS instruction set certain choices were made each instruction is exactly 32 bits long. Using actual MIPS instructions (not pseudo instructions) how do you load a 32 bit constant into a register? **(points 2)**
- (c) With examples explain who the `jal` and `jr` instructions work. **(points 2)**

2. Question on Processor Implementation

- (a) What is latch, give one example of a latch and describe how it works. **(points 2)**.
- (b) What is the longest path digital circuit and how does it effect the clock speed of a processor? **(2 points)**.
- (c) In a multicycle approach to processor implementation a finite machine is needed to control the processor. What is a finite state machine and what does it do in a multicycle implementation? **(points 4)**
- (d) What is microcode, you should explain in some detail. **((4 points)**

- (e) What are the advantages and disadvantages of microcode over directly coding a state-machine in hardware? (**2 points**).

### 3. Pipelines

- (a) Briefly describe the principle of pipelining, in particular how does it enhance the performance of a processor. (**4 points**)
- (b) What causes pipeline stalls? You should describe each type of Stall and give an example of each type of Stall. (**4 points**)
- (c) Assuming your processor has data-forwarding of arithmetic instructions identify all the pipeline stalls in the following piece of code:

```
lw $t0,4($s0)
sw $t0,0($t0)
lw $t1,0($s0)
addi $t1,$t1,4
lw $t1,0($t1)
```

(**2 points** )

- (d) Rewrite the code to minimise the number of pipeline stalls. (**2 points** )
- (e) The MIPS processor uses a branch delay slot. What is a branch delay slot and how does it reduce pipeline stalls. (**points 3**).

### 4. Caches and Virtual Memory.

- (a) What is a memory Cache? What principles does it rely on to increase the performance? (**4 points**)
- (b) What are multi-level Caches? (**2 points**)
- (c) Given a memory reference a Cache has to determine if the memory is in the Cache. There are a number of schemes for determining where a global memory reference should be placed in the cache memory. Describe the following Schemes: Direct mapped, n-way associative and fully associative. Describe the pros and cons of each different scheme. (**6 points**)
- (d) Describe virtual memory, in particular explain the role of the *page table* and *virtual addresses*. (**points 4**)
- (e) Why would it be inefficient to have a small page size (say 256 bytes) in a virtual memory system (**2 points**).

- (f) Explain what a *translation-look-aside buffer* is and what it attempts to achieve in virtual memory system. (**4 points**)