



# Försättsblad till skriftlig tentamen vid Linköpings Universitet

(fylls i av ansvarig)

<b>Datum för tentamen</b>	2013-08-26
<b>Sal</b>	TER2, Terra-salarna VTI-huset ingång bredvid Godsterminalen
<b>Tid</b>	08-12
<b>Kurskod</b>	TDTS10
<b>Provkod</b>	TEN 2
<b>Kursnamn/benämning</b>	Datorarkitektur
<b>Institution</b>	IDA
<b>Antal uppgifter som ingår i tentamen</b>	
<b>Antal sidor på tentamen (inkl. försättsbladet)</b>	5 pages plus one for this page
<b>Jour/Kursansvarig</b>	Unmesh Dutta Bordoloi
<b>Telefon under skrivtid</b>	
<b>Besöker salen ca kl.</b>	About 1 hour after exam
<b>Kursadministratör (namn + tfnr + mailadress)</b>	Helene Meisinger 281868, helene.meisinger@liu.se
<b>Tillåtna hjälpmedel</b>	Dictionary between English and native language of the student
<b>Övrigt (exempel när resultat kan ses på webben, betygsgränser, visning, övriga salar tentan går i m.m.)</b>	
<b>Vilken typ av papper ska användas, rutigt eller linjerat</b>	
<b>Antal exemplar i påsen</b>	

## **TDTS10 Exam Computer Architecture**

**Jour** : Unmesh Bordoloi (07 66 34 89 68)

- **Admitted materials**
  - Dictionary between your native language and English
  - Calculators or any type other electronic devices are NOT allowed
  
- **General instructions**
  - You may answer in Swedish or in English.
  - Write clearly, unreadable text will be ignored.
  - The exam is for 40 points. At least 10 points are necessary for passing this course.
  - If a question is clearly divided into sub-parts, the points for sub-parts are also shown.

### Question 1. (4 points)

Consider the performance equation :

$$\text{CPU time} = \frac{\text{Instruction Count}}{(\text{IC})} \times \frac{\text{Clock Cycle Per Instruction}}{(\text{CPI})} \times \frac{\text{Clock Cycle Time}}{(\text{CT})}$$

What can a programmer (as opposed to a hardware architect) influence out of IC, CPI and CT in order to influence performance? You must explain why.

Note: You may select more than one of IC, CPI, and CT.

### Question 2. (3 points)

Categorize each of the following 3 instructions into either R-type or I-type instruction format:

sub, addi, sw

### Question 3. (3 points)

(I) A processor logically comprises of two major components – datapath and control. Explain what both terms mean. (2 points)

(II) What is the main difference between a combinational logic and a state element in a datapath? (1 point)

### Question 4. (3 points)

The following table incorrectly maps the 3 types of pipeline hazards with their solutions. Write down the correct table.

Type of hazard	Solution
Structural hazard	Branch prediction
Data hazard	Separation of instruction and data memory
Control hazard	Forwarding/Bypassing

### Question 5. (3 points)

With regards to I/O devices what is the difference between polling and interrupts? Which one of them may lead to wastage of CPU time and why?

### Question 6. (2 points)

How does virtual memory ensure that two different processes would not write into each other's address space?

### Question 7. (2 points)

Who gets the control when there is a page-fault (with regards to virtual memory – is it the operating system or is it the hardware? Why?

For the following questions, Q8 to Q13, it is mandatory to write couple of lines of explanation to discuss your approach to solve the problem.

### Question 8. (4 points)

Consider two different implementations, M1 and M2, of the same instruction set. There are three classes of instructions (A, B, and C) in the instruction set. For a given program, the average number of cycles for each instruction class is shown below except for the class A in Computer M2. The table also shows how many instructions of a given class are in the program, as a percentage. E.g., if there are 100 instructions in total, there are 60 Class A instructions.

Instruction Class	Computer M1 (Cycles Per Instruction Class)	Computer M2 (Cycles Per Instruction Class)	Percentage of total instruction
A	1	?	60%
B	2	3	30%
C	4	5	10%

Given that the machine M2 has average CPI that is twice that of machine M1, find the number of cycles for the class A in computer M2.

---

### Question 9. (4 points)

Write the MIPS assembly language instructions for the following C statement. Assume f is stored in \$s0, g in \$s1 and h in \$s2. You **must** use a minimal number of MIPS statements and a minimal number of registers.

$$f = i - (g + h)$$

---

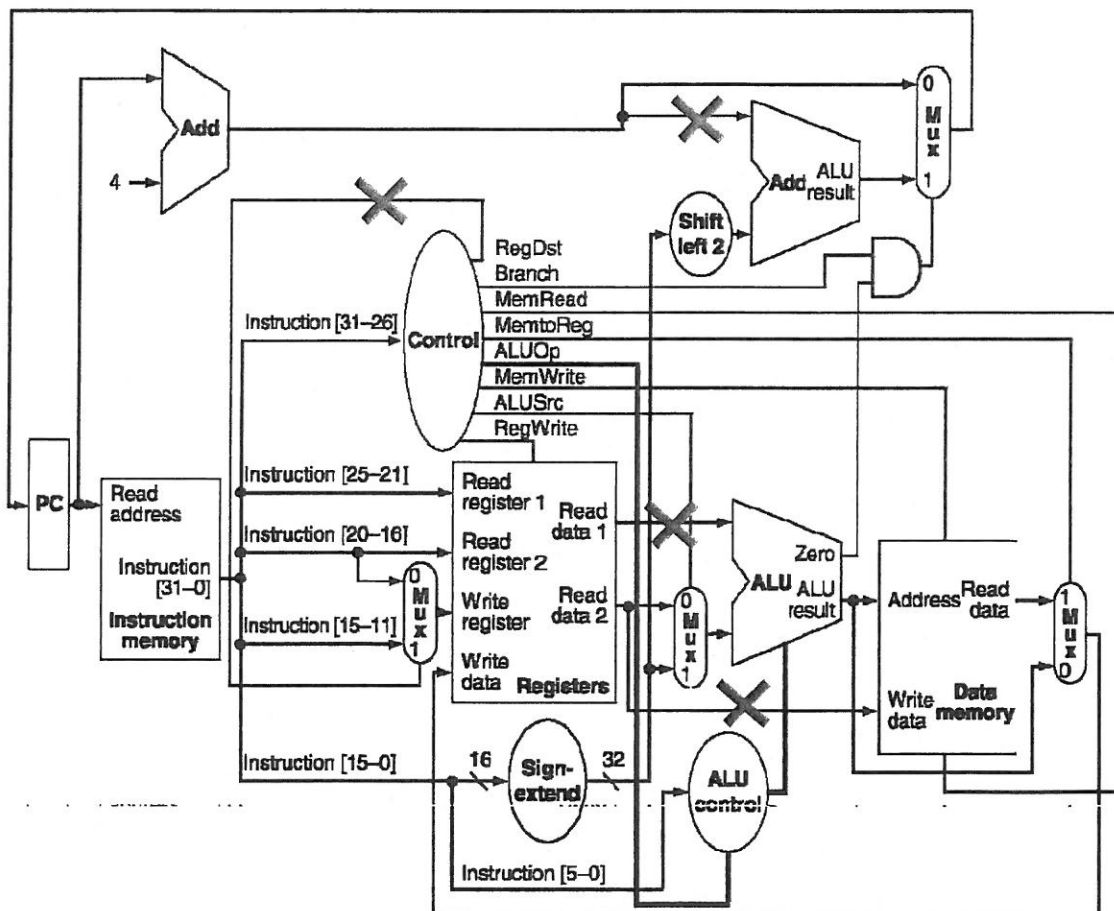
### Question 10. (2 points)

Perform the following operation by converting the numbers to 16 – bit binary numbers. Use 2's complement for subtraction.

9 - 13

### Question 11. (4 points)

For the MIPS datapath below, several lines are marked with 'X'. For each one describe in words the negative consequence of cutting this line.



### Question 12. (3 points)

Assume the miss rate of an instruction cache is 4% and the miss rate of the data cache is 10%. The processor has a CPI (clock cycles per instruction) of 1 without any memory stalls. Assume that the miss penalty is 12 cycles for each cache miss. Determine the total CPI of the processor when memory stalls are considered given that frequency of all load and stores is 20%. In your answer, show how the misses due to the instruction cache and the misses due to the data cache contribute to the total CPI.

---

### Question 13. (3 points)

For the following code, identify the variables that exhibit temporal locality and the variables that exhibit spatial locality. The variables are I, J, A.

```
for (I = 0; I < 8; I++)  
    for (J = 0; J < 8000; J++)  
        A[I][J] = 5 + A[J][I];
```

---