Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2015-01-15
Sal	T1
Tid	8-12
Kurskod	TDTS08
Provkod	TEN1
Kursnamn/benämning **Provnamn/benämning**	Datorarkitektur Skriftlig tentamen
Institution	IDA
Antal uppgifter som ingår i tentamen	13
Antal sidor på tentamen (inkl. försättsbladet)	5
Jour/Kursansvarig Ange vem som besöker salen	Zebo Peng
Telefon under skrivtiden	013-282067
Besöker salen ca kl.	9:45
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Åsa Kärrman, tel 285760, asa.karrman@liu.se
Tillåtna hjälpmedel	Engelsk ordbok
Övrigt	
Vilken typ av papper ska användas, rutigt eller linjerat	rutigt
Antal exemplar i påsen	

TEKNISKA HÖGSKOLAN I LINKÖPING
Institutionen för datavetenskap (IDA)
Zebo Peng

Tentamen i kursen

TDTS08 Datorarkitektur

(Examination on TDTS 08 Advanced Computer Architecture)

2015-01-15, kl. 8-12

Hjälpmedel:

Engelsk ordbok.

Supporting material:

English dictionary.

Poänggränser:

Maximal poäng är 40.
För godkänt krävs 21 poäng.

Points:

Maximum points: 40.
You need 21 points to pass the exam.

Jourhavande lärare (Teacher on duty):

Zebo Peng, tel. 013-28 2067

Note: You can give the answers in English or Swedish.

1.   What is a Harvard architecture? What is the main feature of such an architecture? What are the advantage and disadvantage of such an architecture?

(2p)

2.   A computer has a main memory and a cache. If a referenced word is in the cache, 5 *ns* are required to access it, while the main memory's access time is 50 *ns*. Assume that the cash block size (line size) is 4, the cache hit ratio is 0.98, and the time needed to check for cache hit/miss is 1 *ns*. What is the average time in *ns* required to access a word in this memory system? (Note that you should give the steps of your calculation, not just the final result.)

(3p)

3.   a) What are the three main types of hazards that can reduce the performance of an instruction pipeline?

b) Describe each of the three pipeline hazards. For each hazard, discuss one technique that can be used to reduce its impact on the instruction execution performance.

c) In your opinion, which hazard causes the biggest problem for instruction pipeline? Why?

(4p)

4.   a) What is a register window? How is a register window used.

b) Which problem is addressed by using a register window?

c) Why can a register window improve dramatically the performance of a computer system?

(3p)

5.   a) What is the most essential characteristics of a superscalar architecture?

b) What are the differences between the superscalar and super-pipelining approaches? Compare these two approaches to each other, and discuss their advantages and disadvantages, respectively.

c) Why is data dependence a bigger issue in a superscalar architecture than in an ordinary computer?

(3p)

6.   a) What are the main features and advantages of a VLIW architecture?

b) What are the main problems associated with a classical VLIW computer? How are these problems addressed by the IA-64 architecture?

(3p)

7. Someone says that since both CISC computers and VLIW computers try to perform many computations with a single instruction, they are very similar from an architectural point of view. Do you agree with this statement? Why? Provide all the arguments you have to support your answer.

(3p)

8. a) Identify all the different types of data dependencies in the following code. Indicate the type of dependency you have identified for each one, and give the reasons for your answers.

```
L1: move r3,r9      Note: r3 <- r9
    load r8,(r3)    Note: r8 <- memory location pointed by r3
    add r4,r3,4     Note: r4 <- r3 + 4
    load r9,(r4)    Note: r9 <- memory location pointed by r4
    ble r8,r9,L1    Note: branch to L1 if r8 <= r9
```

b) Which of the identified dependencies can be eliminated? How?

(3p)

9. a) What is a NUMA computer system? What are the motivations for using such a system?

b) Draw a picture of a typical NUMA system. Use the picture to illustrate and discuss the important concepts and components of such a system.

c) What is the purpose of having the directories in a NUMA system?

(3p)

10. a) What are the main features and advantages of a vector processor?

b) What do they mean by memory-to-memory operations and register-to-register operations respectively? Why is the register-to-register operation mode usually used in modern vector computers?

c) What is the role of the mask register in a vector computer? Give an example to illustrate the use of the mask register.

(4p)

11. a) There are two basic approaches to implement a snoopy protocol: write-invalidate and write-update. How do they work, respectively?

b) Describe the situation when the write-invalidate approach works better, and the situation when the write-update works better, respectively.

(3p)

12. a) What are the main features of a graphics processing unit (GPU)?

    b) What does it mean by divergent execution in a GPU? Why is divergent execution bad for performance?

    c) Discuss one technique that can be used to address the divergent execution problem.

    (3p)

13. We have discussed several techniques to reduce power consumption of processor cores. One of them is called pipeline gating.

    a) What does it mean by pipeline gating?

    b) Describe one way to implement the pipeline gating technique.

    (3p)