

Linköpings Universitet
Institutionen för datavetenskap (IDA)
Zebo Peng

**Tentamen i kursen
TDTS08 Datorarkitektur**

**Examination of the course
TDTS08 Advanced Computer Architecture**

2018-10-23, 8:00-12:00

Hjälpmedel:

Engelsk ordbok.

Supporting material:

English dictionary.

Poänggränser:

Maximal poäng är 40.
För godkänt krävs 21 poäng;
för betyg 4 krävs 27 poäng; och
för betyg 5 krävs 33 poäng.

Points:

Maximum points: 40.
You need 21 points to pass the exam;
for grade 4, 27 points are needed; and
for grade 5, 33 points are needed.

Jourhavande lärare (Teacher on duty)

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

1. a) What is a Harvard architecture? What is the main feature of such an architecture?
b) What are the advantages and disadvantages of a Harvard architecture?

(2 p)

2. a) When do we need a cache replacement algorithm?
b) Describe each of the cache replacement algorithms and their features, respectively.
c) What is the advantage of using the random cache replacement algorithm?
d) Why isn't the random replacement algorithm used for virtual memory?

(4 p)

3. The following sequence of virtual page numbers is encountered in the course of execution on a computer with virtual memory:

7 5 4 5 4 2 3 6 4 7 1 2 1 7

Assume that the least-recently used (LRU) page replacement policy is used. Assume also that the main memory has four page frames, and is initially empty. How many page misses will be encountered during this execution? Which are the virtual pages in the main memory when this execution finishes?

(3 p)

4. a) Why is instruction pipeline *widely* used to enhance performance of modern computers?
b) What are the three main types of hazards that can reduce the performance of an instruction pipeline? What are the impacts of each of these hazards?
c) In your opinion, which hazard causes the biggest problem for instruction pipeline? Why?

(4 p)

5. a) Provide a taken/not-taken execution pattern consisting of a sequence of 4 branches where a bimodal predictor will perform better than a one-bit predictor. Assume that the one-bit predictor is initially set at 0 (not taken) while the bimodal predictor is initially set at 01 (weakly not taken). Your answer should be of the form {T, T, T, NT}, for example.
b) Explain why the bimodal predictor gives better prediction results than those of the one-bit predictor.

(3 p)

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

6. a) Describe the concept of overlapping register windows. How is a register window used?
b) Which problem is addressed by using the overlapping register windows?
c) Why can the overlapping register windows improve dramatically the performance of a computer system?

(3 p)

7. a) What are the most essential characteristics of superscalar architecture and VLIW architecture, respectively?
b) Compare superscalar architecture with VLIW architecture from a performance point of view. Which architecture gives usually better performance? Why?
c) Compare superscalar architecture with VLIW architecture from a power consumption point of view. Which architecture consumes usually less power? Why?

(3 p)

8. a) Define the concept of loop unrolling. Why is loop unrolling very useful for a VLIW processor?
b) Can the loop unrolling technique be used in a superscalar processor? Why?
c) If a loop is unrolled completely (i.e., there is no need for loop control any longer), what will happen? Discuss the negative side effects of unrolling a loop completely?

(4 p)

9. a) What is Amdahl's law? What can we learn from it?
b) In your opinion, is the sequential computation part of a program completely determined by the application? Why or why not?

(2 p)

10. 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 directories in a NUMA system? What information is stored in them?

(3 p)

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

11. a) What are inclusive caches and exclusive caches, respectively?
b) Comparing them to each other, what are the advantages and disadvantages of these two different cache organizations, respectively?
(3 p)
12. a) Why has Graphics Processing Unit (GPU) become very popular recently?
b) Describe all features of a GPU that have contributed to its high performance.
c) Describe all features of a GPU that have contributed to its power efficiency.
(3 p)
13. We have discussed several techniques to reduce power consumption of a processor. One of them is called pipeline gating.
a) What does it mean by pipeline gating?
b) When should this technique be used?
c) Describe one way to implement the pipeline gating technique.
(3 p)