TEKNISKA HÖGSKOLAN I LINKÖPING
Institutionen för datavetenskap
Zebo Peng

Tentamen i kursen

TDTS08 Datorarkitektur

(Examination on TDTS 08 Advanced Computer Architecture)

2011-12-16, 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. 28 2067 / 070 258 2067

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

1. a) There are several write policies that are used to keep the cache contents and the contents of the main memory consistent. Describe briefly each of these policies and discuss the advantages and disadvantages of each of them, respectively.

   b) Describe the additional problems we have when applying these policies in a multiprocessor system.

   (4p)

2. 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 during this execution? Which are the virtual pages in the main memory when this execution finishes?

   (3p)

3. A register file severs as a small and fast buffer for holding the variables that are currently manipulated by the CPU. From this point of view, a register file acts like a cache memory.

   a) Can we then draw the conclusion that we can replace the cache with a large register file? Why?

   b) Discuss the different characteristics of a large register file and a cache, including the way they are accessed and their usual contents, respectively.

   (3p)

4. a) Why is instruction pipeline widely used to enhance performance of modern computers?

   b) In general, a larger number of pipeline stages gives better performance. However, when the number of stages is becoming very large, the efficiency of the pipeline will not be further improved. Why? Discuss the different issues that prevent the number of pipeline stages to go beyond a certain limit.

   (3p)

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

5. a) In a CICS architecture, a micro-memory is usually used to store the microprograms. Should the micro-memory be considered as a part of the memory hierarchy in a computer architecture. Why?

   b) What are the main differences between a micro-memory and a main memory.

   (3p)

6. a) In a superscalar architecture, the window of execution plays an important role. Why?

   b) The window of execution is usually extended over the basic block borders by speculative execution. What is speculative execution?

   c) What are the possible disadvantages associated with speculative execution?

   (3p)

7. a) Identify all the true data dependencies, output dependencies and anti-dependencies on the following code. Provide the reasons for your answers.

```
L1:  move r3,r7        Note: r3 <- r7
     load r8,(r3)      Note: r8 <- memory location pointed by r3
     add r3,r3,4       Note: r3 <- r3 + 4
     load r9,(r3)      Note: r9 <- memory location pointed by r3
     ble r8,r9,L1      Note: branch to L1 if r8 less than/equal r9
```

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

   (3p)

8. a) What does it mean by branch predication (as implemented in the Itanium machine)? How does it work? Illustrate the technique with an example.

   b) What are the differences between branch predication and branch prediction? What are their advantages and disadvantages, respectively.

   (3p)

9. a) What is a vector processor? Draw the block diagram of a typical vector processor architecture.

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

   (3p)

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

10. a) What is a directory protocol? What is it used for? Give an example of an architecture where a directory protocol is usually used.

    b) What are the advantages and disadvantages of a directory protocol, as compared with a snoopy protocol?

    (3p)

11. a) What does it mean by parametric computing in the context of parallel processing? Give an example to illustrate the features of such an approach.

    b) Why is the parametric computing approach appropriate to be used in a cluster computer?

    (3p)

12. a) Describe the different multithreading approaches and discuss how they are applied in the context of superscalar architectures. What are the advantages and disadvantages of these different approaches, respectively?

    b) Why does multithreading improve system performance even in the case when there is only a single scalar processor in your computer?

    (3p)

13. a) One argument for using a graphics processing unit (GPU) is that it is power efficient. Describe all features of a GPU architecture that contribute to the reduction of power consumption.

    b) Can we use GPUs for non-graphics computation? Support your answer with some good arguments.

    (3p)