

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

1. a) Describe the instruction execution cycle (machine cycle). What are the two main phases of instruction execution?
b) Which computer components are used in each of these two phases, respectively?
(3 p)

2. a) What are the differences among sequential access, direct access, and random access of computer memories.
b) Give an example to illustrate the main features of each of these three different memory types.
(3 p)

3. What is a Harvard architecture? What is the main feature of such an architecture? What are the advantage and disadvantage of such an architecture?
(2 p)

4. We have discussed two different cache write policies to be used when the CPU writes a word to the memory system. Describe them and discuss the advantages and disadvantages of each of them, respectively.
(3 p)

5. 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)

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6. Given a one-address computer with an accumulator, and the following memory contents:

- Word 10 contains 40;
- Word 20 contains 60;
- Word 40 contains 15;
- Word 50 contains 20;

What values will the following instructions load into the accumulator? Note: the keyword after LOAD in the following instructions denotes the *addressing mode*, and the number indicates the memory word-address in decimal numbers.

- a) LOAD Direct 20.
- b) LOAD Indirect 10.
- c) LOAD Indirect 50.

(3 p)

7. a) What does it mean by immediate addressing? Why is it useful to have this addressing mode?

b) Give an example to illustrate how immediate addressing can be used.

(3 p)

8. a) If an instruction contains four addresses, what is the purpose of each of these four addresses?

b) Why is the 4-address instruction format usually not used?

(3 p)

9. a) Why is it useful to have many general-purpose registers in the CPU?

b) Is there any disadvantage of having many general-purpose registers? Describe the most significant disadvantage, if there is any. Discuss one method that can be used to address this problem.

(3 p)

10. 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?

(3 p)

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11. You have just purchased a high-speed hard disc to be connected to your computer. You have to select the most appropriate method to control the I/O operations with this hard disc. Which one will you select (you can make your own assumptions, if needed)? Why? Explain also how the selected method works.

(3 p)

12. a) What are the most essential characteristics of a superscalar architecture?
b) What does it mean by register renaming? What is the main purpose of using such a technique?
c) Give a concrete example to illustrate how register renaming is used.

(3 p)

13. What are the main features of RISC computers? What are the main advantages of such computers?

(2 p)

14. a) What is a NUMA computer 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.

(3 p)