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

1. What are the von Neumann architecture principles? What are the main advantages of the von Neumann architecture?

   (2 p)

2. a) What does it mean by a memory hierarchy? Why it is useful to build a memory hierarchy?

   b) What is the fundamental assumption which makes a memory hierarchy work efficiently?

   (3 p)

3. a) What is the basic idea of associative mapping for cache organization? What are the advantages and disadvantages of the associative mapping organization?

   b) Why is the fully associative cache organization seldom used in practical computers? Which cache organization is commonly used? Why?

   (3 p)

4. 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)

5. What is an input/output module? Why is such a module needed? Describe the main functions of such a module.

   (3 p)

6. a) Give an example of an optical memory device.

   b) Briefly explain how the given device works, and its main features.

   c) Can the given device be used as a main memory? Why?

   (3 p)

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

7. 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)

8. a) What is the basic principle of an instruction pipeline? Why is it useful to have such an pipeline?

b) 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 cache
Control hazard	Forwarding/bypassing

(3 p)

9. a) Explain the difference between static and dynamic branch prediction.

b) Describe briefly an example of static branch prediction and dynamic branch prediction, respectively.

(3 p)

10. Describe the functions and features of a compiler and an interpreter respectively. What are the main differences between them?

(2 p)

11. a) What are the most essential characteristics of a superscalar architecture?

b) Draw a diagram of a typical superscalar architecture design.

c) Why is the window of execution an important mechanism for a superscalar architecture?

(3 p)

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

12. 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?

(3 p)

13. Microprogramming can be used for several purposes, besides implementing the control functions of a computer. Discuss how microprogramming can be used to provide each of the following functions. For each function, describe briefly an example to illustrate the basic idea.

a) high-level language support;

b) control of special-purpose devices; and

c) user-tailoring.

(3 p)

14. Describe Flynn's classification of computers. Give briefly the definition of each alternative architecture class and an example of each class. Draw a block diagram to illustrate each architecture example you have given.

(3 p)