

# Entrance exam - Informatics

Name and Surname - fill in the field	Application No.	Test Sheet No.
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## Algorithms and data structures

- 1** Which statement is correct for the data structure known as AVL tree (self-balanced binary search tree)?
- A An AVL tree contains root, leaves and at least one cycle.
  - B An AVL tree with  $(n - 1)$  nodes contains exactly  $n$  edges.
  - C The depth of an AVL tree is quadratic w.r.t. the number of nodes in the worst case scenario.
  - \*D The depth of an AVL tree is always logarithmic w.r.t. the number of nodes.
  - E The search operation in an AVL tree with  $n$  nodes has the time complexity  $O(\log(\log(n)))$ .
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- 2** Assume that every  $n$ -bit positive number is stored as a doubly linked list of separate bits of a number  $X$ . The first item of the list is the least significant bit of the number  $X$ . E.g., the number  $X = 12$  in the decimal system is stored as the list  $(0,0,1,1)$  with length of 4. What is the time complexity of replacement of any number  $X$  stored in this data structure by the value  $X / 8$ , if we will use integral division?
- A  $\theta(n^2)$
  - \*B  $\theta(1)$
  - C  $\theta(n^3)$
  - D  $\theta(n)$
  - E  $\theta(\log(n))$
- 
- 3** The hash algorithm used in databases provides access with a time complexity of  $O(1)$ :
- A to the value of all stored records without any knowledge of key values
  - B to the value of key  $X$  when the value of key  $Y$  satisfies equation  $X = Y - 1$
  - \*C to the value of a record when the corresponding key value is known
  - D to the value of a key when the corresponding record value is known
  - E no, access to the key value addressed by the hash algorithm has a time complexity  $\theta(\log(n))$
- 
- 4** In the data structure known as complete binary tree every node has exactly two siblings (except the leaves). How many internal nodes (all nodes except the leaves) are in the complete binary tree having 256 leaves?
- A 127
  - B 512
  - C 256
  - D 128
  - \*E 255
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- 5** Which statement is correct for the data structure known as stack?
- A The structure always contains at least two items (bottom and top of the stack).
  - B The item inserted as the last one is read out as the last one.
  - \*C The item inserted as the last one is read out as the first one.
  - D The item with the lowest value is always kept at the bottom of the stack.
  - E The item with the lowest value is always kept at the top of the stack.

## Computer systems

- 6** If a process  $P$  needs to allocate 100 bytes of memory and the minimum allocation unit of the operating system is 4kB then the following problem occurs:
- A external memory fragmentation
  - B mutual exclusion
  - C deadlock
  - \*D internal memory fragmentation
  - E starvation
- 
- 7** The carry flag in the x86 processors family indicates:
- A the need to handle a maskable interrupt
  - B the odd parity of the result of the operation
  - \*C the carry from the most significant bit
  - D that the maskable interrupts are enabled
  - E that the result of the operation is zero

- 8** Which binary number is an equivalent of the hexadecimal number A629?
- A 0111 0110 0010 1001
  - B 1001 0100 0110 0101
  - \*C 1010 0110 0010 1001
  - D 42537
  - E 1001 0010 0110 1010
- 
- 9** Let the processor be scheduled using the SJF (Shortest Job First) algorithm in the preemptive version. The process P1 requirement is arriving at time 0 and the process needs 11 units of CPU; the process P2 requirement is arriving at time 5 and the process needs 2 units of CPU; the process P3 requirement is arriving at time 5 and the process needs 3 units of CPU; the process P4 requirement is arriving at time 5 and the process needs 4 units of CPU. The scheduling starts at time 0. What process will be running on the processor at time 12?
- A P3
  - B none of the processes
  - \*C P4
  - D P2
  - E P1
- 
- 10** The Peterson's algorithm can typically be used to:
- A solve the thrashing problem
  - B schedule the CPU
  - \*C solve the problem of mutual exclusion
  - D handle the page fault interrupt
  - E search for the victim frame when the physical memory is full (in virtual memory management)
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## Programming

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- 11** Given the following code fragment:
- ```
a = 0;
b = 5;
c = 0;
while (a < 5) {
    b = 5;
    while (b > a) {
        c = c + 1;
        b = b - 1;
    }
    a = a + 1;
}
```
- What values will the variables a, b, c have after execution of the given code?
- A The program will cycle and never stop.
  - B a = 4, b = 4, c = 5
  - C a = 4, b = 5, c = 20
  - D a = 0, b = 5, c = 0
  - \*E a = 5, b = 4, c = 15
-

**12** Given the following code fragment:

```

index1 = 0;
index2 = 0;
while ((index1 < 10) && (index2 < 10)) {
    if (array1[index1] < array2[index2]) {
        PRINT(array1[index1]);
        index1 = index1 + 1;
    }
    else {
        PRINT(array2[index2]);
        index2 = index2 + 1;
    }
}
while (index1 < 10) {
    PRINT(array1[index1]);
    index1 = index1 + 1;
}
while (index2 < 10) {
    PRINT(array2[index2]);
    index2 = index2 + 1;
}

```

Assume that array1 and array2 are continuous arrays each containing 10 items sorted by item value in an increasing order. The arrays are indexed from 0. Therefore, the first item is positioned at array1[0], the second at array1[1], ... and the last (the 10th one) at array1[9]. The function PRINT outputs the provided item value. The operator && means logical AND (both conditions are valid).

Which from the listed options is correct?

- \*A The program will output increasingly ordered content of merged arrays array1 and array2.
- B The program will output only the content of array2.
- C The program will output only the content of array1.
- D The program will output the content of array1 and then the content of array2.
- E The program will output decreasingly ordered content of merged arrays array1 and array2.

**13** Assume that a processor executes a function or method call and starts to execute its body. Decide which of the listed options (for common OOP languages like C++, Java, C#) contains only all valid statements in I., II. and III.

- I. The stack pointer is updated.
- II. The heap pointer is updated.
- III. The program counter is updated.

- A II.
- B I. and II.
- \*C I. and III.
- D II. and III.
- E I.

**14** Decide which statement is generally valid in common OOP languages (C++, Java, C#):

- A When an exception is caught and handled, the program execution will continue on the next instruction after the instruction that caused the exception.
- B If an exception is not caught in the current function, it is discarded and the program continues with the next instruction of a calling function.
- \*C An exception is propagated to the calling function if not caught in the current function.
- D The standard library does not contain any predefined types for exceptions - exceptions are always user-defined types.
- E A code block in which exceptions can be thrown is enclosed in a catch {} statement.

**15** Decide which statement is generally valid in common OOP languages (C++, Java, C#):

- A Encapsulation helps to simplify a method header by hiding all its arguments.
- B Encapsulation is automatically provided by the execution environment on the level of memory protection without the necessity to specify accessibility.
- \*C Encapsulation helps to increase robustness of implementation by hiding internal details of object's state and by restricting its modification.
- D Accessibility can be used to control access to attributes of the class, but not to the methods of the class.
- E Encapsulation allows to hide internal implementation of methods, but doesn't allow to hide class attributes.

## Computer Networks

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- 16** Interdomain routing with the BGP (Border Gateway Protocol) protocol is characterized by the following properties:
- A** Routers exchange complete copies of their routing tables; the split horizon method is applied.
  - B** Routers use metrics based on path costs derived from the bandwidth; load-balancing is supported for the same cost paths.
  - C** It supports complex topologies; routers exchange description of complete paths including hops; optimal solution is calculated based on metrics being used.
  - D** It supports complex topologies; routers exchange information about their neighbours; slow convergence leads to inconsistencies in routing tables.
  - \*E** It supports complex topologies; routers exchange description of the complete paths including hops; CIDR is used for path aggregation; routing is based on policies.
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- 17** Errors can occur during data transmission. Self-correcting codes allow the receiver:
- A** to correct all errors
  - B** to correct most errors and to detect all remaining errors
  - C** to correct most errors with the knowledge of a secret password and not to detect some errors
  - \*D** to correct most errors, to detect some other errors; exceptionally not to detect some errors
  - E** to detect most errors
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- 18** The aim of addressing on the transport layer of the OSI model is:
- A** to connect any two nodes of a local network
  - B** to distinguish MAC addresses of all devices in a local network
  - C** to connect any two nodes of a sensor network
  - \*D** to connect sending and receiving applications
  - E** to connect any two nodes of a global network
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- 19** Information is digital or analogue. As well, signals are digital or analogue. Select the correct answer:
- A** Digital signals always transmit analogue information without any distortion.
  - B** Digital and analogue signals can transmit analogue information only.
  - \*C** Digital and analogue signals can transmit digital as well as analogue information.
  - D** Digital and analogue signals can transmit digital information only.
  - E** Analog signals can transmit analogue information only.
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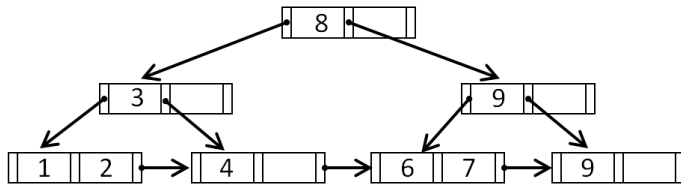
- 20** The DNS name service provides for:
- A** The translation of physical addresses (MAC) to network addresses and vice versa. It works on the network layer.
  - B** The translation of IPv4 addresses to IPv6 addresses and vice versa. It works on the network layer.
  - C** The translation of IPv4 addresses and IPv6 addresses to physical addresses.
  - D** The translation of domain names to physical addresses and vice versa. It is part of the data link layer.
  - \*E** The translation of domain names to IP addresses and vice versa. It is a part of the application layer.
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## Databases

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- 21** Which one of the following properties is **not required** for database transactions?
- A** Consistency - the database is in consistent state after a completed transaction.
  - B** Durability - changes applied by a finished transaction are saved and cannot be lost.
  - C** Isolation - changes applied by an unfinished transaction are visible only by this transaction.
  - D** Atomicity - a transaction is either fully completed or not at all.
  - \*E** Completeness - every transaction must complete all its specified database changes in finite time.
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22 Consider the following B+tree that represents an index on attribute id of some relation:



If the database needs to access a record with id = 3, then:

- \*A Three comparison operations will be evaluated and the record will not be found.
- B Three comparison operations will be evaluated and the record will be found.
- C Two comparison operations will be evaluated and the record will be found.
- D Two comparison operations will be evaluated and the record will not be found.
- E One comparison operation will be evaluated and the record will not be found.

23 Consider relations *customer* (*custid*, *name*, *address*) and *account* (*accid*, *custid*, *balance*). Let the attribute *account.custid* be a non-null foreign key. Select the one of the following statements that **is not** true:

- A All values of the attribute *account.custid* must exist in the customer relation.
- B Some values of the attribute *customer.custid* need not exist in the account relation.
- C Relation account can be empty.
- \*D There are at least as many tuples in the account relation as in the customer relation.
- E Relation customer can be empty.

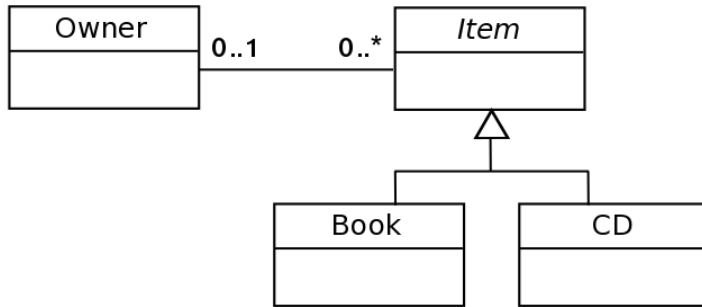
24 Consider the following relations in a banking schema: *customer* (*custid*, *name*, *address*), *account* (*accid*, *custid*, *balance*), and *loan* (*loanid*, *custid*, *total\_loan\_amount*, *paid*). Assume that a customer can have multiple accounts and multiple loans. Note that there can be customers with no account or no loan. From the following SQL queries choose the one that returns the total balance of the bank, i.e. the amount of money that the bank has on its accounts without the money loaned to customers.

- \*A `SELECT SUM(money) FROM (SELECT balance AS money FROM account UNION SELECT paid - total_loan_amount AS money FROM loan) totals;`
- B `SELECT SUM(balance) + SUM(paid) - SUM(total_loan_amount) FROM account, loan WHERE account.custid = loan.custid;`
- C `SELECT SUM(balance + paid - total_loan_amount) FROM account NATURAL INNER JOIN loan;`
- D `SELECT SUM(money) FROM account, loan WHERE account.custid = loan.custid;`
- E `(SELECT SUM(balance) FROM account) MINUS (SELECT SUM(paid - total_loan_amount) FROM loan);`

25 Select the correct statement about primary keys (PK):

- \*A PK is a candidate key.
- B PK is any subset of relation's attributes.
- C There can be several PKs for one entity relation.
- D PK contains the maximal number of dependent attributes.
- E PK always contains at least two attributes.

**26** Consider the design depicted in the following UML class diagram, containing inheritance (relationship with the triangle end) and an abstract class Item:



Based on the diagram, select the only option that applies:

- A An object of the Owner type can have at most one reference to an instance of Book, CD or Item.
- B An object of the Owner type can have any number of references to the instances of Item, but can have no reference to the instances of Book or CD.
- C An object of the Owner type can have any number of references to the instances of Book and Item.
- \*D** An object of the Owner type can have any number of references to the instances of Book and CD, but can have no reference to the instances of Item.
- E An object of the Owner type can have at most one reference to an instance of Item.

**27** Which one of the following descriptions best characterizes the Test-Driven Development (TDD) technique?

- A TDD is a testing strategy that emphasizes manual testing over automated testing.
- B TDD is a software development process that suggests that after any piece of code is written, a test should be designed, written and executed.
- C TDD is a software development process that suggests periodical testing of the developed software at the end of every month.
- D TDD is a testing strategy that emphasizes static testing methods over dynamic testing methods.
- \*E** TDD is a software development process that suggests that in each implementation step, a test should be written prior to the implementation of the functionality that shall be tested.

**28** As a software engineer you are seeking a programming paradigm that shall help you to best realize the concepts of encapsulation and polymorphism. Which one of the following paradigms best relates to these concepts (is characterized by them)?

- A Data-oriented
- \*B** Object-oriented
- C Functional
- D Procedural
- E Logic

**29** As a software engineer you shall decide if a newly developed system shall be designed for a single-server deployment, or shall rather be designed as distributed (deployed on multiple servers). Consider the following three arguments:

- I. If the performance of the single-server solution is satisfactory, one shall prefer the single-server deployment, because the shift to a distributed environment may negatively affect reliability and security of the system.
- II. If it is acceptable from the financial point of view, one should always prefer distributed deployment, because it guarantees higher performance, reliability and security.
- III. If it is acceptable from the financial point of view, one should always prefer distributed deployment, because it guarantees higher performance, security and maintainability.

Decide, which of the given arguments I., II. and III. are valid in general (select the option containing all and only the valid arguments):

- A II. and III.
- B I. and II.
- \*C** I.
- D II.
- E III.

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**30** Which diagram of the Unified Modelling Language (UML) is best suited to model system processes?

- A** Data flow diagram
  - B** Entity-relationship diagram
  - \*C** Activity diagram
  - D** Class diagram
  - E** Consequence diagram
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