

# FI - Entrance exam: Computer Science

Name and Surname - fill in the field	Application No.	Test Sheet No.
		<b>1</b>

## Algorithms and Data Structures

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**1** Which statement is true?

- A** The worst-case time complexity of inserting an element into a hash table with linear probing is in  $\mathcal{O}(1)$ .
  - B** The B-trees are a special case of binary search trees.
  - C** There exists an  $\mathcal{O}(\log n)$  algorithm that creates a binary heap from an unsorted array of elements.
  - \*D** The functions  $n \log n$  and  $\log(n!)$  have the same asymptotic growth.
  - E** We say that an algorithm is partially correct if it produces a correct output for at least some of the inputs.
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**2** Let  $f(n) \in \mathcal{O}(n^2)$  and  $g(n) \in \mathcal{O}(n^2)$ . Which of the following statements is necessarily true?

- \*A**  $f(n) * g(n) \in \mathcal{O}(n^4)$
  - B**  $f(n)/g(n) \in \mathcal{O}(1)$
  - C**  $g(n) \in \mathcal{O}(f(n))$
  - D**  $g(n)/f(n) \in \mathcal{O}(1)$
  - E**  $f(n) \in \mathcal{O}(g(n))$
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**3** Which of the following is always true for every binary search tree (BST)?

- A** The depth of the tree is at most seven times the logarithm of the number of all nodes.
  - B** The median key is stored in one of the leaves.
  - \*C** The node with the maximum key does not have any right child.
  - D** Every internal node (i.e. not a leaf) contains exactly two children.
  - E** The median key is stored in the root.
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**4** Consider a maximum binary heap with integer keys implemented as an array. We first insert the following keys in the given order: 2, 8, 12, 1, 5, 7, 9 and then extract the maximum **twice**. What does the array contain at the end?

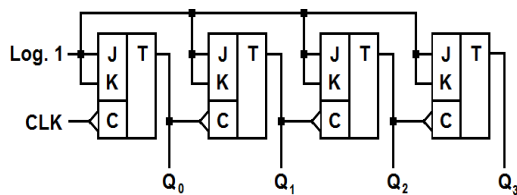
- A** [1, 2, 5, 7, 8]
  - B** [7, 8, 2, 5, 1]
  - C** [5, 7, 8, 9, 12]
  - D** [8, 7, 5, 2, 1]
  - \*E** [8, 5, 7, 1, 2]
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- 5** Consider a directed graph. We run a depth-first search on this graph; the search assigns to each vertex  $v$  two numbers:  $v.d$  is the discovery time of  $v$ ,  $v.f$  is the finishing time of  $v$ . Which one of these statements is true in general?
- A** If there is a path from vertex  $u$  to vertex  $v$  in the graph then  $u.f > v.f$ .
  - B** If there is a path from vertex  $u$  to vertex  $v$  in the graph then  $u.d > v.d$ .
  - \*C** None of the other statements is true in general.
  - D** If there is a path from vertex  $u$  to vertex  $v$  in the graph then  $u.d < v.d$ .
  - E** If there is a path from vertex  $u$  to vertex  $v$  in the graph then  $u.f < v.f$ .

## Computer systems

- 6** Which of the following specifications does **not** represent a computer expansion bus?
- A** PCI-E - Peripheral Component Interconnect Express
  - B** VESA Local Bus
  - C** ISA - Industry Standard Architecture
  - \*D** ESIB - Enhanced System Interconnection Bus
  - E** PCI - Peripheral Component Interconnect

- 7** Consider the following logic circuit.



This circuit serves as:

- A** Multiplexer
- B** Parallel register
- C** Frequency multiplier
- D** Shift register
- \*E** Counter

- 8** Consider two 8-bit signed integer variables  $x$  and  $y$ . These variables contain hexadecimal integers  $0xA9$  and  $0x23$  in two's complement representation, respectively. Which decimal number is the mathematical equivalent of the number stored in  $x$  after performing the operation  $x=x+y$ ?
- \*A** -52
  - B** 76
  - C** -76
  - D** 204
  - E** 52

- 9** Which of the following techniques is **not** performed by modern processors when processing instructions?
- A** Register renaming
  - \*B** Instruction simplification
  - C** Out-of-order execution
  - D** Branch prediction
  - E** Speculative execution

**10** Cache memories integrated in current microprocessors are made as?

- A Sequential memories
- B Ferrite core memories
- C Synchronous dynamic memories
- \*D Associative memories
- E Non-volatile memories

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## Programming

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**11** Which statement is generally true in common OOP languages such as C++, Java, C#?

- A The notions "class" and "object" mean the same thing.
- B The difference between static and non-static methods (member functions) is that only the static methods may access the static attributes (member variables) of a class.
- C If class B inherits from class A (via public inheritance), the instances of B can access all attributes (member variables) of A.
- D If class B inherits from class A (via public inheritance), every instance of A is considered to be an instance of B.
- \*E If early binding (non-virtual method calls) is used, the actual method to be called is decided at compile time.

**12** Let us consider the following program. The print instruction outputs the given number without an end-of-line character.

```
function foo(integer n)
begin
    if n > 0 then
        foo(n-1)
        print n
        foo(n-2)
    end if
end
```

```
program main()
begin
    foo(4)
end
```

What is going to be printed by the program?

- A 342
- \*B 1231412
- C The program runs forever and never halts.
- D 342231
- E 1234

**13** Which of the following statements is **false**?

- A In purely functional languages, functions can have no side effects.
  - B A tail-recursive function can always be rewritten in an iterative manner.
  - \*C When using call-by-value, the change of a parameter value inside of a function can be observed from the outside of the function.
  - D A recursive function can always be rewritten in an iterative manner.
  - E The normal evaluation strategy in functional programming allows working with infinite data structures.
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**14** Which of the following three statements I, II, and III are true (in common languages such as C++, Java, C#)? Choose the option that contains all the true statements and none of the false ones.

I. Local variables of functions are always allocated on the heap.

II. Function calls are implemented using the heap.

III. If an exception is caught (in a catch block), it can be re-thrown (using throw).

- A I, II, III
- B I, II
- \*C III
- D II, III
- E I, III

**15** Let us consider the following function:

```
function fun(unsigned integer n)
begin
    result = 1
    while n != 0
        n = n - 1
        result = result + 2 * n
    end while
    return result
end
```

end

Assume that  $n > 0$ . What is the result computed by fun?

- A  $2n$
- B  $n^2$
- C  $2n - 2$
- D  $2^n$
- \*E  $n^2 - n + 1$

## Computer Networks

**16** Choose the option that contains basic approaches to distributed routing:

- A All protocols of transport layer.
- \*B Distance Vector (DV), Link State (LS) and Path Vector protocols.
- C Distance Vector (DV) and Reliable Blast UDP (RBUDP) protocols.
- D RTP and RTC, especially for real-time data transport.
- E CSMA/CA and CSMA/CD, especially for wireless networks.

**17** TCP controls the amount of transferred data in such a way that:

- \*A it protects the receiver from being congested (Flow Control) and protects the network from being congested (Congestion Control).
- B it protects the shared medium from collisions (Mac Control) and protects the receiver from being congested (Flow Control).
- C the amount of data allowed to be sent to the network is limited by the larger value of these parameters: receiver's window size and congestion window.
- D it protects the shared medium from collisions (Mac Control).
- E the amount of data allowed to be sent to the network is equal to the sum of values of these parameters: receiver's window size and congestion window.

**18** IPv6 address is of

- A** 128 bits (16 Bytes) that are represented in the hexadecimal notation instead of the decimal one -- pairs of bytes are separated by a colon ":". Rules for address abbreviation are defined, e.g., FDEC::BBFF::0:FFFF is a correct address.
  - B** 64 bits (8 Bytes) that are represented in the octal notation instead of the decimal one -- pairs of bytes are separated by a colon ":".
  - C** 128 bits (16 Bytes) that are represented in the binary notation instead of the decimal one -- pairs of bytes are separated by a semi-colon ";".
  - D** 128 bits (16 Bytes) that are represented in the decimal notation -- pairs of bytes are separated by a dot ".".
  - \*E** 128 bits (16 Bytes) that are represented in the hexadecimal notation instead of the decimal one -- pairs of bytes are separated by a colon ":". Rules for address abbreviation are defined, e.g., FDEC::BBFF:0:FFFF is a correct address.
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**19** Domain Name Space of Internet

- A** has a structure of distributed tree for routing (PRR-tree) with the maximum number of levels equal to 256.
  - B** has an inverted binary tree structure with the maximum number of levels equal to 1024.
  - \*C** has an inverted tree structure with the maximum number of levels equal to 128.
  - D** has a structure of virtually-balanced B<sup>+</sup>-tree structure with the maximum number of levels equal to 64.
  - E** has a hypercube structure with the maximum number of dimensions equal to 16.
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**20** Network Protocol

- A** defines only syntax of communication, i.e. the structure/format of data (byte order in which they are presented) and nothing else.
  - B** defines only timing of communication, i.e. when data should be sent and how fast they can be sent and nothing else.
  - C** defines only semantics of communication, i.e. the meaning of each section of bits (how should a particular pattern be interpreted) and nothing else.
  - \*D** is a set of rules that define the format and order of messages exchanged among two or more communicating entities, as well as the actions performed during sending/receiving that messages.
  - E** defines only syntax and semantics of communication and nothing else.
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## Database Systems

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**21** Select the correct statement in the context of entity-relationship (E-R) diagrams and the database relational model:

- \*A** Each many-to-many relationship in an E-R diagram will always be represented by a new relation in a database.
  - B** There is always just one way of transforming a given E-R diagram to database relations.
  - C** Each one-to-many relationship in an E-R diagram will always be represented by a new relation in a database.
  - D** An entity with just simple attributes in an E-R diagram can be represented by more than one relation in a database.
  - E** The transformation of an E-R diagram to database relations is a one-way process, i.e. it is impossible to recreate the E-R diagram from the database relations and their integrity constraints.
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- 22** Select the correct statement about primary keys:
- A** A primary key restricts the values of the given database relation in such a way that only values that exist in another (foreign) database relation are valid.
  - B** A primary key cannot be a super-key of the respective database relation.
  - C** A primary key can only be defined using a single attribute of the database relation.
  - \*D** A primary key is an integrity constraint that specifies that each its value must be both unique and not null in the database relation.
  - E** A database relation can have multiple primary keys.
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- 23** Which is the correct sequence of keywords in the SELECT command of the SQL language:
- A** SELECT, FROM, GROUP BY, WHERE, HAVING
  - \*B** SELECT, FROM, WHERE, GROUP BY, HAVING
  - C** SELECT, WHERE, HAVING, GROUP BY, FROM
  - D** SELECT, GROUP BY, HAVING, WHERE, FROM
  - E** SELECT, WHERE, GROUP BY, HAVING, FROM
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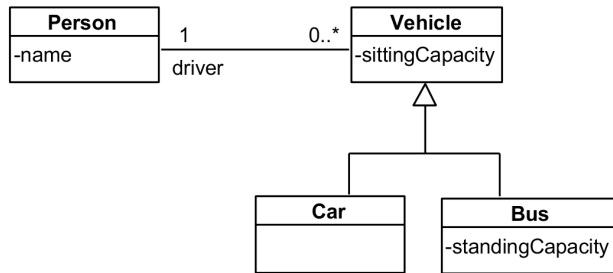
- 24** Assume the relation  $course(\underline{code}, name, credits)$  that contains information about university courses. Which relational-algebra expression returns the number of courses for each distinct value of credits:

- A**  $COUNT(\underline{code})\mathcal{G}_{DISTINCT(credits)}(course)$
  - B**  $code\mathcal{G}_{COUNT(credits)}(course)$
  - \*C**  $credits\mathcal{G}_{COUNT(*)}(course)$
  - D**  $COUNT(\underline{code})\mathcal{G}_{credits}(course)$
  - E**  $COUNT(*)\mathcal{G}_{code,credits}(course)$
- 

- 25** In the context of transaction processing in a relational database system where transactions are executed simultaneously, choose the correct situation when a conflict can occur:
- A** the transactions are conflict-serializable.
  - B** the transactions read different values (rows).
  - \*C** the transactions write to the same value (row).
  - D** the transactions write to different values (rows).
  - E** the transactions read the same value (row).
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- 26** Which of the following statements are true for "performance" as a quality attribute of information systems?
- I. Performance is being primarily characterized by "elasticity", which is the degree to which a system is able to adapt to workload changes by provisioning and de-provisioning resources in an autonomic manner.
- II. Performance is being primarily characterized by "response time", which is the time that system needs to execute its computation and return a response.
- III. The properties of performance include "throughput" and "resource utilization".
- A** All I., II. and III.  
**B** Only I.  
**\*C** Only II. and III.  
**D** Only I. and III.  
**E** Only II.
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- 27** As a software engineer, you shall choose an approach to modeling persistent data of an object-oriented software system that is to be stored in a relational database. Will you choose Entity Relationship Diagram (ERD) or UML Class Diagram (UML CD), and why?
- A** I will choose UML CD, because ERD is not suitable in the context of object-oriented software systems.  
**\*B** I will choose ERD, because it is better suited to describe data that are to be stored in a relational database.  
**C** I will choose UML CD, because it is better equipped to model important properties of persistent data, such as primary and secondary keys.  
**D** I will choose ERD, because UML CD cannot be used to model persistent data.  
**E** I will choose UML CD, because ERD cannot model inheritance.
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- 28** Which diagram is the best suited for modeling interactions among objects with the emphasis on the order of exchanged messages, i.e. method calls among the objects?
- \*A** UML Sequence Diagram  
**B** UML Class Diagram  
**C** UML Timing Diagram  
**D** UML Use Case Diagram  
**E** UML State Diagram
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- 29** Which of the following statements are true for "version control systems"?
- I. Version control systems support the management of changes to documents, software programs, and other collections of information.
- II. Version control systems can run as stand-alone applications, but can also be embedded in various types of software such as IDEs.
- III. Version control systems allow for the ability to revert a document to a previous revision, which is important for allowing editors to track each other's edits and correct mistakes.
- IV. The three most commonly used commands of version control systems are import, export and merge.
- A** Only I., III., IV.  
**B** Only I. and III.  
**C** Only II. and III.  
**\*D** Only I., II., III.  
**E** All I., II., III., IV.
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**30** Based on the following UML Class diagram, which is the complete list of attributes of an instance of the Bus class?



- A standingCapacity, sittingCapacity
  - B standingCapacity, sittingCapacity, driver, name
  - \*C standingCapacity, sittingCapacity, driver
  - D standingCapacity
  - E standingCapacity, sittingCapacity, name
-