Entrance exam - Computer Science

Name and Surname – fill in the field	Application No.	Test Sheet No.
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Algorithms and Data Structures

1 Which one of these statements is true?

A We say that an algorithm is partially correct, if it produces a correct output for at least some of the inputs.

B B-trees are a special case of binary search trees.

C The worst-case time complexity of inserting an element into a hash table is in $\mathcal{O}(1)$.

*D The binary heap can be efficiently implemented using an array.

E The logarithm and square root functions have the same asymptotic growth.

2 Consider a hash table with linear probing and the hash function h(x) = (5*x + 3) mod 7. We start with the hash table empty. In what order do we have to insert the values 1, 2, 5, 7, 9, 12, so that the contents of the resulting hash table look as follows: 2, 12, 1, 5, 7, empty field, 9?

A 9, 2, 12, 5, 1, 7
*B 9, 2, 12, 1, 5, 7
C 2, 9, 12, 5, 1, 7
D 2, 9, 5, 12, 1, 7
E 9, 2, 5, 12, 1, 7

3 Which one of the following is **always true** for any binary search tree (BST)?

A Every internal node (i.e., not a leaf) contains exactly two children.

*B The node with the maximal key does not have a right child.

C The minimal key is stored in the root.

D The minimal key is stored in one of the leaves.

E The depth of the tree is logarithmic to the number of all nodes.

4 Let $f(n) \in \mathcal{O}(n)$ and $g(n) \in \mathcal{O}(n^2)$. Which one of the following statements is true?

A $g(n)/f(n) \in \mathcal{O}(1)$

*B $f(n) * g(n) \in \mathcal{O}(n^3)$

C $f(n) \in \mathcal{O}(g(n))$

D $g(n) \in \mathcal{O}(f(n))$

E $f(n)/g(n) \in \mathcal{O}(1)$

5 Consider a directed graph. We run a depth-first search on this graph. The search algorithm assigns to each vertex v two numbers: v.d is the discovery time of v, and 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.d < v.d.

*B None of the other statements is true in general.

C If there is a path from vertex u to vertex v in the graph then u.f > v.f.

D If there is a path from vertex u to vertex v in the graph then u.f < v.f.

E If there is a path from vertex u to vertex v in the graph then u.d > v.d.

Computer systems

6 Which of the following algorithms **can not** be used as a strategy for processor scheduling?

A Shortest remaining time first
B Round robin scheduling
*C Least recently served
D First come, first served
E Earliest deadline first (closest to its deadline)

7 Which of the following logic circuits is sequential?

A Half adder
B Demultiplexer
C Multiplexer
*D Serial binary adder
E Parity generator

8 The algorithm for mutual exclusion that allows two or more processes to share a single-use resource without conflict is:

A greedy algorithm
B Ford-Fulkerson algorithm
*C Peterson's algorithm
D Bellman-Ford algorithm
E Dijkstra's algorithm

9 Which hexadecimal number is equivalent to the **octal** number 7264?

A 4BE
B BE4
C EC2
D F4E
*E EB4

10 Modern desktop processors (Intel Core i3, i5, i7) **do not** have integrated:

A Memory controller
B Branch target predictor
C Floating point unit
D Graphics processing unit
*E Universal Serial Bus controller

Programming

11 Which one of the following statements is **false**?

A A tail-recursive function can always be rewritten in an iterative manner.
B In purely functional languages, functions have no side effects.
C The lazy evaluation strategy in functional programming allows working with infinite data structures.
*D When using call-by-reference, the change of a parameter value inside a function cannot be observed from the outside of the function.
E A recursive function can always be rewritten in an iterative manner.

12 Consider the following program. The `print` function outputs the given number followed by an end-of-line character.

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

program main()
begin
        foo(3)
end
```
How many lines are going to be printed by the program?

A The program will run forever and never halt.
B 30
C 7
D 14
*E 29

13 Consider the following function:

```
function fun(unsigned integer n)
begin
        result = 1
        while n != 0
                n = n - 1
                result = result + result
        end while
        return result
end
```
What is the result computed by `fun(n)`?

A result $= 2 * n$

B result $= n$

C result $= 1$

*D result $= 2^n$

E result $= n^2$

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

*A If a class B inherits from a class A (via public inheritance), every instance of B is considered to also be an instance of A.

B If a class B inherits from a class A, instances of B can access all attributes (member variables) of A.

C The difference between static and non-static methods (member functions) is that only static methods may access the static attributes (member variables) of a class.

D The notions "class" and "object" mean the same thing.

E If late binding (virtual method calls) is used, the actual method to be called is decided by the compiler at compile time.

15 Which statements I, II, and III are true (in common languages such as C++, Java, C#)? Choose the option that contains **all 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 stack.
III. If an exception is caught (in a `catch` block), it can be re-thrown (using `throw`).

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

Computer Networks

16 Transmission media in computer networks

A are responsible for packing digital data into packets.

B are responsible for routing and switching data in a network.

*C provide an environment for the functionality of the physical layer.

D are responsible for packing digital data into frames.

E ensure the communication of particular applications.

17 Medium Access Control (MAC) is responsible for

A redundant data transmissions for forward error correction.

B elimination of cycles and loops in local area networks.

*C the coordination of multiple devices' access to shared transmission media and for the elimination of collisions caused by concurrent transmissions (emissions).

D the conversion between digital and analog signals in the local area networks and elimination of the collisions between analog and digital signals.

E redundant data transmissions for error detection and ensuring transmission repetition.

18 Transmission Control Protocol (TCP)

A is responsible for finding optimal paths (the optimality criterion is a metric based on costs assigned for passing through network) and for delivering data packets to their receiver.

B is a supplement to IP protocol that provides information about errors occured during data delivery and basic information about the network state.

*C provides a connection-oriented and fully-reliable service with flow and congestion control during data transmission.

D is a protocol for real-time data transmission and is often used with multicast communication.

**E** is the simplest transport protocol providing a connection-less and unreliable service.

19 Domain Name Space of Internet

A has a hypercube structure with the maximum number of dimensions equal to 16.

B has a virtual balanced B^+-tree structure with the maximum number of levels equal to 64.

C has a structure of distributed tree for routing (PRR-tree) with the maximum number of levels equal to 256.

D has an inverted binary tree structure with the maximum number of levels equal to 1024.

*E has an inverted tree structure with the maximum number of levels equal to 128.

20 The **only** types of IPv4 addresses are

A unicast address, broadcast address, multicast address and anycast address.

B unicast address and broadcast address.

C unicast address, broadcast address and anycast address.

D unicast address, multicast address and anycast address.

*E unicast address, broadcast address and multicast address.

Database Systems

21 Choose the option that describes the following E-R diagram (in Chen notation) of a database of products and categories:
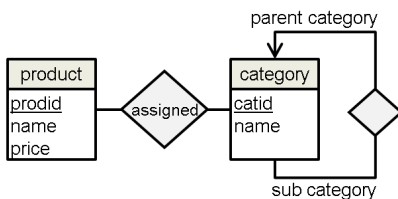
A Each product can be assigned to exactly one category, and a category must have at least one product assigned. Categories can be hierarchically structured, and each category can have multiple parent categories.

*B Each product can be assigned to multiple categories, where a product may not have any category assigned. Categories can be hierarchically structured, and each category can have at most one parent category.

C Each product can be assigned to multiple categories, where a product must have at least one category assigned. Categories can be hierarchically structured, and each category can have multiple parent categories.

D Each product can be assigned to multiple categories, and a category must have at least one product assigned. Categories can be hierarchically structured, and each category can have at most one parent category.

E Each product can be assigned to at most one category. Categories can be hierarchically structured, and each category can have at most one parent category.

22 An e-shop application contains a non-empty relation `product(`<u>`id`</u>`, name, quantity, price, category)` with the primary key `id`. Assume that quantity is a non-negative number.
Which one of the following SQL statements returns the total price of all products for which the e-shop has at least one item in the inventory?

A `SELECT TOTAL(price) * COUNT(quantity) FROM product WHERE quantity > 0`

B `SELECT price * quantity FROM product`

*C `SELECT SUM(price * quantity) FROM product`

D `SELECT price * quantity FROM product WHERE quantity > 0`

E `SELECT SUM(price * quantity) FROM product HAVING quantity > 0`

23 Consider a relation `employee(`<u>`id`</u>`, name, start_date, end_date, salary, superior_id)` that represents a simple registry of employees and their superiors. Dates correspond to the start and end date of the employee's contract, respectively. If end_date is not set, the contract is still active.
What is the result of the following SQL query?

```
SELECT s.name, SUM(e.salary)
FROM employee AS e, employee AS s
WHERE s.id = e.superior_id AND e.end_date IS NULL
GROUP BY s.id, s.name
```

*A Names of all superiors and the total amount of money paid as the salaries of all their direct subordinates that are currently working for the company.

B Names of all superiors and the total amount of money paid as the salaries of all their direct subordinates that no longer work for the company.

C Names of all employees and the total amount of money paid as the salaries of all their direct superiors that are currently working for the company.

D Names of all employees and the total amount of money paid as the salaries of all their direct superiors that no longer work for the company.

E The SQL query is syntactically incorrect thus an error will be returned.

24 Consider the relations customer(<u>custid</u>, name, address) and account(<u>accid</u>, custid, balance). The attribute account.custid is a not-null foreign key to customer. Choose the statement that is **incorrect**:

A All values of the attribute account.custid must have a corresponding customer.custid.

B Relation account can be empty.

*C Relation account contains at least as much tuples as the relation customer.

D If there is at least one tuple in the relation account then the relation customer is not empty.

E Relation customer can be empty.

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25 Choose the option that contains **only true** statements about relations (tables) in the context of relational database systems:

*A A relation is an unsorted bag of tuples (rows). The tuples are members of the Cartesian product of domains of the relation's attributes.

B A relation is a sorted list of tuples (rows). The elements of each tuple are values from the domain of the respective attribute of the relation.

C A relation constitutes a relationship between two tables and is represented as a set of tuples, where each tuple's element is a foreign key to the corresponding table.

D A relation is a matrix, where columns correspond to attributes and rows to tuples. The values in each row must be from the domain of the respective attribute (column), and the matrix is symmetric.

E A relation is an unsorted set of tuples (rows). The elements of each tuple are arbitrary values set by the user updating the database.

Software Engineering

26 Which one of the following statements about design patterns is **false**?

A A design pattern is not a finished design, but rather a design template that can be used in many different situations.

*B Design patterns primarily focus on security problems within software.

C Object-oriented design patterns typically show relationships and interactions between classes or objects.

D An example of a design pattern is *Singleton*. It helps secure the existence of at most one instance of a specific class.

E Design patterns describe solutions to commonly occurring problems within the context of software design.

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27 Consider the model depicted with the UML class diagram in the following figure.
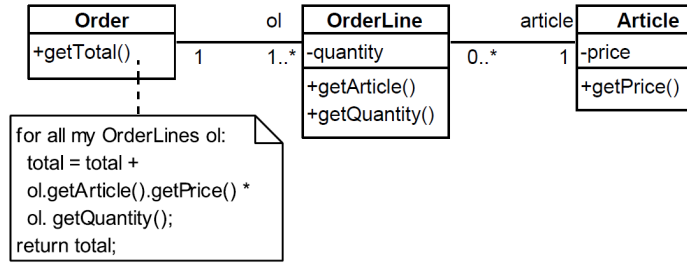
Now consider a change of the model in terms of adding a subtotal attribute (with the value article.getPrice()*quantity) and a get method for it to the OrderLine class, and using it within getTotal(). What effect would this change have on the non-functional properties of the system?

A better performance of Order.getTotal(), better maintainability of the system

B no effect

C worse performance of Order.getTotal(), better maintainability of the system

*D better performance of Order.getTotal(), worse maintainability of the system

**E** worse performance of Order.getTotal(), worse maintainability of the system

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28 Which of the following **is not** a principle of agile development?

A Customer collaboration over contract negotiation

B Responding to change over following a plan

C Working software over comprehensive documentation

*D Complete product delivery over incremental delivery

E Individuals and interactions over processes and tools

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29 Which diagram of the Unified Modelling Language (UML) is best suited for the modelling of system processes?

A Entity-relationship diagram

B Data flow diagram

*C Activity diagram

D Class diagram

E Consequence diagram

30 Consider the model depicted with the UML class diagram in the figure.
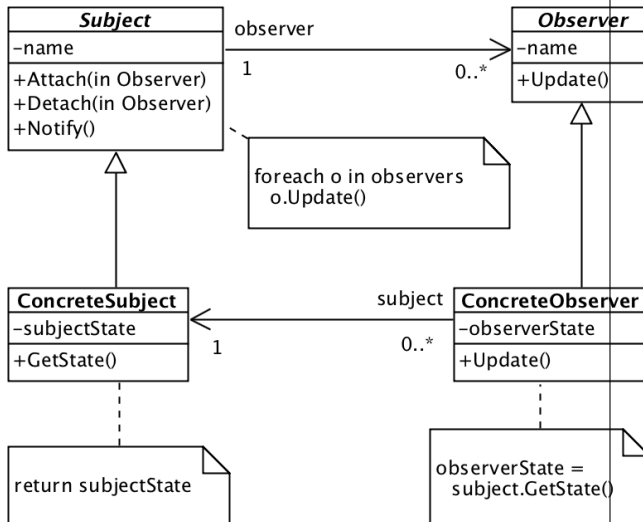
Which one of the following statements is in correspondence with the model?

A An instance of the ConcreteObserver class might have a reference to zero or more instances of the ConcreteSubject class.

*B An instance of the ConcreteSubject class might have a reference to zero or more objects of the Observer type.

C Each instance of the Subject class has a reference to exactly one instance of the Observer class.

D An instance of the ConcreteSubject class cannot have any reference to an instance of any other class.

E Each instance of the Observer class has a reference to exactly one instance of the Subject class.