

Číslo zadání	Předmět / Odpovědník	Jméno a příjmení / učo
1	FI - Přijímací zkouška: Test z informatiky (zahájení v 15:00)	

The computer science test consists of 30 questions, where you choose one of the possible answers. Each question has just one correct answer. Each correctly answered question is valued by 1 point, an incorrectly answered question is valued -0.25. You get 0 points for no answer. Once you have submitted the test (by clicking the Submit button) and confirmed your submission, you will not be able to return to the test.

Algorithms and data structures

1. Consider the following sequences of expressions, where each expression denotes a function of one natural argument n .

Choose the sequence that correctly orders the functions by their asymptotic growth from the slowest growing to the fastest growing:

- *Ⓐ $42n + 3, \log n^n, n(n + 1)$
- Ⓑ $n(n + 1), 42n + 3, n(n + 1)$
- Ⓒ $\log n^n, n(n + 1), 42n + 3$
- Ⓓ $42n + 3, n(n + 1), \log n^n$
- Ⓔ $\log n^n, 42n + 3, n(n + 1)$

2. Consider the following algorithm, where input reads a user input into its argument:

```
input a
x = a; y = 0
while x > y
    x = x - 1
    y = y + 1
end while
```

The postcondition (output condition) of this algorithm is $2y = a$.

Choose the precondition (input condition) that makes this algorithm totally correct:

- Ⓐ $x > y$
- Ⓑ $a > y$
- *Ⓒ $a > 0$ and a is even
- Ⓓ a is even
- Ⓔ $a \geq 0$

3. Which statement about the single-source shortest-path (SSSP) graph problem is true?

Notation: V is the number of vertices, and E is the number of edges of the graph.

- Ⓐ If the graph contains negative-weight edges, we can use Dijkstra's algorithm to solve the SSSP problem in $\mathcal{O}(E \log V)$ time.
- *Ⓑ If the graph is acyclic, we can solve the SSSP problem in linear time, i.e., in $\mathcal{O}(V + E)$.
- Ⓒ If all the edges have the same positive weight, we can use the depth-first search (DFS) algorithm to solve the SSSP problem.
- Ⓓ If the graph contains negative-weight edges, we can use Bellman-Ford's algorithm to solve the SSSP problem in $\mathcal{O}(E + V \log V)$ time.
- Ⓔ If all the edges have positive weight, there is an algorithm that solves the SSSP problem in $\mathcal{O}(V \log V)$ time.

4. Consider a red-black tree with unique keys. The tree is initially empty. We insert the following keys in the given order: 2, 8, 12, 1, 5, 7, 9, 11.

How many *red* nodes does the resulting tree have?

- *Ⓐ 4
- Ⓑ 0
- Ⓒ 3
- Ⓓ 2
- Ⓔ 1

5. We have a binary search tree organizing all integer keys in the interval [0;9]. Its **preorder** traversal is 2, 1, 0, 7, 5, 3, 4, 6, 9, 8.

Which keys are stored in the tree's leaves?

- (A) 0, 4, 6, 9
 - (B) 0, 3, 6, 8
 - (C) 0, 3, 6, 9
 - * (D) 0, 4, 6, 8
 - (E) 4, 6, 9, 8
-

Programming

6. On common platforms, every running program has two kinds of memory available, called the **stack** and the **heap**. Which of the following three statements I, II, and III are generally true?

- I. The stack is used to implement function calls.
- II. Local variables are usually allocated on the heap.
- III. Global variables are usually allocated on the heap.

Choose the option that contains all the true statements and none of the false ones.

- * (A) I
 - (B) I, II
 - (C) I, III
 - (D) II, III
 - (E) II
-

7. 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)
        foo(n-2)
        print n
    end if
end

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

What is going to be printed by the program?

- * (A) 1213124
 - (B) 1231412
 - (C) 4321121
 - (D) 2141321
 - (E) None of the other answers is correct.
-

8. Which of the following statements is **false**?
- (A) The lazy evaluation strategy in functional programming allows working with infinite lists (also known as streams).
 - * (B) "Call by name" and "call by reference" are two names for the same function evaluation strategy.
 - (C) Any recursive function can always be equivalently rewritten in an iterative manner.
 - (D) Any primitive recursive function can always be equivalently rewritten in an iterative manner.
 - (E) Any tail-recursive function can always be equivalently rewritten in an iterative manner.
-

9. Which statement is generally **true** in common OOP languages such as C++, Java, C#?
- (A) If a method of a class is declared public, the method is called using early binding.
 - (B) If a method of a class is declared virtual, the method cannot be overridden in the derived classes.
 - (C) If a method of a class is declared static, the method is called using late binding.
 - * (D) If using late binding, the actual method to be called is decided at runtime.
 - (E) If class B inherits from class A (via public inheritance), every instance of A is considered to also be an instance of B.
-

10. Let us consider the following function:

```
function fun(unsigned integer n)
begin
    result = 0
    while n != 0
        digit = XXX
        result = result + digit
        n = YYY
    end while
    return result
end
```

We want the function to compute the sum of the values of all the digits in base-seven representation of n .

Assume that `div` is the integer division operator and `mod` is the modulo operator. What should we write instead of `XXX` and `YYY`?

- (A) $XXX = n \bmod 10$; $YYY = n \operatorname{div} 10$
- (B) $XXX = \operatorname{digit} + 1$; $YYY = n - 7$
- (C) $XXX = n \bmod 10$; $YYY = n \operatorname{div} 7$
- * (D) $XXX = n \bmod 7$; $YYY = n \operatorname{div} 7$
- (E) $XXX = n \bmod 7$; $YYY = n \operatorname{div} 10$

Computer Networks

11. What are the advantages of networks with cycles, and how is the packet looping eliminated?

- (A) No advantages. Network topology must be hierarchical. When a looping packet is detected by TTL (hop count), the link causing the route cycle is dropped.
- (B) Robustness. The Backward Learning Algorithm prevents packet looping and ensures the shortest packet delivery in all situations.
- (C) Robustness. Hierarchical Routing defines a tree of routers that eliminates cycles in routing. When a link is down, a backup tree is used.
- * (D) Robustness. The Distributed Spanning Tree Algorithm prevents the creation of cycles, or the parameter TTL limits the number of hops of a packet.
- (E) Robustness is negligible due to large routing tables. When a routing cycle is detected, the corresponding interval in the routing table is split.

12. Which listed IPv6 address is not abbreviated correctly?

- (A) `dead::beef`
- (B) `ffff::`
- (C) `::`
- * (D) `0::0:0:0:0::0`
- (E) `::1`

13. Computer networks interoperate due to extensive standardization. Which claim is correct?

- (A) Carrier-grade NAT maps IPv4 address space to IPv6 address range.
- (B) NAT64 extends time sync protocol (NTP protocol) with fields that represent the time after the year 2038 (to handle the 32-bit UNIX timestamp overflow).
- * (C) DHCPv6 does not utilize broadcast, unlike IPv4 DHCP.
- (D) IP address allocations in Czechia are managed by NIX.CZ, which is a branch of the European RIPE (RIPE NCC).
- (E) A server that only implements the later IMAP protocol can also serve a client that only implements the older POP3 protocol, as IMAP is a superset of POP3.

14. TLS is a key component of contemporary network security. However, it is not represented as an explicit ISO/OSI layer. Which answer would position TLS correctly, if it were part of ISO/OSI?

- (A) The concept of TLS is far too different, so it would span over multiple layers.
 - (B) Layers: Physical, TLS, Data Link, Network, Transport, Session, Presentation, Application
 - * (C) Layers: Physical, Data Link, Network, Transport, TLS, Session, Presentation, Application
 - (D) Layers: Physical, Data Link, Network, Transport, Session, Presentation, Application, TLS
 - (E) Layers: Physical, Data Link, TLS, Network, Transport, Session, Presentation, Application
-

15. Assume HTTPS-based network traffic, which network type and topology is the most prone to unobserved eavesdropping?
- (A) All options are equally prone to eavesdropping
 - (B) UTP as 1000Base-T, ring topology
 - (C) Fiber link as 10000Base-F (point-to-point topology)
 - (D) UTP as 1000Base-T, star topology
 - * (E) WiFi as 802.11ac, no WPA (all versions)
-

Computer systems

16. Which item is **not** stored in the thread control block (TCB)?
- (A) Register values
 - (B) Pointer to process control block (PCB)
 - (C) Program counter
 - * (D) Process page table
 - (E) Stack pointer
-

17. Which logic circuit can select among several input signals and forward the selected input to a single output line?
- (A) Decoder
 - * (B) Multiplexer
 - (C) Demultiplexer
 - (D) Comparator
 - (E) Coder
-

18. The processor is 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 **7** units of CPU,
 - the process **P2** requirement is arriving at time **2** and the process needs **4** units of CPU,
 - the process **P3** requirement is arriving at time **4** and the process needs **1** unit of CPU,
 - the process **P4** requirement is arriving at time **5** and the process needs **4** units of CPU.

What is the average waiting time for all four processes?

- * (A) 3
 - (B) 5
 - (C) 2
 - (D) 6
 - (E) 12
-

19. Which statement is correct?
- (A) Program instructions are always executed by the processor in the same order in which they are written.
 - * (B) The processor uses the stack to store return addresses when subprograms are called (e.g., by the CALL instruction of x86 processors).
 - (C) The Least Recently Used (LRU) algorithm selects the block that was last used for eviction from memory.
 - (D) The problem of little and big-endian does not need to be solved with 64-bit processors.
 - (E) Access to virtual memory is restricted to virtual processors exclusively.
-

20. A signed integer data type whose values are represented in two's complement code and stored on 8 bits in the operating memory has the range:
- (A) -128 to 128
 - (B) -127 to 127
 - (C) -127 to 128
 - (D) -255 to 256
 - * (E) -128 to 127
-

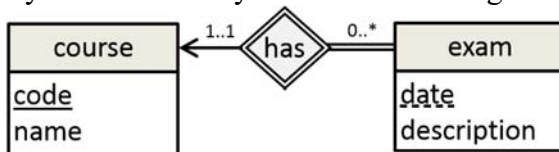
Database systems

- 21.** Consider a database with the following three relations that are all not empty:
 employee(emp_id, name, salary),
 project(proj_id, name), and
 works_on(emp_id, proj_id, start_date).
 The attributes emp_id and proj_id in works_on are foreign keys that reference employee and project, respectively.

Choose the SQL query that returns a list of all employee names with the number of projects they work on (including those employees that work on zero projects):

- ***(A)** SELECT name, COUNT(proj_id) FROM employee NATURAL FULL JOIN works_on GROUP BY emp_id, name;
- (B)** SELECT name, COUNT(proj_id) FROM works_on GROUP BY emp_id, name;
- (C)** SELECT name, COUNT(*) FROM employee NATURAL JOIN works_on GROUP BY emp_id, name;
- (D)** SELECT name, COUNT(proj_id) FROM employee RIGHT JOIN works_on USING (emp_id) GROUP BY emp_id, name;
- (E)** SELECT name, COUNT(*) FROM employee NATURAL LEFT JOIN works_on GROUP BY emp_id, name;

- 22.** Transform the following E-R diagram to the relational model. Note that primary keys are denoted by solid underlining, and partial keys are denoted by dashed underlining.



Choose the answer that specifies the exact relations that the resulting relational model should have:

- (A)** course(code, name), exam(date, description)
- (B)** course(code, name), exam(date, description), has(code, date)
- (C)** course(code, name), exam(date, description), has(code, date)
- ***(D)** course(code, name), exam(code, date, description)
- (E)** course(code, name), exam(date, description), has(code, date)

- 23.** Consider the relations:
 customer(custid, name, city, regdate)
 and
 account(custid, number, value).
 There is the following integrity constraint defined in the relation account:
 FOREIGN KEY (custid) REFERENCES customer.

Choose the option that contains only the true statements:

- (A)** The relation customer cannot be empty.
- (B)** If the relation customer is not empty, the relation account cannot be empty.
- ***(C)** If the relation account is not empty, the relation customer cannot be empty.
- (D)** The relation account cannot be empty.
- (E)** The relations account and customer must have exactly the same number of tuples.

- 24.** Let us have a relation $r(A, B, C, D, E, F, G, H)$ that is already in the first normal form (1NF), and the following set of functional dependencies:

$A, B \rightarrow C, D, E$
 $A \rightarrow G, H$
 $E \rightarrow F$

Choose the decomposition of the relation r that is lossless, preserves the functional dependencies, and satisfies the Boyce-Codd normal form (BCNF):

- (A)** $r_1(A, B, C)$, $r_2(A, B, D)$, $r_3(A, G)$, $r_4(A, H)$, $r_5(E, F)$
- (B)** $r_1(A, B)$, $r_2(C, D, E)$, $r_3(F, G, H)$
- (C)** $r_1(A, B, C, D, E)$, $r_2(A, E, F)$, $r_3(A, G, H)$
- ***(D)** $r_1(A, G)$, $r_2(E, F)$, $r_3(A, H)$, $r_4(A, B, C, D)$, $r_5(A, B, E)$
- (E)** $r_1(A, G)$, $r_2(A, H)$, $r_3(A, B, C, D)$, $r_4(E, F)$

25. Consider the relations:
 customer(custid, name, city, regdate)
 and
 account(custid, number, value).

For the following relational algebra expression, choose the SQL command that returns an equivalent answer:

$\rho_{city} \left(\text{COUNT}(\text{custid})(\text{customer} \bowtie \sigma_{\text{number}=2}(\text{account})) \right)$

- ***(A)** SELECT city, COUNT(*) FROM customer, account WHERE number = 2 AND customer.custid = account.custid GROUP BY city;
- (B)** SELECT city, COUNT(*) FROM customer, (SELECT custid FROM account WHERE number = 2) AS acct GROUP BY city;
- (C)** SELECT city, COUNT(custid) FROM customer JOIN account ON number = 2 GROUP BY city;
- (D)** SELECT city, COUNT(*) FROM customer NATURAL JOIN account GROUP BY city HAVING number = 2;
- (E)** SELECT city, COUNT(custid) FROM customer NATURAL JOIN account GROUP BY city;

Software engineering

26. Consider the phases of **Software Requirements Validation and Verification** for a given software system. Given the following statements:

I. **Validation** means checking that the defined specifications are according to the customers' needs; **verification** is about checking that the software system meets the specifications.

II. **Verification** means checking that the defined specifications are according to the customers' needs; **validation** is about checking that the software system meets the specifications.

III. Formal methods can be used for requirements **verification** and prototyping techniques can be used to **validate** the software requirements with the customer.

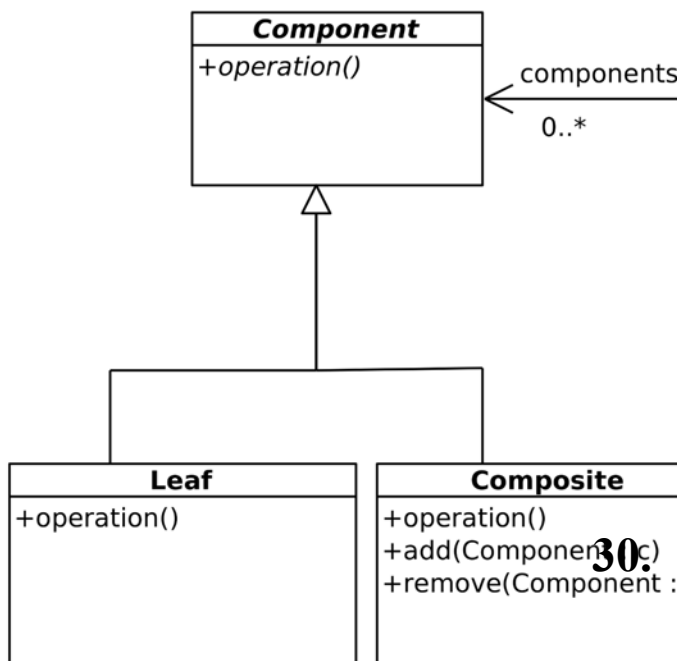
IV. **Verification** focuses on non-functional requirements, while **validation** focuses on functional requirements.

V. **Verification** focuses on functional requirements, while **validation** focuses on non-functional requirements.

Which option contains all true statements and no false ones?

- (A)** Only II, III.
 - (B)** Only I, V.
 - (C)** Only II, III, IV.
 - ***(D)** Only I, III.
 - (E)** Only I, III, V.
-

27. Based on the UML notation representing the **Composite Design Pattern** diagram in the figure, consider the following statements:
- I. Component(s) associated with the Composite **cannot** exist independently from the Composite.
 - II. Component(s) associated with the Composite **can** exist independently from the Composite.
 - III. operation() in the Composite class uses polymorphism to invoke operation() for all the different types of components.
 - IV. Leaf and Composite classes inherit from the abstract Component class.
 - V. Leaf and Composite classes have an association with the Component class.



Which option contains all true statements and no false ones?

- (A) Only I, IV.
- (B) Only I, III, V
- (C) Only II, IV.
- *(D) Only I, III, IV.
- (E) Only II, III, IV.

28. The goal of the Software Requirements Elicitation phase is to:
- *(A) Gather and understand the user and main stakeholders' needs.
 - (B) Perform the software system's testing based on the needs of the customer.
 - (C) Define the planning aspects of the project, such as a cost/benefit analysis.
 - (D) Define the software architecture of the planned software system.
 - (E) Translate the acquired requirements specifications into implementation details.

29. What is the main responsibility of a SCRUM Master in the context of the SCRUM agile methodology?
- (A) Writing code and developing software features within the main development team.
 - (B) Providing technical support to developers newly introduced to the project.
 - (C) Managing project timelines, budgets, and cost/benefit analysis, keeping contact with the customers.
 - (D) Making all the decisions related to product features and priorities, informing afterward the development team.
 - *(E) Facilitating the whole team by removing impediments and ensuring the SCRUM process is followed.

30. What is the main characteristic of a message-driven architectural (MDA) style?
- (A) MDA relies on a centralized server to handle all communication between components.
 - (B) MDA requires components to send messages using the HTTP protocol.
 - (C) MDA is based on tightly coupled (*point-to-point*) interactions between components.
 - *(D) MDA decouples components by allowing them to communicate through asynchronous messages.
 - (E) MDA emphasizes synchronous communication between components.