Thematic areas for the Bachelor state exam (Computer Science and Technology)

A. Subject Information and Communication Technology

1. **Logical Circuits**
    a) Boolean algebra, Boolean functions and combination circuits.
    b) Integer representation and corresponding arithmetic (binary complement, offset binary code, BCD code).
    c) Fixed-point number representation, fixed-point arithmetic.
    d) Floating-point representation (IEEE 754-2008, binary and decimal basis), floating-point arithmetic.
    e) Character encoding, ASCII, Unicode.
    f) Finite-state automaton (finite state machine), Moore and Mealy automaton.
2. **Telecommunication networks**
    a) LAN and WAN networks (Ethernet, ATM, Frame Relay).
    b) Transport networks (SDH, DWDM, MPLS).
    c) Internet, Secure Transport Services (VPN, IPsec, SSL).
    d) Signalling in telecommunications networks.
    e) Access networks (xDSL, DOCSIS, FTTx).
    f) Wireless access networks (WiFi, WIMAX, Bluetooth, Zigbee).
    g) Mobile radio networks (1st to 4th generation).
3. **Introduction to Theoretical Computer Science**
    a) Sets, relations, functions.
    b) Propositional logic, first-order predicate logic.
    c) Regular languages, finite automata.
    d) Algorithms and algorithmic problems, models of computation.
    e) Algorithmically undecidable problems.
    f) Computational complexity of algorithms, asymptotic notation.
4. **Computer Architectures, Computer Networks**
    a) TCP/IP protocol family and its mapping on ISO-OSI reference model. Network Address Translation, IPv6 – specifics of the new protocol version.
    b) Active computer network devices, their use and functions: hub, switch, router.
    c) Layer 7 services and protocols on Internet: E-mail (SMTP, POP, IMAP), HTTP protocol & WWW, SSH vs. Telnet. DNS - domain name system.
    d) Security in TCP/IP-based computer networks: possible attacks, packet filters, stateful firewall. Encryption and authentication, virtual private networks.
    e) Computer architectures, their features, computer operation principles. Hierarchical organization of computer memory, basic characteristics of common memory types.
    f) Basic construction features of RISC processors (CPUs), CPU acceleration techniques, branch prediction. Basic characteristics and operation principles of Intel processor family (starting with Pentium Pro).

5. **Programming**
    a) Principles of object oriented programming (OOP) – class, object, encapsulation, inheritance, and polymorphism.
    b) Array based search algorithm – linear (sequential) search algorithm, binary search, informal explanation of their complexities.
    c) Sorting algorithms – classification, description of functionality, informal explanation of complexity of selected algorithm.
    d) Data structures – array, list, queue, stack, tree, graph**.**
6. **Mathematics**
    a) Solving systems of linear equations.
    b) Vector space.
    c) Linear mapping.
    d) Derivation of a real function.
    e) Definite and indefinite integral.
    f) Combinatorial selections.
    g) Graphs and their use (Graph Theory).

B. Subject Computer Science and Technology

1. **Introduction to Theoretical Computer Science**
    a) Interpretations and models in first-order predicate logic. Resolution logic.
    b) Nondeterministic finite automata, the closure properties of the class of regular languages with respect to different operations on languages.
    c) Regular expressions and their relation to finite automata.
    d) Context-free languages and grammars.
    e) Computational complexity of problems, complexity classes.
2. **Computer Architectures, Computer Networks**
    a) IEEE 802 standards. Ethernet. IEEE 802.11 wireless networks.
    b) Routing in computer networks. Routing protocols.
    c) Topologies of computer networks, transmission media, deterministic and non-deterministic media access protocols.
    d) Microcomputers, basic construction features. Common integrated peripherals and their characteristics.
    e) External computer memories: hard drives and optical media. Displays: CRT, LCD, OLED, E-ink.
    f) Parallel graphical processor architectures (e.g. CUDA, OpenCL, etc.).
3. **Programming**
    a) Recursion – examples of recursive algorithms, complexity of recursive algorithms, elimination of recursion.
    b) Tree data structures – binary tree, B-tree, description of related algorithms, explanation of complexity of selected algorithm.
    c) Implementation of OOP in programming languages – description and comparison.
    d) Java technology, .NET technology.
    e) Scripting languages.

4. **Introduction to software engineering**
    a) Software process. Definition of software process, software process models, software process maturity.
    b) Requirements engineering discipline. UML diagrams used in RE phase.
    c) Definition of a discipline “Design”. UML diagrams used in this discipline. Design pattern – classification, description and examples.
    d) Object oriented paradigm. Concept class, object, interface. Basic features of object and relation with class. Basic relations among classes and interfaces. Class vs. instance features.
    e) Mapping of UML diagrams to source code.
    f) Memory management (in languages C/C++, Java, C#, Python), virtual machine.
    g) Support for parallel execution, threads.
    h) Error handling in modern programing languages.
    i) Principles of data streams – for input/output operation. Differences between character and byte oriented data streams.
    j) Unified modelling language (UML) – types of diagrams and its usage during software development cycle.
    k) Structure and usage of compiler. Description of source code and result program. How do an interpreter and compiler work.
5. **Data Processing Theory, Database and Information Systems, Information Systems Development**
    a) Database systems modelling, conceptual modelling, data analysis, functional analysis.
    b) Relational data model; function dependencies, decomposition and normal forms.
    c) Query languages, relational algebra, SQL; DML, DDL.
    d) Transactions, recovery, log file, ACID, COMMIT and ROLLBACK operations.
    e) Procedural extensions of SQL: PL/SQL, triggers, cursors, bind variables, bulk operations.
    f) Physical database design; the heap table, indices (B-tree), table data clustering.
    g) Query evaluation in database systems; query execution plan.
    h) Object-relational data model.
    i) Data layer of information systems; API, frameworks and implementations; transactions in programming languages, security, object-relational mapping.
    j) Concurrency in database systems, anomalies of concurrency, techniques and implementations; serial and serializable plans, isolation levels of transactions in SQL.
    k) Architecture and structure of information system. Rules and principles. Components, connectors, configurations. Decomposition. The relationship of architecture, design and implementation of information systems.
    l) Three competencies of information system and three-tier architecture. The logical and physical architecture of information systems. Patterns for enterprise architecture. Patterns of domain logic, data access, object-relational behavior. Principles of object-relational mapping and mapping of inheritance.

m) Systems development life cycle, Zachman Framework. Tasks, roles, issues. Principles of information system development. Principles and phases of Unified Process. Robust and agile approaches to the information system development.

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