TECHNICAL UNIVERSITY OF VARNA

FACULTY OF COMPUTER SCIENCES AND AUTOMATION

Approved by:

Rector: .....
(Prof. Dragomir Pl. Dimitrov, PhD)

S Y L L A B U S

FOR THE STATE EXAMINATION OF THE SPECIALTY „SOFTWARE AND INTERNET TECHNOLOGIES" EDUCATIONAL AND QUALIFICATION DEGREE "BACHELOR"

Topic 1. Combinatorics, Probability and Mathematical Statistics. Combinatorial arrangements with and without repetition – combinations, variations and permutations. Multiplication of permutations, inverse permutation, representation of a permutation as a product of disjoint cycles (symmetric group). Probability of the sum and product of random events. Formula of total probability and Bayes' formula. Discrete random variables – distribution functions. [1÷2]

Topic 2. Logic functions (LF). Presentation. Minimization of LF with Karnaugh maps. Synthesis of combinational logic circuits in various functionally complete bases. Functional logic nodes without memory - encoders, decoders, multiplexers, demultiplexers, adders, comparators. [3÷4]

Topic 3. Finite state machines. Abstract models. Presentation. Elementary finite state machines (flip-flops). Structural finite state machines. Synthesis of structural finite state machines. Synthesis of microprogrammed finite state machines with hardware-based logic. Functional logic nodes with memory - counters and registers [3÷4]

Topic 4. Functional structure of control systems. Static characteristics and dynamic responses of elements and systems. General form of linear differential equations. The Laplace transform. Transfer function and block diagram. [5÷9]

Topic 5. Stability. Conditions for stability of linear system. Concept of stability. Necessary condition for stability. Algebraic and frequency domain criteria for checking stability of closed-loop systems. [5÷9]

Topic 6. Control statements in the C/C++ programming language. Logical expressions, operators, and comparison operations. Control flow operators. Operators if and switch. Types of loops. Loop operators: for, while, do...while. Operators for forced exit from a loop. [10÷13]

Topic 7. Concept of a function. Global and local variables. Variables scope. Ways to pass parameters and return values. Arrays. Numeric arrays. Initial initialization. Index arithmetic. Multidimensional arrays. [10÷13]

Topic 8. Algorithm complexity and performance evaluation. Algorithmic strategies and methods in programming. Recursion: mechanism, recursive functions, parameters, recursion and iteration. Structured programming. Divide-and-conquer strategy, goal decomposition (subgoals), backtracking, and branch-and-bound methods. Use of heuristics. Greedy algorithms. Stages in the development of algorithms and programs. [13÷27]

Topic 9. Data structures. Linear dynamic data structures – stacks, queues, deques, and linked lists (singly linked lists, doubly linked lists, and circular linked lists). Definitions, basic operations, and algorithms for working with these structures. Non-linear dynamic data structures – tree structures, mathematical properties, basic operations, and types: binary trees, binary search trees (BST), AVL trees, and B-trees. Graph structures – definitions and axioms. Basic operations. Methods for graph representation in memory. Graph traversal algorithms (BFS and DFS). Shortest-path algorithms in graphs – Dijkstra, Floyd, and Ford-Bellman algorithms. [13÷27]

Topic 10. Objects and classes. Java class Object. Object state and behavior. Constructors. Access methods. Encapsulation. Inheritance. Polymorphism. Abstract and concrete classes. Interfaces. Exceptions. [28÷39]

Topic 11. Object containers. Collections, iterators and algorithms. Parameterized types and collections. Interface, abstract classes and concrete container class's structure organization hierarchy. Collection types – List, Set, Map and their derivatives. Fundamental principles of data organization. Methods and algorithms for data processing. [28÷39]

Topic 12. Fundamental object-oriented design principles (SOLID). Introduction to design patterns. Problems solved by design patterns. Types of design patterns. Creational patterns. Singleton. Builder. Abstract Factory. [40÷42]

Topic 13. Structural patterns. Adapter. Bridge. Decorator. Facade. Behavioural patterns. Observer. Chain of Responsibility. Command. [40÷42]

Topic 14. Software development life cycle (SDLC). Classification of software life-cycle models and their major representatives. Modern software engineering technologies for rapid development, reuse-oriented development, and reliable software development. [43÷46]

Topic 15. Software configuration, verification, and testing. Fundamental axioms and methods of software testing. [43÷46]

Topic 16. Language processor. Compilers and Interpreters. Main concepts. Main stages of the translation process and relations between the stages. Formal definition of the programming languages. Grammars. Chomsky classification of formal grammars. Regular expressions and finite automata. Lexical analysis. Algorithm of the lexical analysis. Symbol tables. Searching in symbol tables. Top-down syntax analysis. Recursive descent. LL(1) grammars – requirements. Removing left recursion. Transformation Backus Naur form -> syntax graph -> parsing program. Table-driven top-down syntax analysis. Advantages and disadvantages of LL(1) based syntax analysis. [47÷53]

Topic 17. Bottom-up syntax analysis. LR grammars. Semantic analysis. Organization of tables. Presentation of block structures of the program in the analysis phase. Run-time memory organization. Allocation of memory for simple data types and arrays. Code generation. Tasks and requirements of

the code generation. Generation of reverse polish notation code. Generation of code for tetrads. Generation of tetrads for basic program structures, if statement, loop statements. Examples. [47÷53]

Topic 18. Data representation in digital processors. Forms and formats for representing numerical data. Machine codes of numbers. Ranges of representable numbers. Basic principles and primary organization of the functioning of the digital processor. Methods for addressing instructions and operands. Stages of execution of the machine instruction. Interrupt system - general provisions, types of interrupts and service conditions. Input-output system. Organization of input-output exchange. Storage devices (SD). Logical structure of addressable SDs. Logical structure of SDs with sequential and associative access. Hierarchical structure of the computer storage system. [54÷63]

Topic 19. Architectural features of modern computers. Performance. Efficiency. CISC/RISC. Flynn's taxonomy. Amdahl's law. Supercomputers. SMP/MPP/NUMA. Networks. Clusters. Command pipeline. Inter-command dependencies and transitions and ways to reduce their impact. [54÷63]

Topic 20. Processes. Representation of a process in the OS. Process state graph. Data structures for process management. Process context. Process context switching. Basic operations on processes. Dispatcher. Threads. Implementation of threads (user-level and kernel-level). Multithreaded program models. Access to shared resources. Critical section. Critical section requirements. Synchronization through locks (mutex locks, hardware instructions). Semaphores. Basic operations on semaphores. Solution of the "Producer-Consumer" problem. Monitors. A graph of the states of the processes in the monitor. Process planning. Types of planning. Process scheduler. Process planning algorithms. [104÷108]

Topic 21. Memory management. Logical and physical addresses. Continuous organization of the operating memory. Fixed and dynamic partitions. External and internal fragmentation. Page organization of the operating memory. Segment organization of the operating system. Segment-page organization of the operating system. Virtual memory. Process swapping. Page fault. Page swapping. File system. File attributes. File operations. File structure. File access methods (sequential, direct, index). Disk structure. Directory organization – single-level, two-level, tree-like, acyclic graph. Names in the file system. File access control in Linux and Windows. Disk space usage – continuous, linked, indexed, multi-level index. Disk space management. [104÷108]

Topic 22. Programmatic creation and termination of processes. Retrieving a process termination status value. Replacing the program of a process. Passing command-line arguments and environment variables to a new process program. Signals to processes. Setting a signal disposition. Signal handling. Process termination: normal termination or termination due to an unhandled signal. Signal sets. Process signal mask. [64÷66]

Topic 23. Interprocess Communication and Synchronization. Named pipes (FIFOs). Unnamed pipes. File descriptor duplication. Redirecting standard input and output from and to an unnamed pipe. System V interprocess communication (IPC) mechanisms. Message queues. Shared memory. Semaphores. [64÷66]

Topic 24. Uniform and non-uniform coding of information sources. Data compression. Shannon-Fano and Huffman coding. Data link layer. Error detection and correction codes. CRC coders/decoders. Examples of application in computer networks. [109÷119]

Topic 25. Network layer. IP addressing: IPv4 and IPv6 protocols. Special IP addresses. ARP protocol. Network segmentation. Subnetting. Private and public addresses. Special addresses. Subnetting with fixed (FLSM) and variable length mask (VLSM) addressing. Routing algorithms. Static and dynamic

routing. Direct and indirect routing. Link state and distance vector protocols (OSPF and RIP). NAT and PAT technologies. [109÷119]

Topic 26. Logical configuration of computer networks. Directory services. Active directory concept. Authentication, Authorization and Auditing technologies. Access control to resources and services. Identity and Access Management. Access control rights, permissions, and group policies in Microsoft Directory. Data Sharing. SMB Protocol. [109÷119]

Topic 27. Network security. Attacks on the OS and the network layer. Intrusion detection and prevention systems. Firewalls. Systems and tools for managing network access control and traffic. [109÷119]

Topic 28. Network Operating Systems. Roles and Features. Domain Name System (DNS). Types of records. Configure zones. Types of servers. Autonomous systems. Routing between autonomous systems. BGP. -mail systems. POP3, IMAP, and SMTP protocols. [109÷119]

Topic 29. Virtual Private Networks (VPNs). Concept and architecture. PPTP, L2TP, IPsec protocols. SSL VPN. Remote access to resources and services. Concepts and architectures. SSH protocol. Remote Desktop Services architecture. RDP protocol. Load balancing of traffic and services utilization. Concept and architecture. [109÷119]

Topic 30. Databases. Levels of abstraction in databases. Database architectures. Client-server architecture. Conceptual schemas and data models. Entity-Relationship (E-R) data model. Stages of database design. Oracle Data Modeler. Relational data model. Tables. Keys. Relationships. Normal forms and normalization. Constraints. Physical data model. Indexes. Database management systems. Administration. Oracle DBMS. [67÷96]

Topic 31. SQL. DDL. Creating tables (CREATE TABLE). Modifying existing tables (ALTER TABLE) – adding a column, modifying a column, deleting a column, adding foreign keys. Deleting a table (DROP TABLE). DML. Entering data – INSERT. Deleting data – DELETE. Updating data – UPDATE. Retrieving data through queries – SELECT. Joins – types of joins. Single-row functions. Grouping and ordering data. Aggregate functions. Nested queries. Regular expressions. DCL. Users, objects, and roles. TCL. Transactions. COMMIT and ROLLBACK statements. Sequences – SEQUENCE. Views – VIEW. [67÷96]

Topic 32. Database Programming. PL/SQL. Data types. Structures. Conditional statements – IF statement, CASE statement. Loop statements – LOOP, WHILE, FOR. Modules. Exceptions. Functions. Procedures. Packages. Cursors – types of cursors and cursor operations. Triggers – types of triggers and trigger operations. [67÷96]

Topic 33. Database Systems. OLAP, Data Mining, Data Warehousing, Big Data, XML-DB, NoSQL, NewSQL, OODB, ORM, Cloud DB, Distributed DB, Blockchain, CRM, ERP. [67÷96]

Topic 34. Basic elements of PHP – language syntax, constants, variables, expressions, operators, control structures, declaration and use of functions and arrays in PHP. Mechanism for receiving data from HTML forms and processing it using PHP. Implementation of object-oriented programming in PHP: specifics of class declaration and inheritance in PHP, abstract methods and interfaces. [81÷96]

Topic 35. PHP and MySQL – creating a connection to a MySQL database server. Interaction between PHP and MySQL through php_mysqli.dll: functions for establishing and closing a connection to a MySQL database server; creating, selecting, and deleting a database; retrieving a list of table fields and displaying them; database backup; executing transactions in a MySQL database. [81÷96]

Topic 36. Creation of WIN32 application – program structure and message handling process. Work with timers, graphic context of devices (GDI), sending messages and files. [97÷98]

Topic 37. Creation of MFC application – program structure and handling message to windows and their elements. Creation and usage of dynamic libraries (DLL) in WINDOWS. [97÷98]

Topic 38. Android OS concepts. User interface (UI) organization. UI creation by XML and Java. Graphic interface creation via Kotlin. Jetpack compose. Basic components of Jetpack compose. [99÷103].

Topic 39. Android screen navigation. processes and threads. Parallel and asynchronous work. Background mode information processing. [99÷103]

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