Topics for the Final Exam

Computer Science BSc

Faculty of Sciences, University of Pécs

2023.

Informatics

1. Processors and memories
The von Neumann's principle, the von Neumann loop. von Neumann and Harvard architectures. CISC and RISC processors. Processor commands and processor registers (in case of Intel X86 as an example). Pipeline and superscalar architectures. Types and classification of memories (by physical construction, organization, type of access, speed, etc.)

2. Peripherals and storage, I/O
Classification of storage devices based on their construction, their operation principles, their key parameters, and their comparison. Classification of peripherals (based on functionality, means and direction of communication, etc.). Bus systems. Data, address and control bus. Basics of I/O handling, programmed, IRQ and DMA controlled I/O. Parallel and serial communication protocols (e.g. RS232, USB, Centronics EPP).

3. Operating systems
The concept of an operating system. Types of operating systems, their classification, their functionality. Process management, scheduling. Scheduling methods and procedures in interactive system. Requirements and aims of scheduling. Memory management, relocation, memory protection, swapping, paging.

4. Computer network architectures
Network layers, the OSI and the TCP/IP model. Role and basic operation principles of computer network hardware (network interfaces, repeaters, bridges, hubs, switches, routers, etc.). Operation and characteristics of Ethernet. The 802.11 standards. The Internet Protocol. IP addresses, NAT, CIDR, IPv6. Routing, routing tables. TCP and UDP. QoS parameters, tools and possibilities of maintaining quality of service. The structure and operation of DNS.

5. Network and data security
Data security, service security, physical security. Security risks of the Internet, attack types and methods of defense. Encrypted and unencrypted communication. Classic encryptions, symmetric and public-key cryptography. Key sharing, Diffie-Hellman key exchange. Encryptions and methods for breaking them (social engineering, brute-force attacks, analytical attacks). Firewalls, their types, operation, and functionality. Internal and external network, DMZ, Security of WLAN networks, techniques, risks.

6. Databases
Data models. Main elements of entity-relation models. Mathematical background of relational data models (the concept of a relation, operations with relations). Dependencies, dependency sets. Relational data modelling from entity-relation models. Normal forms (1-4, Boyce-Codd), database normalizations. Properties ant the syntax of the SQL language, DDL, DML, DCL.

7. Algorithms and data structures

The concept of algorithms, the description of an algorithm. Turing machines, the halting problem. Efficiency of algorithms, basics of complexity theory. Approaches to algorithm construction. Linear data structures (lists, collections, FIFO and LIFO stacks, binary heap) and their operations (sorting). Search in hash tables. Search based on binary trees. Search, insertion, deletion, balancing. Applications of B-trees in large databases.

8. Graphs and graph algorithms

The concept of a graph, its representations and visualization. Euler and Hamiltonian paths. Tree graphs. Fundamental graph algorithms. Depth-first and breadth-first search. Optimal spanning trees. Prim's Kruskal's algorithm. Shortest paths. Dijkstra and Bellman-Ford algorithms.

9. Imperative languages, object-oriented programming

Arithmetical and logical operations. Control structures (conditional and unconditional flow control, loops). Functions and procedures (subprograms, subroutines), data passing, local and global variables, the role of stacks in function calls. Basics of object-oriented programming: classes, objects, inheritance, polymorphism, encapsulation.

10. Compilers

Chomsky classification of formal languages, regular languages, their properties and relation to lexical analyzer programs. Finite automata. The structure of compilers, the process of compilation or interpretation, look-ahead. Context-free grammars, their properties and role in the theory of compilers. Methods of parsing (LL(k), LR(1), grammar, syntax trees, etc.) Implementation of symbol trees and operations on them.

11. System engineering and software development

Basics of UML. Meta-models. The 4-layer meta-model of UML. Basics of workflow modelling. The description of the steps of the classic and RUP methodologies with the Software Process Engineering Model (SPEM) UML profile. Programming and software engineering technologies and methodologies. Procedural techniques. The elements of the RUP methodology, phases and activities.

Mathematics

1. Set theory basics
Sets, operations on sets. Relations, functions. Injective, onto, and bijective functions. Equivalence relations. Ordering relations. Natural, integer, rational, real, and complex numbers: their properties, operations and ordering properties.

2. Logics
Propositional logics: propositions (statements), operations with propositions, formulas, formalization, disjunctive and conjunctive normal forms, inferences, inference rules. Predicate logic: predicates, quantifiers, formulae, formalization and interpretation, inferences in predicate logics.

3. Linear algebra
Real vector spaces, normed spaces. Vector operations. Inner (scalar) product. Linear independence, basis, dimension. Matrices and linear operators. Homogeneous and inhomogeneous linear systems of equations. The determinant and trace of matrices. Eigenvalues and eigenvectors, spectral decomposition of symmetric matrices.

4. Calculus
Convergence of sequences and series. Taylor-series. Limits and continuity of functions. Differential calculus of one- and multivariable functions. Finding function minima and maxima. Convexity of functions. Real integral calculus, definite and indefinite integrals.

5. Probability theory
Discrete and continuous random variables. Probability distributions and probability densities. Independence of random variables. Joint probabilities, marginal distributions, expectation value, variance, correlation. Laws of large numbers. Central limit theorem.

6. Number theory
Greatest common divisor. Euclidean division. Euclidean algorithm. Primes and non-factorizable numbers. Unique prime factorization. Systems of linear Diophantine equations, linear congruences. Euler's theorem, Chinese remainder theorem. Number theoretic functions. Multiplicativity. Sum and inverse functions.

7. Operation research
Linear programming and solution with simplex algorithm. Integer programming and mixed integer programming. Network Flow Algorithms, Optimization on Networks. Duality and Duality theorems (Weak Duality, Strong Duality and Complementary theorem).

8. Numerical methods for solving equations and equation systems:
Direct methods for solving Lienar Equation Systems (Gaussian elimination, solution with LU-decomposition, solution with QR-decomposition) Iterative methods for solving Linear Equation Systems (Fixed point theorem, conditions for the contraction property, classical iterations) Numerical methods of non-linear equations (bisection method, fixed point iteration, Newton-Raphson method).

9. Interpolation and quadratures
The basic problem of the interpolation. Methods of polinomial interpolation (Lagrange and Newton form of the interpolation polinomial) Least squares method (the basic problem and the LES for the solution) Interpolation type quadratures. Gauss-type and Chebishev-quadratures. Classical quadratures.