SCOPE OF QUESTIONS FOR THE FINAL EXAM - BSc. Eng.
CONTROL, ELECTRONIC AND INFORMATION ENGINEERING

I. COMMON COURSES FOR ALL SPECIALIZATIONS

Circuit Theory

1. Laws, theorems and principles of electricity. Equivalent passive/active one port. Maximum power transfer condition. Analysis of DC circuits. Superposition principle, nodal analysis method
2. AC circuits phasor analysis. Phasor diagram. Capacitor/Coil description in AC domain
3. Simple RC, RL filters (low pass and high pass configuration). Series and parallel resonances
4. Transient analysis. First order circuits step responses. Real/ideal integrator/differentiator. Capacitor/Coil description
5. Circuits with distributed parameters (transmission lines) – time domain analysis: reflection coefficients, characteristic impedance, forward and backward waveforms

Fundamentals of Computer Programming

1. The von Neumann architecture of computers
2. Variables and fundamental data types in C – size, range, precision
3. Arrays in C – defining, accessing using indexing and pointers
4. Statements and flow control in C, calling functions and passing arguments
5. Pointers and dynamic data structures

Computer Programming

1. Classes – idea, defining and using
2. Input and output operations in C and C++, operations on files
3. Calling functions, passing arguments as values and references in C and C++
4. Inheritance, modes of inheritance
5. The preprocessor, modules, separate compilation, Make files

Computer Programming 3

1. Class methods and operators, operator overloading in C++
2. Polymorphism and virtual methods, the RTTI mechanism, abstract class in C++
3. Multiple inheritance in C++, virtual inheritance
4. Exception mechanism in C++, smart pointers
5. Templates and generic programming in C++, concept of containers, iterators and algorithms in the STL library

Optimization and Decision Making

1. Types of optimization problems (static/dynamic, constrained/unconstrained)
2. Linear Programming Problem (problem statement, solutions, algorithms)
3. Quadratic Programming Problem (problem statement, solutions, algorithms)
4. Numerical optimization algorithms
5. Zero-sum games – pure and mixed strategies
6. Non-zero-sum games (Nash equilibrium, von Stackelberg equilibrium, minmax/maxmin strategy)

Probability and Statistics

1. Theory of probability and combinatorics
2. Discrete and continuous probability distributions
3. Statistics of locations, measures of dispersion, outlier detection
4. Confidence intervals and statistical testing
5. Data relationships and linear regression

Introduction to System Dynamics

1. Method of balances for mechanical systems
2. Method of balances for electrical circuits
3. Lagrange equations
4. Electromechanical analogies of type I
5. Electromechanical analogies of type II

Numerical Methods

1. Types of errors of numerical operations. Loss of significant digits
2. Exact and approximate methods for solving systems of linear equations
3. Interpolation methods. Spline and polynomial interpolation
4. Methods of function approximation. Approximation polynomials
5. Numerical differentiation and its truncation error

Digital Circuits

1. Implementation of logic components using CMOS technology
2. Dynamic requirements and properties of sequential circuits
3. Implementation of arithmetic operations. Methods of improving performance of arithmetic units
4. Memory block types and architecture, operation characteristics and basic applications
5. Interfacing input-output components (pushbuttons, keyboards, LED, line powered components)

Measurements Systems

1. Errors and uncertainty calculation
2. Analog to digital converters, Dual Slope ADC
3. Time, frequency and AC voltage measurements
4. Contact and non-contact temperature measurements
5. Properties and principles of operation of flowmeters

Theory of Computer Science

1. Turing machine - components, construction, programming
2. Cycle of the interrupt, use of the mask register
3. Assembly language, Assembling a program written in symbolic language. Generation of binary result code
4. Formal grammars
5. Features of a good algorithms, ways of comparing algorithms

Artificial Intelligence

1. Methods of knowledge representation
2. Fuzzy reasoning. Generalized modus ponens
3. Expert systems - features, examples of application
4. Artificial neural networks - types, examples of application in signal processing and data classification
5. Evolutionary algorithms –chromosome representation, variation operators, population management

Control Fundamentals

1. Controllability – definition, conditions. Observability – definition conditions. Stability, Hurwitz criterion
2. Closed-Loop system stability. Characteristic equation of the CL system. Applying of Hurwitz criterion. Nyquist criterion, derivation and calculation usage
3. Compensators and controllers. Lead, lag, lead-lag compensators. Recommendation for compensator choice
4. PID controller. Regulator implementations. Regulator parameters tuning. Ziegler-Nichols rules
5. Discrete-time systems. Z-transform. Sampling data system, ideal sampler, Digital control systems, zero order hold, first order hold. Discrete-time (DT) transfer function. Stability conditions

Computer Networks

1. Layered models of communication in computer networks
2. IP technology – addressing, datagram service, routing
3. Data communication in wired and wireless computer networks
4. Quality of services in computer networks – schemes, methods, components
5. Security of computer systems and networks – threats and attacks, firewall, network security models

Fundamentals of Signal Processing

1. Signal representation in the time and frequency domain
2. Sampling theorem
3. Amplidude and phase modulation
4. System function
5. FIR/IIR systems

Microprocessor Systems

1. From microprogramable circuit to microprocessor. Principles of microprocessor operation, architecture and classification
2. Multiprocessor systems - classification and performance. Problem of computation scheduling
3. Argument addressing techniques including dynamic readdressing and principles of virtual addressing
4. Multiprogram operation concepts and implementations. Principles of interrupting the program – interrupt system
5. Integer and floating-point numbers. Arithmetic operations implementation and exemplary numeric algorithms

Computer Graphics

1. Rendering pipeline (performed by the graphics card)
2. Affine transformations
3. Orientation representations (Euler angles, quaternions)
4. Lightning models (global and local illumination, Blinn-Phong model, Lambert model)
5. Parametric curves and surfaces

Embedded Systems

1. Processor architectures: RISC, CISC
2. Embedded systems architectures: Harvard, vonNeumann, mixed
3. Interrupt systems, handling interrupts
4. DMA – direct memory access
5. Synchronous and asynchronous communication protocols: UART, SPI, TWI

Databases

1. SQL language
2. Referential integrity in databases
3. Transactions in databases
4. Normalization of database schema
5. Access management and permissions in databases

Operating Systems

1. Operating systems - types, roles, functions, designs, communication models
2. Algorithms for process scheduling in operating systems
3. Process synchronization - deadlocks, semaphores, mutual exclusion problem
4. Page replacement algorithms - paging, swapping
5. Memory allocation for files in the disks

II. COMMON COURSE FOR SPECIALIZATION - AUTOMATIC CONTROL

Hierarchical Control

1. Types of control of large-scale systems; centralized control, decentralized control
2. Types of hierarchical structures; multi-layer structure, multi-level structure
3. Decomposition and coordination. Methods of coordination

Applied Digital Signal Processing

1. Digital filtering
2. Signal sampling and reconstruction
3. Correlation and spectral analysis
4. Digital conversion of sampling frequency
5. Sampled-data systems

III. COMMON COURSE FOR SPECIALIZATION - ELECTRONICS

Design for Manufacture

1. Describe the standard tools controlled with the output files of Computer Aided Manufacturing software for the Printed Circuit Board design. What are the most characteristic features of the software for controlling these tools (e.g. how is solved the lack of the decimal point in data)
2. Describe briefly the "core" equipment of an electronic assembly line for Printed Circuit Board with SMT (Surface Mount Technology) components
3. Present and describe the choice of soldering maschines depending on the SMT (Surface Mount Technology) or THT (Through-Hole Technology) technologies used in assembling of Printed Circuit Board
4. What are the most popular finishings of the Printed Circuit Boards predicted for assembling SMT (Surface Mount Technology) and THT (Through-Hole Technology) components
5. The basic methods of the heat dissipation in the electronic devices – from the lowest to the highest efficiency of the power dissipation

IV. COMMON COURSE FOR SPECIALIZATION – INFORMATICS

Algorithms and Data Structure

1. Computational complexity, complexity classes
2. Sorting, hashing, heapifying
3. Divide and conquer, dynamic programming paradigms
4. Exhaustive search and greedy algorithms
5. Graphs and graph algorithms

Software engineering

1. Unified Modeling Language (UML)
2. Software development methodologies
3. Software verification and validation
4. Risk management
5. Optimization of computer programs