SCOPE OF QUESTIONS FOR THE FINAL EXAM - BSc. Eng. AUTOMATION AND ELECTRONIC SYSTEMS (AES)

I. COMMON COURSES FOR ALL SPECIALIZATIONS

Theory of Logic Circuits

1. Fundamentals of Boolean algebra
2. Design of combinational circuits
3. Design of sequential circuits
4. Registers and counters

Computer Programming (Introduction to PBL)

1. Functions in C++ - defining, passing parameters by values, references, pointers
2. Input and output operations in C and C++; creating and reading files
3. Classes in C++ - defining, inheritance
4. Operator overloading in C++
5. Exception handling in C++

Optimization and Decision Making

1. Computational algorithms for static unconstrained optimization
2. Linear Programming problem – definition, solution properties and the simplex algorithm
3. Bellman's principle of optimality and the dynamic programming method
4. Application of game theory in decision making – types of problems, types of solutions

Probability and Statistics

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

Electronic Devices and Circuits

1. Key aspects of microelectronics: semiconductors, doping and technological processes for the production of electronic components
2. Principle of operation of the p-n junction: its applications and importance in modern electronics
3. Transistors in electronics: comparison of bipolar transistors (BJT) and field-effect transistors (FET) in terms of operating principles, advantages, disadvantages and applications
4. Applications of operational amplifiers: circuits performing basic mathematical operations and voltage follower

Introduction to Systems Dynamics / Fundamentals of Automatic Control Systems

1. Description of system dynamics in state space and with transfer functions
2. Electric - mechanical analogies (1st and 2nd type) - examples and elements
3. Controllability, observability and stability – definitions and criteria
4. Closed-Loop system stability. Hurwitz and Nyquist criteria
5. Compensators and controllers. Lead, lag, lead-lag compensators. Recommendation for compensator choice

6. PID controller. Controller implementations and tuning rules
7. Discrete-time systems. Z-transform. Sampling data systems, ideal sampler, Digital control systems, zero order hold, first order hold. Discrete-time (DT) transfer function. Stability conditions

Introduction to Numerical Methods

1. Floating point representation (FPR) of real numbers. Consequences of applying FPR in numerical calculations
2. Interpolation – problem statement and methods
3. Approximation – problem statement and methods
4. Numerical methods for solving systems of linear equations
5. Numerical methods for solving ordinary differential equations

Digital Circuits

1. Combinational circuit synthesis. Exact minimization: Quine-McCluskey theorem, Patrick's method, Function decomposition Ashenhurts-Curtis theorem, Shanon expansion and Binary Decision Diagrams
2. Sequential circuit synthesis, Microprogramable circuit structure, performance and maximal clock frequency assessment
3. Arithmetic: numeral systems, signed number representation, adder, multiplier synthesis. Performance improvements – carry-look-ahead adder concept. Operations data flow graph
4. Programmable logic devices, basic types and architectures. FPGA device architecture, basic blocks, dedicated blocks

Measurements Systems

1. Measurement errors. Classification of errors
2. DAQ boards - construction and applications
3. Temperature measurement systems
4. Strain gauges and its applications
5. Flow measurement systems

Microprocessor Systems / Embedded Systems and Peripheral Devices of Digital Systems (PBL)

1. Architecture of microprocessor. Architecture and properties of Harvard and Princeton (von Neuman) machines, CISC and RISC concept
2. Instruction, addressing modes in microprocessors, conditional execution, basic program structures, arguments passing to subprograms, local variables allocation
3. Multiprogram operation principles, methods of task switching and hardware requirements
4. Basic multiprocessor architectures, properties and quantitative description. Task scheduling outline
5. Interrupt System principles of operation, vectorized system, recognition of interrupting device, interrupt subprogram implementation
6. Principles of operation of the following serial transmissions: asynchronous, synchronous, I2C, 1-WireTM, SPI, USART
7. Functions of typical General Purpose Input Output system

Artificial Intelligence

1. Artificial neural networks. Deep learning architectures
2. Performance metrics in machine learning. Statistical learning theory. Support vector machines
3. Evolutionary algorithms - chromosome representation, variation operators, population management
4. Fuzzy set theory, fuzzy logic, fuzzy systems

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. 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. Amplitude and phase modulation
4. FIR/IIR systems

Microprocessor Programming

1. Concept and application of virtual ports
2. Mechanism of updating the microcontroller's firmware via the bootloader function
3. The main features of the FreeRTOS real-time system

Computer Graphics

1. Graphics rendering pipeline (implemented by the graphics card)
2. Affine transformations
3. Representation of orientations (Euler angles, quaternions)
4. Illumination modelling (global and local models, Blinn-Phong model, Lambert model)
5. Parametric curves and surfaces

PLC

1. Principle of operation of an industrial controller
2. Structure of a Programmable Logic Controller
3. Components of a System built on the basis of a PLC controller
4. Programming languages of industrial controllers

Databases

1. SQL language
2. References in relational databases
3. Transactions management in database systems
4. Database design using Entity-Relationship Diagrams
5. Basics of programming in database systems

II. COMMON COURSES FOR SPECIALIZATION - AUTOMATION

Programming and Control of Physical Systems (PBL)

1. Definition, description methods and purpose of kinematics
2. Distinction and examples of high- and low-level programming languages
3. Kinematic joint types
4. The most common ways to realize a rotational motion. Types of motors

Design and Rapid Prototyping of Embedded Control Systems

1. CAD, CAM, CAE, PDM systems
2. Rapid prototyping of control systems
3. Discrete-time control
4. Testing based on mathematical models - MiL, SiL, PiL and HiL methods
5. Sampled-data systems

Complex Systems

1. Methods of describing a complex system
2. Multilayer and multilevel structure
3. Direct coordination method and coordination by price method
4. Sensitivity analysis of a complex system

Applied Digital Signal Processing

1. Digital signal acquisition and reconstruction
2. Correlation and frequency analysis of digital signals
3. Design and use of digital filters
4. Decimation and interpolation of digital signals

Programming for Control Systems

1. Four main features of object-oriented support programming languages
2. Inheritance and composition (similarities and differences, application areas)
3. Definition of polymorphism and its implementation in C++
4. Definition of iterators and their implementation in C++

Advanced Dynamical System Modelling

1. Relations between state-space and transfer function description of a time-continuous, finite dimensional, linear dynamical system
2. Controllability and observability of time-continuous, finite dimensional, linear dynamical systems - necessary and sufficient conditions, examples, applications
3. Full state observer for time-continuous, finite dimensional, linear dynamical system in state-space form – reason for, idea of implementation, limitations
4. Linear-quadratic regulator (LQR) for a state-space realization of a time-continuous, finite dimensional, linear dynamical system – idea, realization, limitations

III. COMMON COURSES FOR SPECIALIZATION – ELECTRONIC SYSTEMS

Analog Circuit Design – Practical Approach

1. Parameters of resistors, capacitors and inductors
2. Bipolar junction transistors and field-effect transistors: bias circuits, small-signal models
3. Passive and active filters: filter responses, parameters, Sallen-Key and multiple feedback topology
4. Non-ideal operational amplifier

Materials and Process for Electronics Technology

1. Parameters determining the current-voltage characteristics of a photovoltaic cell
2. Definition and method of calculating the Temperature Coefficient of Resistance (TCR)
3. Methods of connecting photovoltaic cells in a solar battery
4. Air quality in laboratory rooms

Visualization and Control Systems (PBL)

1. Types of PLC programming languages and differences between them
2. Basic functionalities of HMI/SCADA systems
3. Connection between PLC controllers and the HMI visualization system
4. Testing the visualization and control system in conditions of lack of access to the physical machine

Fundamentals of Telecommunication

1. Methods of generating a sinusoidal signal for DTMF symbol generation. Which of the methods described requires fewer computations?
2. Spectrum of the FM signal
3. The purpose and operating principle of pre-emphasis and de-emphasis filters in FM transmission. Calculating the SNR gain
4. Operation principles of a QPSK modulator and demodulator

Electromagnetic Compatibility

1. Typical coupling paths of electromagnetic noise
2. Reduction of conducted emissions by EMI filters
3. Radiation and shielding of electromagnetic fields in electronic systems
4. Typical emission and immunity EMC tests

Hardware Description Languages (VHDL/Verilog)

1. Logic values set, strengths, and signal value resolution concept
2. Modular concept, the definition of the interface, module parametrization, module instantiation, port linking methods
3. Delay modelling, timing check verification tasks, tasks for printing messages and controlling simulation process
4. Tasks, and functions in modelling, PLI interface. Event-driven modelling and Bus Functional Modelling concepts

Design for Manufacture

1. Basic assumptions of the Six Sigma program
2. Types of PCB surface finishes and their advantages and disadvantages in SMT manufacturing
3. Types of solder, RoHS requirements
4. Protecting electronic devices from the ESD