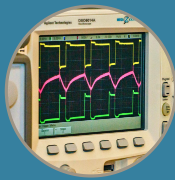
ELECTRICAL ENGINEERING
BSC SPECIALIZATION

EMBEDDED AND CONTROL SYSTEMS SPECIALIZATION



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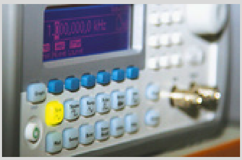
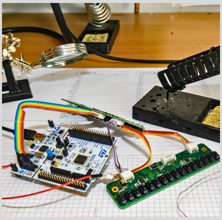
Electronic control units can be found everywhere, including in daily electronic devices and industrial control systems. For example, smartphones, smart televisions, Hi-Fi and other electronic entertainment devices, household appliances with programmed controls, intelligent cars that can assist drivers, medical instruments, and industrial controllers of production lines – and we could continue the list for a long time.
The electronic "brains" operating in such devices are all embedded computers, usually built with microcontrollers. Nowadays, all electrical engineering students – who love their profession and are looking for good employment opportunities after graduation – must be able to navigate the colorful world of microcontrollers, use them to create different tools, and develop increasingly smarter control programs.
The explicit aim of the specialization is to provide usable theoretical and practical knowledge and give students an introduction to the world of embedded systems, microcontrollers, and the applications that can be built from them. We emphasize teaching both hardware and software knowledge about the microcontrollers and deepening the knowledge gained in previous semesters.

The specialization lectures present the theoretical foundations to the students. They can try it in practice in the specialization laboratory, project laboratory, and thesis work.

The specialization subjects are managed by the following three departments:

- Department of Automation and Applied Informatics (AUT)
- Department of Control Engineering and Information Technology (IIT)
- Department of Measurement and Information Systems (MIT)





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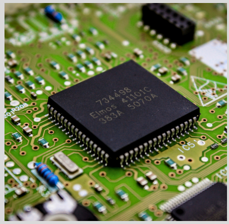
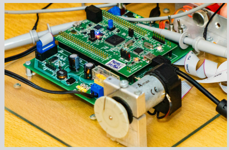
SUBJECTS

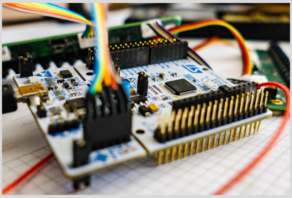
Microcontroller based systems (BMEVIAUAC12)

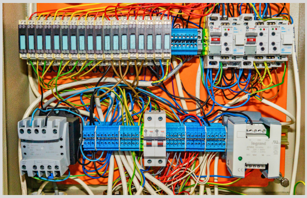
The course describes the most widespread microcontroller architectures and gives guidance for their selection for the given application. The course provides competencies to design and implement the hardware components of microcontroller-based systems and to implement the associated low-level software system. Design phases are demonstrated by case studies.
The following main topics are introduced:

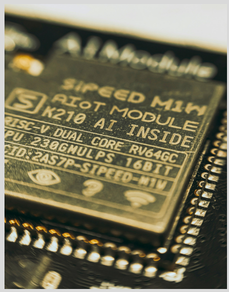
- Architectural basics
- Low-level software development
- Integrated peripherals of microcontrollers
- Connecting external peripherals to microcontrollers, typical interfaces
- Basic concepts and steps of hardware development







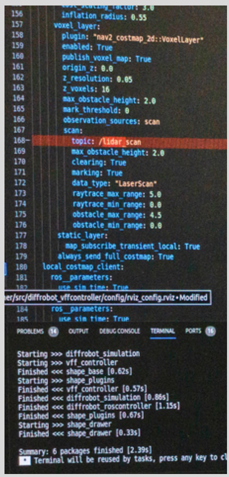




Embedded Software Development (BMEVIMIAC17)

The primary aim of the subject is to introduce the students to the topics of embedded software development.
The following main topics are introduced:

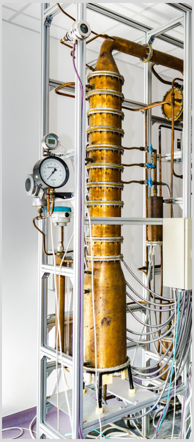
- Basics of C programming in embedded systems, properties of cross compilers, steps and requirements of compiling. Handling of memory-mapped peripherals and related standardization processes (e.g., CMSIS-Core)
- Hardware abstraction layers from low-level hardware libraries, firmware libraries to board and application-level libraries. Coding rules: commenting, naming conventions, restriction of language usage (MISRA-C), standards and examples. Coding examples for DMA-based (Direct Memory Access) hardware handling, porting of LibC library.
- Operating modes of an embedded software with special emphasis on diagnostic and energy saving modes.
- Debugging process in embedded systems, tracing and debugging tools in modern embedded systems.
- Software architectures like simple round-robin scheduling, function queues, embedded operating systems (OS). Basic problems and solutions of parallel programming are presented in theory and in practice through FreeRTOS examples: creating threads, using shared resources, synchronization of threads, stack usage, timing, scheduling and other OS features.

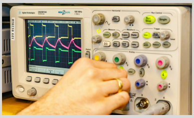


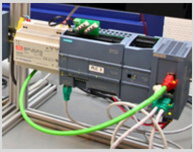
Robotized Manufacturing Systems (BMEVIIIAC06)

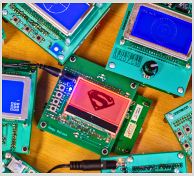
The aim of the subject is to present the main characteristics of discrete control systems, especially the standard programmable devices and industrial robots, widely used in manufacturing systems and supply chains. The subject also presents the sensors and actuators involved in the control loops with special focus on their potential application fields and operation. The subject also describes the characteristics of field bus systems that ensure reliable communication between devices. Students who successfully fulfill the requirements of the subject can

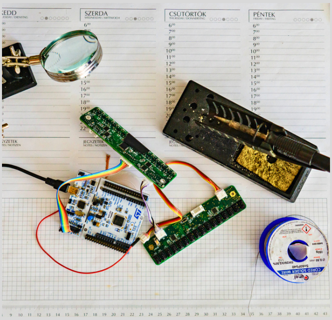
- present the elements and structure of automated and robotized manufacturing systems,
- describe the standard operating and programming model of programmable logic controllers (PLCs) and its frequently used modules,
- implement typical control tasks in automated manufacturing systems with the help of PLCs,
- to present the operating principle and characteristics of some commonly used sensors and actuator devices in automated manufacturing systems,
- present and apply field bus systems,
- describe the structure and characteristics of industrial robot arms, present the geometric model of the robot, and the methods of solving direct and inverse geometric tasks (transformations between the joint space and the work space),
- implement typical assembly and tool handling tasks with industrial robots, using second-generation robot programming languages.

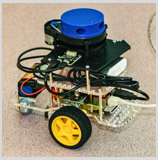
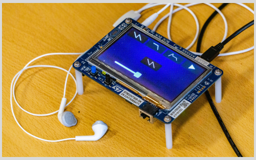
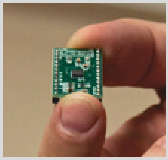
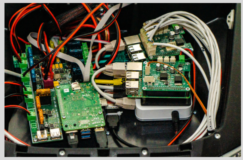










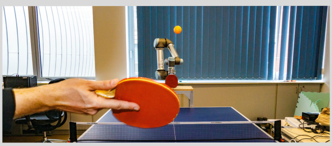
Microcontroller laboratory

The primary goal of the laboratory is to introduce the students to some of the more complex topics that could not be discussed in the demonstrations and exercises in the specialization lectures due to their complexity, equipment requirements, etc.
The students will attend 9 labs, 3-3 related to each specialization lecture.

Project Laboratory

Independent work carried out at the selected department, in the subject area determined by the student and the advisor. The subject provides an opportunity for an in-depth study of a topic, the development of independent knowledge acquisition and problem-solving skills, and through these direct preparation for the thesis.

BSc Thesis Project
Development of a task proving suitability for independent engineering in accordance with BSc requirements under the supervision of an advisor in the selected department.





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