# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Microprocessor systems [S1AiR1E>SM1]

## Course

Field of study
Automatic Control and Robotics

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

## Number of hours

Lecture
30

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

## Number of credit points

4,00

## Coordinators

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## Lecturers

## Prerequisites

Knowledge: A student starting this subject should have basic knowledge of electronics and basic programming. Skills: The student should have the ability to solve basic problems in the field of digital signal processing and the ability to obtain information from specified sources. He should also understand the need to expand his competences and be ready to cooperate in a team. Social competences: In addition, in the area of social competences, the student must exhibit such qualities as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

## Course objective

1. To provide students with basic knowledge about the architecture and programming of microcontrollers. 2. Developing students" skills to solve problems related to data processing and communication using interfaces in microprocessor electronic systems. 3. Developing the importance of knowledge of standards and recommendations related to the construction and programming of microprocessor electronic devices in students.

## Course-related learning outcomes

Knowledge:

Has a structured knowledge of computer architectures, computer systems and networks and operating systems including real-time operating systems [K1_W9 (P6S_WG)].
Knows and understands to an advanced degree the theory and methods in the architecture and programming of microprocessor systems, knows and understands selected high- and low-level microprocessor programming languages; knows and understands the principle of operation of basic peripheral modules and communication interfaces used in microprocessor systems [K1_W13 (P6S_WG)].
Knows and understands typical engineering technologies, principles and techniques of construction of simple automation and robotics systems; knows and understands the principles of selection of executive systems, computational units and measurement and control elements and devices [K1_W20 (P6S_WG)].
Skills:
Can interpret with understanding the design technical documentation and simple technological diagrams of automation and robotics systems [K1_U2 (P6S_UW)].
Be able to use selected rapid prototyping tools for automation and robotics systems [K1_U13 (P6S_UW)].
Is able to select the type and parameters of the measurement system, control unit and peripheral and communication modules for the selected application and integrate them in the form of the resulting measurement and control system [K1_U22 (P6S_UW)].
Is able to construct an algorithm to solve a simple measurement and control task and implement, test and run it in a selected programming environment on a microprocessor platform [K1_U27 (P6S_UW)].
Social competences:
Is ready to critically assess his/her knowledge; understands the need for and knows the possibilities of continuous training - improving professional, personal and social competence, is able to inspire and organize the learning process of others [K1_K1 (P6S_KK)].
The graduate is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the equipment and its components can operate. The graduate is ready to observe the rules of professional ethics and to demand it from others, to respect the diversity of opinions and cultures [K1_K5 (P6S_KR)].

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Formative assessment:
a) in the scope of lectures:
based on answers to questions about the material discussed in previous lectures,
b) in the scope of the laboratory:
based on assessment of knowledge and understanding of current issues presented in the course of the subject.
Summative rating:
a) in the scope of lectures, verification of assumed learning outcomes is carried out by:
i. assessment of knowledge and skills in the form of a test
ii. discussion of exam results.
b) in the scope of laboratory, verification of assumed learning outcomes is carried out by:
i. assessment of student"s preparation for individual classes,
ii. continuous assessment, during each class (oral answers) - rewarding the increase in the ability to use known principles and methods,
iii. assessment of reports prepared partly during classes and also after their completion.
Obtaining additional points for activity during classes, in particular for:
i. independent construction of an electronic module with a microprocessor and preparation of documentation
ii. effectiveness of applying the acquired knowledge while solving a given problem
iii. comments related to the improvement of teaching materials.

## Programme content

This subject covers a wide range of issues related to microprocessor systems, emphasizing their construction, programming and application. Students learn both the theoretical foundations and practical skills necessary to work with microprocessor systems in various fields.

During the lectures, students become familiar with digital logic, including basic logical operations, software and hardware implementation of combinational and sequential circuits, number coding systems, bit operations, as well as the structure of the user interface and the exchange of information between a microcontroller and another device. They will also learn to design electrical diagrams and PCB mosaics for digital and microprocessor circuits.

Laboratory classes will allow students to practically apply the knowledge acquired during lectures and develop the skills necessary to design and implement microprocessor systems.

The course program provides comprehensive preparation for the design and implementation of microprocessor systems. Students will acquire theoretical knowledge and practical skills necessary to work in various fields.

## Course topics

The lecture program covers the following topics:
1. (Digital logic) Basic logical operations - Boolean algebra. Software and hardware implementation of logical operations.
2. (Combinational circuits) Software and hardware implementation of combinational circuits. Minimizing logical expressions.
3. (Digital operations) Basic bitwise operations. Number coding systems. Bitmasks. Spreading and assembling multi-byte numbers using bit masks and data structures. Implementation of converting Gray code to binary code. Introduction to microcontroller registers.
4. (Digital circuits) Software and hardware implementation, among others: multiplexers, demultiplexers, flip-flops and memories.
5. (Sequential circuits) Software and hardware implementation of sequential circuits.
6. (Interface) Standard data types in microprocessor systems. Arithmetic in finite-precision microprocessor systems. Calculations using data structures.
7. (Interface) Construction of a simple user interface presenting the calculation results. Convert numbers to text and text to numbers. Special signs. Conversion of selected data types.
8. (Interface) Math functions. Creating user interface pages. Scrolling interface pages.
9. (Interface) User interface based on a sequential layout. User menu implementation.
10. (Communication) Exchange of information between a microcontroller and another device, e.g. a computer. Preparing the application for data exchange.
11. (Communication) Construction of selected communication protocols, e.g. Modbus.
12. (Hardware layer) Designing electrical diagrams and PCB mosaics for digital circuits.
13. (Hardware layer) Designing basic electrical diagrams and PCB mosaics for microprocessor systems.
14. (Hardware layer) Internal structure and features of digital circuits. Dynamics and delays of electronic systems.
15. Summary.

The laboratory course program covers the following topics:
1. Organizational classes - familiarization with health and safety equipment and footnotes, introduction to project environments.
2. Software and hardware implementation and verification of logical operations.
3. Software and hardware implementation and verification of combinational circuits.
4. Program implementation and verification of bit operations. Spreading and assembling multi-byte numbers using bit masks and data structures. Introduction to microcontroller registers.
5. The use of multiplexers, demultiplexers, flip-flops and memories to implement a selected digital system, e.g. a rotation-pulse/code converter expansion card for a microprocessor system.
6. Software and hardware implementation of sequential circuits.
7. Analysis of arithmetic in finite-precision microprocessor systems. The use of simple and complex data structures.
8. Construction of parts of the user interface presenting the calculation results, including: conversion of numbers to text and text to numbers with various formatting.
9. Implementation of a user menu (e.g. calculator) based on a sequential system.
10. Preparing an application to exchange data between the microcontroller and another device, e.g. a computer.
11. Expansion of the communication channel for two-way transmission in a given mode, e.g. text or binary.
12. Preparation of electrical diagrams for digital systems, e.g. a rotation-pulse/code converter expansion card for a microprocessor system.
13. Preparation of a PCB mosaic for digital circuits, e.g. a rotation-pulse/code converter expansion card for a microprocessor system.

14. Expansion of electrical diagrams and PCB mosaics with a microprocessor system.
15. Presentation of the final task: microprocessor system of a simple user interface or communication interface.

## Teaching methods

1. Lecture: multimedia presentation illustrated with computer simulations
2. Laboratory classes: the use of STM microprocessor development modules, IDE programming environments

## Bibliography

Basic
1. Geoffrey Brown, Discovering the STM32 Microcontroller, 2016
2. Donald S. Reay, Digital Signal Processing Using the ARM Cortex M4, 2015
3. Dogan Ibrahim, Microcontroller Based Applied Digital Control, 2006
4. W. Gay, Beginning STM32 Developing with FreeRTOS, libopencm3 and GCC, APRESS, 2018.
Additional
1. D. Łuczak, A. Wójcik, DSP implementation of state observers for electrical drive with elastic coupling , Przegląd Elektrotechniczny R.92 nr 5, s. 100-105, 2016.
2. M. Szumski, Mikrokontrolery STM32 w systemach sterowania i regulacji, BTC, 2018.
3. A. Kurczyk, Mikrokontrolery STM32 dla początkujących, BTC, 2019.
4. K. Paprocki, Mikrokontrolery STM32 w praktyce, BTC, 2009.
5. Łuczak, D. Machine Fault Diagnosis through Vibration Analysis: Continuous Wavelet Transform with Complex Morlet Wavelet and Time–Frequency RGB Image Recognition via Convolutional Neural Network. Electronics 2024, 13, 452, doi:10.3390/electronics13020452.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 120 | 4,00 |
| Classes requiring direct contact with the teacher | 60 | 2,00 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 60 | 2,00 |