GDAŃSK UNIVERSITY
OF TECHNOLOGY

Subject card

Subject name and code	Physical basis of microcontroller measurement systems, PG_00051072		
Field of study	Technical Physics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	Optional subject group
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	6	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment

Conducting unit	Zakład Fizyki Teoretycznej i Informatyki Kwantowej -> Instytut Fizyki i Informatyki Stosowanej -> Faculty of Applied Physics and Mathematics	
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Paweł Syty
	Teachers	dr inż. Paweł Syty

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	30.0	0.0	45
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	45	5.0	25.0	75

Subject objectives	The aim of the course is to familiarize students with the structure and basic methods of designing and programming simple embedded systems based on microcontrollers, i.e. specialized IT systems responsible for performing strictly defined tasks - mainly related to monitoring and control. The physical basis of the functioning of sensors (receptors) and actuators (effectors / actuators) as the basic components of this type of systems will be discussed.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W02	The student is able to explain the physics of the functioning of selected electronic components (receptors and effectors) used in embedded systems.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
K6_W06	The student is able to describe the functioning of an embedded system on the basis of electronics.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
K6_U06	The student is able to estimate the technical and economic feasibility of building an embedded system.	[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
K6_U05	The student is able to design, build and program simple, specialized embedded systems based on selected microcontrollers.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

Subject contents

Lecture:
Discussion of the physical basis of operation of basic measurement systems based on selected microcontrollers.
Detailed programme
A. Hardware platforms:
a. Arduino (Uno, Mega, Nano, Pro Mini, etc.) - a platform based on 8-bit microcontrollers from the Atmel AVR family
b. Raspberry Pi - a family of 32/64-bit single board minicomputers based on microprocessors from the ARM family (11, Cortex)
c. ESP8266 / ESP32 - 32-bit RISC microcontroller with built-in WiFi / Wifi+Bluetooth transmission, making it convenient to connect the system to the Internet
d. Raspberry Pi Pico - a microcontroller board based on the Raspberry Pi RP2040 chip
e. STM32 - a family of 32-bit microcontrollers from the ARM Cortex family

B. Programming languages:
a. C/C++ - in the context of programming for Arduino / ESP8266 / STM32
b. Python - a general-purpose scripting language, particularly convenient for programming for the Raspberry Pi
c. MicroPython - a version of Python for microcontrollers

C. Programming tools and support hardware:
a. Arduino IDE - a development environment for Arduino and ESP8266, including the necessary libraries
b. NodeMCU - a framework/circuit software to facilitate ESP8266 programming in the context of the Internet of Things
c. Sensors (e.g. temperature, pressure, distance, rain, motion, colour, sound), motors, LCD/LED displays, GPS, GSM, RFID devices, camera support, etc.
d. Web services for the collection and presentation of measurement data

Most topics will be illustrated with a demonstration of the operation of a particular device / hardware / programming language.

Project:
During the first weeks, students will learn, under the supervision of the instructor, how to work with the hardware and will build and program basic systems (e.g. control of LEDs, buzzer, motor, relay, measurement of temperature, atmospheric pressure, distance, recognition of movement, rain, colour, use of GPS, GSM and RFID devices, etc.).

Then, students will present self-prepared prototypes of embedded systems projects for the chosen platform (including implementation), e.g.
- internet radio with remote control (Raspberry Pi + WiFi + remote control / infrared sensor / Python)
- room access control system (Arduino + RFID / C++) weather station with WWW reporting (Arduino + selected sensors + ESP8266 / C++)
- room monitoring with WWW reporting (Arduino + selected sensors + ESP8266 / C++)
- wheeled self-driving robot (Arduino + distance and obstacle sensors + robot platform with motors and wheels / C++)
- home automation (Arduino or Raspberry Pi + sensors + effectors / C++ or Python)
- webcam with object recognition (Raspberry Pi + camera / Python + OpenCV library)

Hardware (microcontroller boards, sensors, effectors, etc.) will be made available to students for the duration of their projects. It is also possible to design the system in TinkerCad or an equivalent service.

Prerequisites and co-requisites

Basic knowledge of programming
Basic knowledge of electronics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Passing the theoretical part	50.0%	20.0%
Completion of the project	50.0%	80.0%

Recommended reading

Basic literature	Michael J. McGrathCliodhna Ní Scanaill, Sensor Technologies. Healthcare, Wellness, and Environmental Applications. Apress, 2013 Andy King, Programming the Internet of Things. O'Reilly Media, 2021 Vedat Ozan Oner, Developing IoT Projects with ESP32. Packt Publishing, 2021
Supplementary literature	Husan Mahey, Robotic Process Automation with Automation Anywhere. Packt Publishing, 2020
eResources addresses	Adresy na platformie eNauczanie: Fizyczne podstawy mikrokontrolerowych układów pomiarowych (2023/2024) - Moodle ID: 34270 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34270

Example issues/ example questions/ tasks being completed

- Internet radio with remote control (Raspberry Pi + WiFi + remote control / infrared sensor / Python)
- room access control system (Arduino + RFID / C ++) weather station with reporting on the website (Arduino + selected sensors + ESP8266 / C ++)
- room monitoring with reporting on the website (Arduino + selected sensors + ESP8266 / C ++)
- wheeled self-propelled robot (Arduino + distance and obstacle sensors + robot platform with motors and wheels / C ++)
- home automation (Arduino or Raspberry Pi + sensors + effectors / C ++ or Python)
- webcam with object recognition (Raspberry Pi + camera / Python + OpenCV library)

Work placement

Not applicable