COURSE DESCRIPTION CARD - SYLLABUS

Course name
Sensors and wireless sensor networks

Course

Field of study
Computing

Year/Semester
1/1

Area of study (specialization)
Internet of Things

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
16

Laboratory classes
16

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
dr inż. Zygmunt Kubiak

Responsible for the course/lecturer:

Prerequisites

A student starting this course should have basic knowledge of physics, electronics, digital and analog techniques. He should have the ability to solve basic problems in the field of electrical engineering and electronics, programming in C, creating application operation algorithms and the ability to obtain information from the indicated sources. He should also be ready to cooperate as part of the team. In addition, in terms of social competences, the student must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. To provide students with basic knowledge in the field of selected wireless transmission protocols and sensors.

2. Providing students with complementary knowledge in the field of construction, operation, sensor applications as well as the organization of protocols, technical implementation of radio transmission, hardware and software solutions for network modules (nodes), transmission security, applications.

3. Developing the ability to solve simple problems related to the use of sensors as well as the construction, operation, programming, and starting low-power radio networks.

4. Shaping students' teamwork skills as part of the tasks carried out in the laboratory.

Course-related learning outcomes

Knowledge

1. has ordered, theoretically founded general knowledge in the field of sensor networks (WSN and LPWAN - IoT applications) and the construction and operation of sensors. - [K2st_W2]

2. has an ordered, theoretically founded knowledge of the organization of sensor network protocols and programming of network nodes with sensors. - [K2st_W3]

3. has knowledge about trends and the most important new achievements in the development of microelectronics, nanotechnology, in particular microcontrollers, sensors, embedded systems and low-power radio networks. - [K2st_W4]

4. has advanced and detailed knowledge of the processes taking place in the life cycle of such systems as radio sensor networks in terms of concept, software and hardware solutions - [K2st_W5]

5. knows the basic methods of solving engineering tasks in the field of design and implementation of sensor network nodes; knows and understands the principles of connecting electronic components and systems with microcontrollers, in particular sensors. - [K2st_W6]

Skills

1. can use literature information, databases and other sources in Polish and a foreign language in the field of sensor networks and sensors, - [K2st_U1]

2. can use analytical, simulation and experimental methods to formulate and solve engineering tasks and simple research problems - [K2st_U4]

3. can - when formulating and solving engineering tasks concerning sensor networks and sensors - integrate knowledge from various areas of computer science (and, if necessary, also knowledge from other scientific disciplines) and apply a system approach, also taking into account non-technical aspects - [K2st_U5]

4. can assess the usefulness and the possibility of using new achievements (methods and tools) and new IT products in the field of sensor networks and sensors - [K2st_U6]

5. can cooperate in a team and implement subsequent stages of design, programming and commissioning of sensor networks, can prepare project documentation - [K2st_U15]

6. can determine the directions of further learning and implement the self-learning process in the field of sensor networks and sensors, - [K2st_U16]

Social competences

1. understands that in IT knowledge and skills very quickly become obsolete, this also applies to sensors and wireless sensor networks. - [K2st_K1]

2. understands the importance of using the latest knowledge in the field of computer science in solving research and practical problems in the field of low-power radio networks and sensors, - [K2st_K2]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Initial assessment:

a) in the field of lectures: - on the basis of answers to questions about the material discussed in previous lectures,

b) in the field of laboratories: - based on the assessment of the current progress in the implementation of tasks,

Summative assessment:

a) in the field of lectures, verification of the assumed learning outcomes is carried out by: - assessment of the knowledge and skills shown in the exam of a problem nature, consisting of problem tasks selected from the list of issues previously made available to students (5 questions from 20 problem issues); - discussion of the results and, in individual cases, additional control questions,

b) in the field of laboratories, verification of the assumed learning outcomes is carried out by: - assessment of skills related to the implementation of laboratory exercises;- continuous assessment during each class; - evaluation of reports prepared on selected issues carried out in the laboratory; this assessment also includes the ability to work in a team,.

Programme content

The lecture program covers the following topics: Wireless sensor and activator networks (BSS; WSN - Wireless Sensor Network). One-hop and multi-hop networks. Low energy radio networks for the Internet of Things, operating on licensed and unlicensed radio bands. Frequency bands used in WSN networks. Introduction to modern solutions of sensor systems - structure, operation, interfaces, rules of application. Radio transmitting and receiving systems (RF) - structure, operation, rules of application. Selected digital interfaces used in RF systems. Modulation techniques used in RF circuits. Basic parameters of RF circuits. Solutions of sensor networks nodes. Security issues in sensor networks: packet integrity, confidentiality - AES encryption. Simple WSN protocols for measurement and control purposes and complex standardized protocols - IEEE802.15.4 / ZigBee protocols and others based on IEEE802.15.4 and LPWAN. Selected routing protocols of WSN network, eg DSR, AODV. Short-range transmission. Introduction to selected microcontrollers and programming in C language to the extent necessary for the implementation of laboratory exercises. Synchronous algorithms.

Laboratory classes are conducted in the form of 2-hour exercises, the required instruction is conducted as part of the exercises. Classes are carried out by 2-person teams of students. The laboratory program covers the following topics: Introduction to the selected hardware and programming environment. Organization of the wireless transmission protocol. Protection of transmission packages. Configuration of the radio system. The simplest transmission (transmit - receive). Support for selected sensors. Project

- Implementation of a given wireless transmission protocol. It is possible to implement a simple project in the field of the subject. The exercises are based on selected development modules with microcontrollers, e.g. from Silicon Labs, Toolstick UNI DC type, with C8051F020 microcontrollers, Texas Instruments, MSP430 Launchpad type, or Arduino, Raspberry Pi, BeagleBone Black, Tiva- C Series TM4C1294, STM32, etc.

Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples given on the board,

2. Laboratory exercises: practical implementation of hardware and software for selected issues in the field of lectures,

3. Consultations in the field of laboratory exercises.

Bibliography

Basic

1. Bezprzewodowe sieci LAN 802.11. Podstawy, Roshan P., Leary J., MIKOM, Warszawa, 2004

2. Protocols and Architectures for Wireless Sensor Networks, Karl H., Willing A., WILEY, Chichester, 2007

3. Sensor and low power signal processing, Islam S.K., Haider M.R., Springer, New York, 2010

4. Sensor networks with IEEE 802.15.4 systems, Buratti C., Martalo M., Verdone R., Ferrari G., Springer, Heidelberg, 2011 5. Presentations for lectures

Additional

1. Embedded programming, Chew M.T., Gupta G.S., Silicon laboratories, 2005

2. Embedded microcontroller interfacing, Gupta G.S., Mukhopadhyay S.C., Springer 2010

3. IEEE Std 802.15.4, Part 15.4: Wireless Medium Accass Control (MAC) and Physical Layer (PHY) Specifications for Low- Rate Wireless Personal Area Networks (LR-WPANs), IEEE, 2003

4. Designing embedded systems and Internet of Things (IoT), Xiao P., Wiley, 2018

5. Internet sources, eg. www.silabs.com, www.atmel.com, www.ti.com, www.st.com

Breakdown of average student's workload

	Hours	ECTS
Total workload	108	4
Classes requiring direct contact with the teacher	38	2
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for exam, project preparation) [1]	46	2

[1] delete or add other activities as appropriate