COURSE DESCRIPTION CARD - SYLLABUS

Course name
Embedded Systems Design and the Internet of Things [N2Inf1-AMiWdIP>SWBUD]

Course

Field of study
Computing

Year/Semester
1/1

Area of study (specialization)
Mobile and Embedded Applications for the Internet of Things

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
16

Laboratory classes
16

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr inż. Ariel Antonowicz
ariel.antonowicz@put.poznan.pl

Lecturers

Prerequisites

A student starting this subject should have basic knowledge of physics, electronics, digital and analog technology and metrology. In addition, the student should have the ability to solve basic problems in electrical and electronic engineering, create algorithms and simple electrical diagrams by obtaining information from indicated and independently selected sources. The student should also have a willingness to cooperate as part of a team. In terms of social competence, the student must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture and respect for other people.

Course objective

1. Providing students with the initial knowledge of the Internet of Things. 2. To provide students with basic knowledge of designing embedded systems in the aspect of the Internet of Things. 3. Providing students with complementary knowledge in the field of designing printed circuits and the use of CAD tools, organization and programming of microcontrollers, selected digital circuits and sensors. 4. Developing the ability to solve simple problems related to the design, construction, operation, programming of digital systems. 5. 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 embedded systems and the Internet of Things - [K2st_W2]
2. has advanced knowledge related to selected issues in the field of computer science, such as: programming microcontrollers in the C language, handling sensors and output circuits, creating simple internet applications related to the operation of modules equipped with microcontrollers and sensors - [K2st_W3]
3. has knowledge about trends and the most important new achievements in the development of microelectronics, nanotechnology, in particular IoT, microcontrollers, sensors, embedded systems, - [K2st_W4]
4. has basic knowledge of the life cycle of embedded systems and IoT systems; has knowledge of trends and the most important new achievements in the development of microelectronics, nanotechnology, in particular microcontrollers, sensors, embedded systems, IoT modules - [K2st_W5]
5. knows advanced methods, techniques and tools used in solving engineering tasks and conducting research in the field of embedded systems at the design, construction and programming stage; knows and understands the rules of connecting electronic components and circuits with microcontrollers and internet applications; - [K2st_W6]
6. has knowledge of ethical codes related to scientific and research work in the field of computer science - [K2st_W7]

Skills:
1. can use literature information, databases and other sources in Polish and in a foreign language; in the field of designing embedded systems and the Internet of Things, - [K2st_U1]
2. can use to formulate and solve engineering tasks and simple research problems in the field of embedded systems and the Internet of Things, analytical, simulation, experimental and diagnostic methods - [K2st_U4]
3. can - when formulating and solving engineering tasks - integrate knowledge from various areas of computer science (also knowledge from other scientific disciplines) and apply a systemic approach, also taking into account non-technical aspects, which is important in Internet of Things systems, relating to various fields, e.g. health care, sport or smart measurements, - [K2st_U5]
4. can assess the usefulness and the possibility of using new achievements (methods and tools) and new IT products in the design of embedded systems and the Internet of Things, - [K2st_U6]
5. can assess the usefulness of methods and tools for solving an engineering task involving the implementation of an Internet of Things project, including the limitations of these tools - [K2st_U9]
6. can - in accordance with the given specification, taking into account non-technical aspects - design a complex embedded system integrated with the Internet, implement this project - at least in part - using appropriate methods, techniques and tools, including adapting the existing or developing new tools for this purpose -[K2st_U11]
7. can cooperate in a team as part of designing embedded systems for the Internet of Things - [K2st_U15]

Social competences:
1. understands the need for continuous training, understands that in computer science knowledge and skills very quickly become obsolete, especially in such areas embedded systems and the Internet of Things - [K2st_K1]
2. understands the importance of using the latest knowledge in the field of computer science to solve problems related to the creation, launch and operation of modern Internet of Things systems - [K2st_K2]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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 30 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 / projects;- continuous assessment during each class (oral answers); - evaluation of reports prepared on selected issues carried out in the laboratory; this assessment also includes teamwork.

Programme content

The module program covers the following topics:
1. Introduction to the Internet of Things.
2. Introduction to Printed Circuit Board (PCB) design.
3. Design of embedded systems.
4. Durability and performance of PCB.
5. Version control and rules.
6. Print fabrication technologies and design errors.
7. Design documentation development.
8. Microcontroller architecture.
9. Peripheral circuits of microcontrollers.
10. Communication interfaces.

Course topics

The lecture program covers the following topics:
1. Introduction to the Internet of Things (IoT): device-to-device communication, architecture of distributed systems in particular IoT, intelligent processing of information obtained from measurement elements.
2 Introduction to PCB design, embedded systems, and IoT: discussion of characteristics, product lifetimes, and applications. Use of CAD/EDA type of tool software (e.g. easyEDA, KiCAD) for electronics engineers. Creating and editing electrical schematics, editing prints.
3. Creation of design documentation, printing technologies and design errors. Durability and operation of printed circuits. Assembly and commissioning of modules.
4. Version control, rules, EMC.
5. Microcontroller architecture, selected families of microcontrollers and runtime modules.
6. Peripheral circuits of microcontrollers and runtime modules (timers, ADCs and DACs). Analog channel, interrupt systems, organization and handling of external events, handling of microcontroller functional circuits, handling of synchronous timing events, implementation of virtual timers.
7. Selected issues of design and commissioning of embedded systems.
8. selected communication interfaces of microcontrollers (necessary for the tasks of the subject): RS232, I2C, SPI, 1Wire, UART.
9. Principles of interfacing microcontrollers with simple input-output elements and software operation.
10. Power circuits, battery power sources.

Laboratory classes are conducted in the form of two-hour exercises held in the laboratory, preceded by a 2-hour instructional session at the beginning of the semester. The exercises are carried out by teams of 2 students. The program of the lab includes the following: introduction to PCB design in KiCAD (or easyEDA), preparation of schematic diagram, single-sided design, double-sided design, creation of new components and integrated libraries, creation of documentation, conversion of schematics to PCB, definition of design versions and DRC control. The labs may include simple projects, consistent with the project theme (e.g., an header on a selected hardware platform: Arduino, Raspberry Pi, BeagleBone Black, Tiva-C Series TM4C1294, STM 32). Student projects implemented on the selected base module. Consultation on the implemented projects.

Teaching methods

Lecture: multimedia presentation, films, presentations illustrated by examples given on the blackboard.

Laboratory exercises: presentation of the problems of the exercises, implementation of the issues presented in the topics of classes on laboratory exercises.

Bibliography

Basic
1. Elektronika praktyczna – projektowanie PCB, Świontek Tomasz, 2009
2. Projektowanie systemów mikroprocesorowych, Hadam P., BTC, Warszawa, 2004
3. Spraw, by rzeczy przemówiły. Programowanie urządzeń elektronicznych z wykorzystaniem Arduino, Igoe T., Helion, 2013
4. Arduino dla zaawansowanych, Anderson R., Cervo D., Helion, 2014
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. Microcontrollers in practice, Mitescu M., Susnea I. , Springer , Berlin, 2005
4. Mikrokontrolery STM32 w praktyce, Paprocki K., BTC, Warszawa, 2009
5. Arduino w akcji, Evans M., Noble J., Hochenbaum J., Helion, 2014
6. Designing embedded systems and Internet of Things (IoT), Xiao P., Wiley, 2018
7. Internet sources, eg. www.silabs.com, www.atmel.com, www.ti.com, www.st.com
8. Forbot (SquareShox), Aleksander Flont, Poradnik KICAD, 2020

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	34	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	66	2,50