POZNAN UNIVERSITY OF TECHNOLOGY
EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)
pl. M. Skłodowskiej-Curie 5, 60-965 Poznań

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Designing Embedded Systems for the Internet of Things

Course

Field of study	Year/Semester
Computing	1/1
Area of study (specialization)	Profile of study
Internet of Things	general academic
Level of study	Course offered in
Second-cycle studies	Polish
Form of study	Requirements
full-time	elective

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	20	
Tutorials	Projects/seminars	
	20	

Number of credit points

5

Lecturers

Responsible for the course/lecturer:

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Faculty of Computing and Telecommunications

Piotrowo 2, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

A student starting this course should have basic knowledge of physics, electronics, digital and analog techniques, and metrology.

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. 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 advanced knowledge in the field of microcontrollers, embedded systems and the Internet of Things, including design, construction, startup methods, and programming tools and environments used for their implementation - [K2st_W1]

2. has advanced detailed knowledge related to selected issues in the field of computer science, such as: programming microcontrollers in C language, handling sensors and output circuits, creating internet applications related to the operation of modules equipped with microcontrollers and sensors - [K2st_W3]

3. 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]

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 - using conceptual methods - solve complex design tasks in the field of the Internet of Things, including non-standard tasks and tasks with a research component - [K2st_U10]

7. 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]

8. 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:

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 / projects: - 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 / projects, 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; -assessment and defense by the student of the report on the implementation of the project.

Programme content

The lecture program covers the following topics: Introduction to the Internet of Things (IoT): communication between devices, architecture of distributed systems, in particular IoT, processing of information obtained from sensors, IoT applications. Designing of embedded systems and IoT: Embedded systems. Characteristics. Product life time. Applications.

Introduction to PCB design. CAD / EDA type tool program (eg Eagle) for electronics. Edition of schemas. Editing printed circuit boards. Creating project documentation. Technologies of making printed circuit boards, design errors. Installation and commissioning of modules. JTAG diagnostic bus. Introduction to microcontrollers (to the extent necessary). Architecture of microcontrollers. Selected families of microcontrollers and development boards. Microcontroller peripherals, timers, AC and CA converters. Analog channel. Interrupt system, organization, handling of external events, handling of microcontroller functional systems, handling of synchronous time events, implementation of virtual timers.

Selected issues of design and commissioning of embedded systems. Selected communication interfaces of microcontrollers (necessary for the implementation of the tasks of the subject): RS 232, IIC, SPI, 1-Wire. Principles of connecting microcontrollers with simple input-output elements and program service. Power circuits. Battery power source. Transistors. Direct current motors (DC), brushless direct current motors (BLDC), stepper motors, servos - construction, principles of control and cooperation with microcontrollers. In detail, sensors are the subject of another lecture.Cooperation with analog elements. Programming microcontrollers in C language. Programming microcontrollers for real-time systems - program algorithms for simple sequential programs, complex with select-type and parallel branches, connecting many real-time applications.

Laboratory classes are conducted in the form of seven 2-hour exercises in the laboratory, preceded by a 2-hour instructional session at the beginning of the semester. Classes are carried out in teams of 2 students. The laboratory program covers the following topics: Introduction to PCB design e.g. in Eagle. Preparation of a schematic diagram. Single-sided, double-sided printing project. Creating documentation. Introduction to running applications on selected development modules with microcontrollers, eg Arduino, Raspberry Pi, BeagleBone Black, Tiva- C Series TM4C1294, STM32. Configuration of the microcontroller. Implementation of simple C language programs, such as LED control with a simple time loop; using a timer; without interrupts and with interrupt handling. Programs that use AC and CA processing. Use of selected sensors.

Programming microcontrollers for real-time systems according to the rules presented in the lectures for various classes of microcontrollers (8-, 16-, 32-bit) and various programming tools. Creation of simple applications for selected TCP / IP protocols in combination with a microprocessor module equipped with sensors.

Student projects implemented on the selected base module.

Teaching methods

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

2. Laboratory exercises: presentation of the issues of exercises, implementation of the issues presented in the laboratory exercise program,

3. Projects: checking the progress, discussion and ongoing consultations in the field of implemented projects.

Bibliography

Basic

1. Eagle pierwsze kroki, Wieczorek H., BTC, Warszawa, 2007

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

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,0
Classes requiring direct contact with the teacher	55	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	70	2,5

[1] delete or add other activities as appropriate