POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Prototyping of embedded systems in LabVIEW environment [N2AiR1-SW>labVIEW]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/3

Area of study (specialization)
Vision Systems

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
20

Laboratory classes
10

Other (e.g. online)
0

Tutorials
0

Projects/seminars
10

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Knowledge: A student starting this subject should have a basic knowledge of electronic components and circuits, the basics of analog and digital electronics, programmable digital circuits, microprocessor systems and signal processors. Skills: A student should have the ability to solve basic problems in the design of electronic circuits, programming in high-level languages, and the ability to obtain information from specified sources. She or he should also understand the need to expand her/his competences and be ready to cooperate in a team. Social competences: In addition, she or he should exhibit qualities such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture and respect for other people.

Course objective

1. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation. 2. Developing students' ability to solve problems in the field of prototyping embedded systems using the LabVIEW environment. 3. Preparing students to obtain a certificate confirming the basic programming skills in LabVIEW (CLAD - Certified LabVIEW Associate Developer). 4. Developing students' teamwork skills in implementing projects.

Course-related learning outcomes

Knowledge
A student:
1. understands the design methodology for specialized analog and digital electronic systems - [K2_W4]
2. has advanced and deepened knowledge of methods of analysis and design of control systems - [K2_W7]
3. has theoretically founded detailed knowledge related to automation systems, control systems and measurement systems, - [K2_W11]
4. A student has basic knowledge about the life cycle of automation and robotics systems as well as control and measurement systems - [K2_W13]
Skills
A student:
1. is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules - [K2_U13]
2. can make a critical analysis of the functioning of control systems and robotics systems; also has the ability to select automation systems with the use of microprocessor controllers - [K2_U19]
3. can design improvements in the existing design solutions for automation and robotics components and systems, - [K2_U20]
3. is able to design and implement a complex device, object or system, taking into account non-technical aspects - [K2_U23]
4. is able to build an algorithm for solving a complex and unusual engineering task and a simple research problem and implement, test and run it in a selected programming environment for selected operating systems - [K2_U25]
5. can design control systems for complex and atypical multidimensional systems; is able to consciously use standard functional blocks of automation systems and shape the dynamic properties of measurement paths - [K2_U27]
Social competences
1. A student is aware of the responsibility for own work and has willingness to comply with the principles of teamwork and taking responsibility for jointly implemented tasks. She or he can lead a team, set goals and define priorities leading to the task - [K2_K3]
2. A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function - [K2_K4]

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, quizes checking understanding of the lecture content
b) in the scope of laboratories:
based on an assessment of the current progress of task implementation.
c) in the scope of project classes:
based on an assessment of the current progress of tasks implementation.

Summative assessment:
a) in the scope of lectures: the verification of the assumed learning outcomes is carried out by:
i. assessment of knowledge and skills demonstrated in the written exam: a multiple-choice test (40 questions). The exam can also be a certification exam to obtain the CLAD (Certified LabVIEW Associate Developer) certificate. The student can get a total of 40 points, must obtain 21 points for a satisfactory grade. If she or he scores over 70% of points, therefore can get the CLAD certificate.
ii. discussion about exam results,
b) in the scope of laboratories and project classes: verification of assumed learning outcomes is carried out by:
i. assessment of student's preparation for individual sessions of laboratory and project classes
ii. assessment of knowledge and skills related to the implementation of project tasks,
iii. assessment of technical documentation of the project; this assessment also includes teamwork skills.

Obtaining additional points for activity during classes, in particular for:
i. discuss of additional aspects of the issue,

ii. effectiveness of applying the acquired knowledge while solving a given problem,
iii. ability to work as part of a team that practically performs a specific task in the laboratory,
iv. comments related to the improvement of teaching materials,
v. indicating students' perceptive difficulties enabling ongoing improvement of the didactic process.

Programme content

The lecture program includes the following topics:
1. Embedded circuits and systems - introduction: definition, history, characteristics and architecture of embedded systems; embedded system design according to model V.
2. Embedded programming: embedded programming methods, low-level and high-level programming, real-time operating systems, code translation, virtual machines, response time for an event, processor timing and input-output systems, clock and instruction cycle, pipeline processing, parallel operation.
3. Tools for designing embedded electronic circuits: LabVIEW (National Instruments) environment, graphic programming language, virtual measurement instruments, basics of programming, data types, use of library functions.
4. LabVIEW environment: control structures, loops, task timing, feedback, implementation of charts, matrices, polymorphism, clusters.
5. LabVIEW environment: type definitions, conditional structures, input and output tunnels, management of the order of actions, event control,
6. LabVIEW environment: error handling, modularity, subroutines, code documentation.
7. LabVIEW environment: measurements with the hardware components, file operations, data streaming, program diagrams: sequential programming, state machine.
8. LabVIEW environment: variable usage, global variables, local variables,
9. LabVIEW environment: producer-consumer model; communication, synchronization, error handling
10. LabVIEW environment: advanced programming and program control models.
11. LabVIEW environment: User interface support
12. LabVIEW environment: VI server, references, methods of modifying block and control parameters, event control, queues.
13. LabVIEW environment: advanced file support.
14. LabVIEW environment: code optimization, software distribution.
15. Summary, test preparation for the CLAD exam.

Laboratory classes are conducted in the form of seven 2-hour exercises that take place in the laboratory, preceded by a 1-hour instructional session at the beginning of the semester. Exercises are carried out by 2-person teams.
The program of laboratory classes includes the following issues:
1. Programming in LabVIEW: introduction, communication with I / O modules.
2. Programming in LabVIEW: analog-to-digital and digital-to-analog processing in embedded systems, reduction of aliasing, signal filtering, selection of hardware and software elements.
3. Programming in LabVIEW: program operation control, loops, conditional structures.
4. Programming in LabVIEW: use of library functions, error handling.
5. Programming in LabVIEW: advanced programming models and program control.
6. Hardware platforms: NI CompactDAQ, PXI, ELVIS II.
7. Support for selected communication interfaces.
Project classes are conducted in the form of seven 2-hour meetings held in the laboratory and a 1-hour organizational meeting. Projects are implemented by 2 or 3-person teams.
The purpose of the first 2 classes is to determine the assumptions of the embedded system design, its functionality and to choose the hardware and software platform that performs tasks. During the remaining classes, the project tasks, a preparation of equipment, the software and project documentation are carried out. Students have National Instruments (CompactDAQ) input and output modules available, modules with Atmel, Microchip, Texas Instruments microcontrollers, Texas Instruments signal processors, Analog Devices and Nanoboard 2 FPGA development boards. Implemented projects can be used in measurements, control, audio / video processing as well as in communication.

Teaching methods

1. Lecture: multimedia presentation illustrated with examples on the board, solving of tasks, quizes

checking understanding of the lecture content
2. Laboratory classes: configuration of measuring systems (hardware and software), performing of measurements, teamwork
3. Project classes: circuits designing, teamwork

Bibliography

Basic
1. Embedded system design, Marwedel P., Kluwer Academic Publishers, Boston, 2003
2. Wbudowane systemy mikroprocesorowe, Timofiejew A., Wyd. Uniwersytetu Przyrodniczo-Humanistycznego, 2012
3. Komputerowe projektowanie układów cyfrowych, Łuba T., Zbierzchowski B., WKŁ, Warszawa, 2000
Additional
1. Documentation of LabVIEW environment, National Instruments, 2015
2. Documentation of Altium Designer environment, Altium, 2011
3. Documentation of Code Composer Studio environment, TI University Program, Texas Instruments, 2012
4. Rapid prototyping of digital systems, 2nd ed. a tutorial approach, Hamblen J., Furman M., Kluwer Academic Publishers, 2002
5. Sztuka elektroniki, cz.1 i 2, Horowitz P., Hill W., WKŁ, Warszawa, 2009
6. Datasheets of electronic components

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	40	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	2,50