COURSE DESCRIPTION CARD - SYLLABUS

Course name

Designing specialized electronic devices

Course

Field of study

Computing

Area of study (specialization)

Computing Microsystems

Level of study

Second-cycle studies

Form of study

full-time

Year/Semester

1/1

Profile of study

general academic

Course offered in

polish

Requirements

compulsory

Number of hours

Lecture

15

Laboratory classes

15

Other (e.g. online)

0

Tutorials

0

Projects/seminars

15

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

dr hab. inż. Szymon Szczęsny

Responsible for the course/lecturer:

dr inż. Mariusz Naumowicz

Prerequisites

The student starting this course should have basic knowledge of digital and analog electronics and basic knowledge of electrical engineering. Moreover, the ability to read catalog cards, understand the documentation of electronic components, components and microsystems is required. The ability to expand your knowledge and work in a team is also essential. Due to social competences, the student should be aware that knowledge in computer science quickly becomes obsolete and requires constant expansion. The student should present an attitude of honesty, creativity, reliability, and cognitive curiosity.

Course objective

1. Provide students with basic knowledge in the field of designing dedicated electronic devices (provided for the implementation of such tasks as: measurement and registration, remote supervision, data transmission).

2. Discussion of the methodology of comprehensive design of electronic printed circuits from concept, through the formulation of a schematic diagram to the visualization of the final product, taking into account the issues of version management and design rules.

3. Familiarization with popular tools for designing printed circuits and methods of design correctness verification.

4. Presentation of case studies illustrating various implementations of typical functional blocks found in microsystems: power supply circuits, programmable units, communication interfaces.

5. Developing students' skills in practical use of knowledge in the field of electronics for the implementation of design tasks, the ability to use technical documentation to implement a defined design task.

6. Developing the ability to critically evaluate the existing solutions in terms of meeting a given criterion (eg power consumption, physical dimensions of modules, reaction time of sub-circuits).

Course-related learning outcomes

Knowledge

1. The graduate knows EDA methods and tools for designing the hardware layer of the microsystem

2. The graduate knows selected protocols of fast data transmission and has knowledge of information processing in hardware

3. The graduate knows the current trends in the embedded systems market, has knowledge of the tools and solutions available on the market for the implementation of microsystems

Skills

1. The graduate is able to include in the design of the hardware layer of the microsystem the electronic, physical and legal aspects related to the implementation of commercial PCB projects

2. The graduate is able to analyze the technical documentation of various commercial items and assess their usefulness in the designed solution

3. The graduate has the ability to assess the technical values of selected commercial solutions dedicated to the embedded systems industry

4. The graduate knows the limitations of selected PCB layout design tools and is able to choose the appropriate design environments for the implementation of the assigned task

5. The graduate is able to design a dedicated printed circuit, taking into account the technical details resulting from the specifications of individual components and the functional requirements of the entire embedded system

Social competences

1. The graduate is ready to constantly expand knowledge in the area of embedded systems, especially in the field of changing trends in the development of the IT market

2. The graduate understands the necessity to use the latest solutions in the implementation of microsystems

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative 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 knowledge and skills demonstrated in a problem-based written test

- discussion of the results of the final test,

b) in the field of laboratories, verification of the assumed learning outcomes is carried out by:

- evaluation of the report prepared partly during the course and partly after its completion; this assessment also includes teamwork; concerns laboratory exercises of a restorative nature (the student carries out the exercise according to the instructions provided)

- assessment of the implementation of a complex task requiring the integration of knowledge and skills acquired during laboratory classes; Technical aspects of implementation, the ability to solve unconventional problems and the proficiency in using the available design tools are assessed

Obtaining additional points for activity during classes, especially for:

- discussion of additional aspects of the issue,

- the effectiveness of applying the acquired knowledge while solving a given problem,

- the ability to cooperate as part of a team practically carrying out a detailed task in the laboratory,

- remarks related to the improvement of teaching materials,

- identifying students' perceptual difficulties enabling ongoing improvement of the teaching process.

Programme content

The lecture program covers the following topics:

Features and functional requirements for electronic devices: degrees and classes of insulation, galvanic separation; electromagnetic compatibility and immunity (EMI, EMC); modularity, complementarity, substitutability in the implementation of devices for embedded systems; metaproducts and full-custom devices. Methodology of designing printed circuits: review of the production technology of printed circuits; rules for creating schematic diagrams, component hierarchy, using library components, creating a network of connections between components, using bundles, creating connection classes, managing component designators, applying ERC design rules; component database management, creating symbols for components with different levels of abstraction (ideological symbol, housing, 3D model, simulation model); rules for the implementation of a connection mosaic (layout); defining and maintaining differential pairs, techniques supporting paths, autorouting, control of DRC design rules; three-dimensional visualization of designed devices, rules of component description in Step models. Realizations of power and supply stages (impulse, continuous, monolithic, protections, monolithic, discrete bridges, unipolar and bipolar H-type, DC, BLDC, multiphase, stepper motor drivers, impulse voltage converters drivers). Control units (including digital and analog implementations of input / output interfaces, including their protections). Current and voltage measurements (systems dedicated to measuring voltages and currents, direct and differential method, using the Hall effect), construction and operation of selected sensors depending on environmental conditions (temperature, pressure, humidity, acceleration), pyroelectric effect, methods of gas concentration detection and dust, PIR detectors. Shaping the properties of the feedback path, filtration, Kalman filter, windup phenomenon. Communication interfaces - overview of integrated communication systems for MODBUS, CAN, Ethernet networks, basics of transmission protocols, methods of compiling the transmission in the microprocessor system. Writing of models of peripheral devices using the VHDL-AMS language. Modeling of complex digital and mixed systems using the AMS standard.

Laboratory classes are conducted in the form of fifteen hours of tutorials and fifteen design hours, held in the laboratory, preceded by a 2-hour instructional session at the beginning of the semester. All laboratory classes are conducted by 2-person teams of students. The laboratory program covers the following issues: advanced methods of designing the hardware layer of the microsystem based on the Altium Designer environment (selection of components, creation of a schematic diagram, development of own library components, implementation of a mosaic of connections, 3D visualization for the designed PCB). The summary of the laboratory classes is the implementation of a simple mini-project of a printed circuit, taking into account the methods and techniques learned in the previous laboratory classes. During the second part of the laboratory, students prepare a project of an exemplary hardware layer for a microsystem with a given functionality in teams of two. Implementation of the project requires the independent selection of components on the basis of documentation, taking into account design rules at each of the design stages and the efficient use of design tools in order to obtain a topography suitable for fabrication dedicated to the embedded system.

Teaching methods

1. Lecture: multimedia presentation supplemented with examples given on the blackboard

2. Laboratory exercises: problem solving, practical exercises, data analysis, simulation, discussion, team work, case studies, multimedia show.

Bibliography

Basic

1. The industrial electronics handbook Wilamowski B, Irwin D., Taylor & Francis, 2011

2. Silniki elektryczne w praktyce elektronika, Przepiórkowski J., BTC, Wa-wa, 2007

3. Komputerowe systemy automatyki przemysłowej, Kwiecień R., Helion, 2012

4. Metrologia elektryczna, Chwaleba A, Poniński M., Siedlecki A., WNT, 2007

5. Podstawy technologii montażu dla elektroników, Kisiel R., BTC, 2012

Additional

1. Programowalne moduły Ethernetowe w przykładach, Chruściel, M. BTC, Wa-wa 2013

2. Linux. Podstawy i aplikacje dla systemów embedded Skalski Ł., BTC, Wa-wa 2012

3. A. Handkiewicz, P. Katarzyński, S. Szczęsny, M. Naumowicz, M. Melosik, P. Śniatała, M. Kropidłowski, Design automation of a lossless multiport network and its application to image filtering, Expert Systems with Applications, vol. 41, Issue 5, 2014

4. A. Handkiewicz, S. Szczęsny, M. Kropidłowski, Over rail-to-rail fully differential voltage-to-current converters for nm scale CMOS technology, Analog Integrated Circuits and Signal Processing, vol. 18, Issue 1, 2018

Breakdown of average student's workload

	Hours	ECTS
Total workload	95	4,0
Classes requiring direct contact with the teacher	45	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for test, project preparation) [1]	50	2,0

[1] delete or add other activities as appropriate