SYLLABUS

Name: ***Rapid prototyping of energy-efficient driving systems (AiRAu-R>SM2-RP-19)***
Name in Polish:
Name in English: ***Rapid prototyping of energy-efficient driving systems***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

ZAL

Language:

English

Course homepage:

https://platforma.polsl.pl/rau1/course/view.php?id=511

Short description:

The aim of the course is to familiarize students with the construction of energy-efficient drive systems used in automation and robotics systems. Students will learn about a range of new technologies that help achieve optimal performance, including energy-efficient motors, variable speed drives and optimized control strategies. A significant part of the course focuses on the issue of rapid prototyping in various hardware and software structures.

Prerequisites - student knowledge should include: classical mechanics, control fundamentals, robotics fundamentals, basics of measurement, embedded systems, programming in Matlab/Simulink and C++.

Description:

ECTS: 3
Total workload: 90 hours (60 contact hours, 30 students' own work hours)
Forms of contact hours:
Lecture 30h
Laboratory 30h
Number of hours allocated to students' own work:
Preparation for colloquium: 15 hours
Preparation for laboratory: 15 hours

Lecture:
1. Introduction. CAD / CAM / CAE systems - basic information.
2. Mechatronics. Computer aided design of mechatronic systems.
3. Sensors – construction, principle of operation, basic applications in mechatronic systems. MEMS technology.
4. Discrete-time control.
5. The issue of rapid prototyping - basic information. Rapid prototyping of control systems. Model-Based Design (MBD). Testing based on mathematical models: MiL, SiL, PiL, HiL. Automatic generation of controller codes directly from the CACSD environment. Real-time simulation.
6. Software solutions supporting prototyping.
7. Hardware solutions supporting prototyping.
8. Electric motors - basic information, classification, principle of operation.
9. DC commutator motors.
10. BLDC brushless motors.
11. Stepper motors.
12. AC motors.
13. Power electronic systems. Frequency inverter.
14. Inverter control methods.
15. Renewable energy sources and energy-efficient drive systems.

Laboratory:
The aim of the laboratory is to familiarize students with the issues of computer aided design and rapid prototyping of control systems in energy-efficient drive systems. The laboratory consists of two parts. In the first, the students become familiar with the issue of rapid prototyping of a simple drive system consisting of a DC motor and a PID controller. In the second part, students divided into project sections perform exercises on laboratory stands equipped with propulsion systems with: DC, AC, stepper and BLDC motors.

Bibliography:

Primary literature:
1. Khorrami F., Krishnamurthy P., Melkote H.: Modeling and adaptive nonlinear control of electric motors. Springer, 2003.
2. Hristu-Varsakelis, Dimitrios, Levine, William: Handbook of networked and embedded control systems. Springer, 2005.
3. Lawrenz W.: CAN system engineering. Springer, 1997.
4. Kamrani, Ali K., Nasr, Emad Abouel : Rapid Prototyping, Theory and Practice. Springer, 2006.

Supplementary literature:
1. Steven Nadel, R. Neal Elliott, Michael Shepard, Steve Greenberg, Gail Katz, and Anibal T. de Almeida: Energy-Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities, 2nd Ed., E-Book, American Council for an Energy-Efficient Economy, 2002.
2. Li Li, Fei-Yue Wang: Advanced Motion Control and Sensing for Intelligent Vehicles. Springer, 2007.
3. Ali K. Kamrani, Emad Abouel Nasr : Engineering Design and Rapid Prototyping. Springer, 2010.

Learning outcomes:

Course-specific learning outcomes: at the completion of the course, student:

- Knows the issue of rapid prototyping of control systems in relation to electric drive systems (report, colloquium) K2A_W04, K2A_W11.
- Knows software and hardware solutions supporting rapid prototyping (report, colloquium) K2A_W11, K2A_W13, K2A_W16.
- Knows the structure and operating principles of electric motors: direct current, alternating current, and pulse-controlled (project, colloquium) K2A_W13, K2A_W16.
- Can perform rapid prototyping of the designed control system in various software and hardware structures (project) K2A_U08.
- Can select components and configure an electric drive system (project) K2A_U20, K2A_U22.
- Can design control systems for electric drives and optimize parameters in terms of energy efficiency (project, colloquium) K2A_U20, K2A_U22.

Assessment methods and assessment criteria:

Course consists of two components: lecture and laboratory. According to SUT regulation, lecture attendance is optional (however highly recommended), whereas laboratory exercises are obligatory.

Students need to pass colloquium (C) and must complete all laboratory exercises and obtain a pass mark on all reports. Making up missed laboratory work is possible on the dates specified in the schedule. On the lecture test, students must obtain a minimum of 50% to pass.
Final laboratory grade (L) is calculated as average of all report grades. The final grade is calculated as: Grade = (0.4C + 0.6L)
The grade is rounded according to the following rules:
[3.00 - 3.25) - 3.0
[3.25 - 3.75) - 3.5
[3.75 - 4.25) - 4.0
[4.25 - 4.75) - 4.5
[4.75 - 5.00] - 5.0

The syllabus is valid from academic year 2023/24 and its content cannot be changed during the semester.

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	3	2020/2021-Z	