COURSE DESCRIPTION CARD - SYLLABUS

Course name
Electric drives of battery and traction vehicles [S2Elmob1>NEPAiT]

Course

Field of study
Electromobility

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Lecture: lectures using illustrative material, simulation results, animations and films. Laboratory: exercises performed in task groups, involving configuration and software of laboratory stations with physical and virtual models of drive systems.

Course objective

The purpose of the course is to obtain knowledge and skills in the field of modern drive systems used in electric vehicles and industrial aplications, with particular focus on control issues. The subject matter of the course includes an overview of the synthesis of drive control systems, energy-efficient drives, sensorless drives and fault-tolerant drive systems. The topics are also expanded to include an analysis of visible development trends in electric drive of vehicles.

Course-related learning outcomes

Knowledge:
1 The student has an advanced and in-depth knowledge of the design, diagnosis and operation of drive systems of hybrid and electric vehicles including traction vehicles; he/she knows the basic processes occurring in the life cycle of technical systems of hybrid and electric vehicles including traction vehicles

2 The student has extended and in-depth knowledge of modeling, analysis and synthesis of components and systems specific to hybrid and electric vehicles including traction vehicles
3. The student has an in-depth knowledge of magnetic and electrical insulating materials, as well as of coupled phenomena in systems with electric, magnetic, thermal and mechanical fields

Skills:
1 The student is able to design, develop and incorporate into data communication, electronic, power electronics and drive systems for hybrid and electric vehicles including traction vehicles
2 The student is able, when determining the functionality and design of electric vehicle systems and systems, to apply adequate analytical, simulation and experimental methods, assessing their suitability and limitations in advance, as well as adapting them to the specifics of the problem or the need to take into account unpredictable operating conditions
3 The student is able, in the formulation and solution of complex and unusual engineering tasks and simple research problems, to apply the system approach and, using appropriate tools and equipment, to make a critical analysis of the performance of simple and complex electric systems of hybrid and electric vehicles including traction, to evaluate them and propose their improvements

Social competences:
1. The student understands that in the field of technology, knowledge and skills are rapidly devaluing which requires their constant updating
2 The student is aware of the need to develop professional achievements, follow the principles of professional ethics

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Verification of learning outcomes for lecture classes is realized through a written exam. During the exam, students answer 3 to 5 problem topics from a previously given pool of topics. The final evaluation will also include individual assessment of students' activity in class.
2. Verification of learning outcomes for laboratory classes consists of evaluation of the level of preparation for classes, evaluation of activity during classes and evaluation of completed reports documenting the course of classes.

Programme content

Lecture: Each topic contains a combination of theoretical concepts, practical examples and case studies to provide a comprehensive understanding of the topic. Programme coverage includes the following topics:
1. The concept of advanced drive systems in industry and electromobility, current trends and future prospects.
2. Fundamental solutions and block structures of electric drive control systems.
3. Overview of control system solutions for electric machines used in electromobility: classic and brushless DC drives, drives with induction motors, drives with permanent magnet and reluctance synchronous motors and drives with switched reluctance motors. Overview of hardware solutions and control systems of power electronic converters for supplying different drive systems.
4 Energy efficient control of selected drive systems, hardware and software solutions for energy efficient control.
5. Sensorless control: introduction to sensorless control, advantages and challenges, techniques for implementing sensorless control, reducing cost and increasing system robustness with sensorless control.
6 Fault-tolerant control: need for fault-tolerant control, fault detection and isolation strategies, design of fault-tolerant control systems, concept of predictive maintenance.
Laboratory: laboratory activities include practical illustrations of selected topics discussed in lectures.

Course topics

1 Introduction to advanced drive systems: Overview of advanced drive systems, meaning in electromobility, current trends and future perspectives.
2 Fundamentals of drive systems: elements of drive systems, principles of operation, types of drive systems.
3 Structure, properties and control of a DC motor drive. Properties of a DC series motor drive.
4. Structure, properties and control of a DC brushless motor drive. DC/DC power electronic converter and

its control.
5. Mathematical description of AC machines using the space vector concept. DC/AC three-phase power electronic converters and their control.
6. Structure, properties and control of a permanent magnet synchronous motor drive.
7. Structure, properties and control of a reluctance synchronous motor drive.
8. Structure, properties and control of an induction motor drive.
9. Structure, properties and control of a switched reluctance motor drive.
10. Measurement of electrical and mechanical variables in electric drives. Voltage, current, position and speed sensors.
11. Sensorless control: introduction to sensorless control, advantages and challenges of sensorless control technology, reducing cost and increasing system reliability with sensorless control.
12 Fault-tolerant control: the need for fault-tolerant control, fault detection and isolation strategies, fault-tolerant control system design.
13. The concept of predictive maintenance and determination of remaining time of correct operation.
Laboratory: laboratory activities include practical illustrations of selected topics discussed in lectures.

Teaching methods

Lecture: lectures using illustrative materials, simulation results, animations and videos.
Laboratory: exercises performed in task groups, involving the configuration and programming of laboratory workstations with physical models of drive systems; a small number of classes can be carried out using computer simulation methods.

Bibliography

Basic:
1. Dębowski. A: Elektryczny napęd trakcyjny, Wydawnictwo Naukowe PWN 2019
2. Lech Grzesiak L., Arkadiusz Kaszewski A. , Bartłomiej Ufnalski B.: Sterowanie napędów elektrycznych, Wydawnictwo Naukowe PWN 2023
3. Zawirski K., Deskur J., Kaczmarek T.: Automatyka napędu elektrycznego, Wydawnictwo Politechniki Poznańskiej,
4. Lecture materials provided by instructor

Additional:
1. Materials from Texas Instruments in the field of electric drives
2. Materials from Mathworks in the field of electric drives
3. Shyni P Nair, M S Sivagama Sundari: Technologie für Elektrofahrzeuge, 2023
4. Nikowitz M.: Advanced Hybrid and Electric Vehicles, Springer 2018
5. Ehsani M., Gao Y., Longo S.: Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Taylor & Francis 2018

Breakdown of average student's workload

	Hours	ECTS
Total workload	77	3,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00