COURSE DESCRIPTION CARD - SYLLABUS

Course name
Elective subject E: Electromobility and energy storage

Course

Field of study
Electrical engineering
Year/Semester
4/7
Area of study (specialization)
Electromobility and electrical systems in vehicles and industry
Profile of study
practical
Level of study
First-cycle studies
Course offered in
polish
Form of study
full-time
Requirements
elective

Number of hours

Lecture
30
Laboratory classes
15
Other (e.g. online)
Tutorials
Projects/seminars
15

Number of credit points

5

Lecturers

Responsible for the course/lecturer:
D.Sc. Leszek Kasprzyk
email: Leszek.Kasprzyk@put.poznan.pl
tel. 61 665 23 89
Instytut Elektrotechniki i Elektroniki Przemysłowej
ul. Piotrowo 3A 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Basic knowledge of electrical engineering, electrical machines, and forms and methods of energy conversion. Ability to interpret transmitted messages and effective education in the field related to energy storage and hybrid systems as well as teamwork.

Course objective

To familiarize students with the current state and directions of electromobility development in Poland and in the world. Presentation of the classification and general characteristics of electric energy storage facilities and presentation of selected methods of testing and fastening them.

Course-related learning outcomes

Knowledge

Structured knowledge in the field of electromobility.

Knowledge about the energy consumption of motor vehicles and electricity storage used in electric and hybrid vehicles.

Knowledge of the design of simple vehicle power systems.

Skills

Able to classify and analyze the operation of the propulsion system and energy storage in electric and hybrid vehicles.

Able to research, analyze and model the work of selected electricity storage facilities used in mobiulic systems.

Social competences

Is aware of the growing energy problem in the world.

Understand various aspects and effects of electrical engineer activities, including environmental impact

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Knowledge acquired as part of the lecture is verified during the written test, which takes place during the last lecture. The exam consists of open-ended points depending on the level of difficulty. Passing threshold: 50% of points. Final issues are sent by e-mail to the group staroste using the university e-mail system 2-3 weeks before the date of passing.

Completion of project classes is based on ongoing control of progress, class participation and implementation of the final project.

Completion of laboratory exercises is based on the assessment of theoretical and practical knowledge necessary to complete the task being carried out, verified on an ongoing basis during classes with students and on the basis of written reports on the task.

Programme content

The lecture:

History of vehicles, current statistics on transport and motorization worldwide. Worldwide electromobility including Poland. Methods of improving efficiency of motor vehicles. Technical parameters of electric and hybrid vehicles. Determining the power and energy requirements of a conventional vehicle. Selection and analysis of energy storage operation in a vehicle. Energy storage charging systems in electric and plug-in hybrid vehicles. Economic analysis of the profitability of electric and hybrid vehicles. Introduction to electrical storage. Classification of energy storage facilities. Parameters characterizing electrical storages (power density, energy, SOC, SOP, SOH, ready time). Principles of operation of electrochemical batteries. Selection and analysis of operation of selected energy storages (modelling of lead-acid, lithium-ion and supercapacitors). Energy storage charging systems (wired and wireless), including electric and plug-in hybrid vehicles. Analysis of the profitability of energy storage. Methods and modelling of electrochemical energy storage (PbO2, Li-Ion). Modelling

of electrical energy storage systems (supercapacitors). Durability of electrochemical storages. Operation of energy storage in packages, BMS (active and passive balancers, etc.). UPS solution overview. Electric traction. Rail and individual transportation. Drones. Smart Grid, V2G.

The usage and tasks of energy storage facilities in the power system, including those with a significant share of unstable sources. Characteristics of mechanical storages (fly wheel, compressed air systems, pumped-storage power plants). Chemical storages (fuel cells and hydrogen).

The project:

Identification of parameters of the lithium-ion battery model. Identification of parameters of the supercapacitors model. Electrochemical impedance spectroscopy. Selection and design of installations containing energy storages.

The lab:

1. Tests of the charging and discharging process of lead-acid batteries (charging and discharging characteristics, determination of capacity, internal resistance, power density and energy).

2. Tests of the charging and discharging process of li-ion batteries (charging and discharging characteristics, determination of capacity, internal resistance, power density and energy)

3. Analysis of the operation of the lithium-ion battery pack (voltage balancers, thermal tests, including thermovision)

4. Identification of parameters of the lithium-ion battery model

5. Identification of parameters of the supercapacitors model

6. Kinetic storage - demonstration exercise; Lithium-ion battery with supercapacitor

Teaching methods

Lectures: Multimedia presentation, illustrated with examples on the board, initiating discussions during the lecture. Additional materials are placed in the Moodle system.

Laboratory exercises: multimedia presentation illustrated with examples given on a blackboard, demonstrations and implementation of tasks given by the teacher - practical exercises

Projects: Didactic classes in the auditorium (calculations in books and on the board supported by the application in the Matlab environment).

Bibliography

Basic

1. Andrzej Czerwiński, Akumulatory, baterie, ogniwa. Wydawnictwa Komunikacji i Łączności, Warszawa, 2012.

2. Hariharan Krishnan S., Piyush Tagade, Sanoop Ramachandran. Mathematical Modeling of Lithium Batteries: From Electrochemical Models to State Estimator Algorithms. Springer, 2017

3. Herner A., Riehl H. J.: Elektrotechnika i elektronika w pojazdach samochodowych, WKiŁ, Warszawa 2003.

4. Jastrzębska G.: Odnawialne źródła energii i pojazdy proekologiczne, WNT, Warszawa 2009.

Additional

1. Akumulatory elektryczne - Terminologia PN-88/E-01004 Polski Komitet Normalizacji Miar i Jakości.

2. Akumulatory do napędu pojazdów elektrycznych drogowych - Część

3: Badania dotyczące działania i trwałości (kompatybilne w ruchu kołowym pojazdy do ruchu miejskiego) PN-EN 61982-3 / Polski Komitet Normalizacyjny

5. Denton T.: Automobile electrical and electronic systems, Arnold, London 2000.

6. Larminie J., Lowry J.: Electric vehicle technology. Explained, Wiley, West Sussex 2003

Breakdown of average student's workload

	Hours	ECTS
Total workload	130	5,0
Classes requiring direct contact with the teacher	70	3,0
Student's own work (literature studies, preparation for laboratory classes, preparation for tests, project preparation)[1]	60	2,0

[1] delete or add other activities as appropriate