POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Aircraft Power Systems [S2AiR2-SIiB>PO1-SZSP]

Course

Field of study

Automatic Control and Robotics

Year/Semester

1/2

Area of study (specialization)

Intelligent and Unmanned Systems

Profile of study

general academic

Level of study

second-cycle

Course offered in

Polish

Form of study

full-time

Requirements

elective

Number of hours

Lecture

15

Laboratory classes

15

Other

0

Tutorials

0

Projects/seminars

15

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student entering this subject should have a basic knowledge of the mathematics of electrical engineering, drive systems and energy conversion methods. The student should be familiar with the basics of using programs that support scientific calculations, such as Matlab. He should have the ability to obtain information from the indicated sources.

Course objective

To provide students the knowledge related to the construction, application and modeling of energy storage systems. To gain knowledge and skills on how to solve problems related to the selection and analysis of the operation of energy storage in vehicles, with particular emphasis on flying vehicles.

Course-related learning outcomes

Knowledge:

1. has a structured and in-depth knowledge of energy storage technologies and the types and principles of operation of different types of storage (K2_W5, K2_W12).
2. has knowledge of the applications of selected methods of testing and modeling of electric energy storage (K2_W5, K2_W12).

Skills:
1. Can perform to classify and analyze the performance of energy storage (K2_U1, K2_U2).
2. Can perform to select the type and parameters of energy storage for a selected vehicle (K2_U2).
3. Can perform to perform basic testing of selected energy storage (K2_U2, K2_U18).
4. Can perform to classify and analyze the propulsion system and energy storage (K2_U18).

Social competences:
1. is aware of the responsibility for his own work and the need for a professional approach to technical issues (K2_K4)

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired in the lecture is verified in a written exam. The exam consists of 5-8 open questions scored according to the level of difficulty. Examination questions are sent to the group leader by e-mail using the university e-mail system 2-3 weeks before the exam date.
Skills acquired in laboratory classes are verified on the basis of ongoing progress control and evaluation of the reports prepared.
Skills acquired in project classes are verified on the basis of current progress control, activity in class and completion of the final project performed in subgroups.
The following grading scale is used for all forms of classes: <0...50%> of possible points - insufficient (2.0), <50...60%) - sufficient (3.0),<60...70%) - sufficient plus (3.5), <70...80%) - good (4.0), <80...90%) - good plus (4.5), <90...100%> - very good (5.0).

Programme content

Construction, principle of operation, classification and operating parameters of electric energy storage devices with particular emphasis on batteries.

Determination of energy consumption of aircraft and issues of selecting an energy storage device for electric vehicles.

Course topics

Lecture:
Classification of electric energy storage used to power vehicle propulsion systems including flying vehicles. Parameters characterizing electrical energy storage. Principles of operation of lithium-ion cells. Safety of operation and operation of high-voltage vehicle systems. Energy storage charging systems.
Selection and analysis of operation of selected energy storages for flying vehicles. Cost-effectiveness analysis of the use of energy storages. Durability of electrochemical energy storages. Operation of packaged energy storages, cell management systems. Fuel cells.

Project:
Analysis of the electrical energy requirements of mobile objects including flying. Design of battery power systems. Modeling methods for electrochemical cells (PbO_2, Li-Ion) and electric energy storage (supercapacitors). Identification of lithium-ion battery model parameters.

Laboratory:
Study of electrical, thermal properties and modes of operation of electrical energy storage. Construction and operation analysis of lithium-ion cells. Study of electrochemical cell packages for powering electric vehicles.

Teaching methods

Lecture: multimedia presentation, illustrated by examples given on the blackboard, initiation of discussion during the lecture. Additional materials uploaded to the Moodle system.
Laboratory: detailed review of reports by the laboratory instructor and discussion of comments, demonstrations, work in teams.
Projects: didactic activities in the auditorium - calculations in zesist and on the blackboard supported by an application in the Matlab environment.

Bibliography

Basic:
1. Kasprzyk L.: Wybrane zagadnienia modelowania ogniw elektrochemicznych i superkondensatorów w pojazdach elektrycznych, Poznan University of Technology Academic Journals. Electrical Engineering - 2019, Issue 101, s. 3-55
2. Damian B., Kasprzyk L.: A novel method for the modelling of the state of health of lithium-ion cells using machine learning for practical applications, Knowledge-Based System, 2021, vol. 219, s. 106900-1-106900-11
3. Kasprzyk L., Bednarek K., Burzyński D.: Symulacja pracy akumulatorów kwasowo-ołowiowych, Przegląd Elektrotechniczny, Nr 12 (92), 2016, s. 61-64, nr DOI: 10.15199/48.2016.12.16.
4. Wang C., Hussaini H., Gao F., Yang T.: Modeling and control of DC grids within more-electric aircraft, Modeling, Operation, and Analysis of DC Grids, Academic Press, 2021, pp. 337-366,

Additional:
1. Akumulatory elektryczne - Terminologia PN-88/E-01004 Polski Komitet Normalizacji Miar i Jakości.
2. Andrzej Czerwiński, Akumulatory, baterie, ogniwa. Wydawnictwa Komunikacji i Łączności, Warszawa, 2012.
3. Hariharan Krishnan S., Piyush Tagade, Sanoop Ramachandran. Mathematical Modeling of Lithium Batteries: From Electrochemical Models to State Estimator Algorithms. Springer, 2017

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00