COURSE DESCRIPTION CARD - SYLLABUS

Course name
Energy conversion systems in renewable energy sources and electric vehicles [N1Eltech1>F-UPEwOZE]

Course

Field of study
Electrical Engineering

Year/Semester
5/9

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
part-time

Requirements
elective

Number of hours

Lecture
10

Laboratory classes
10

Other (e.g. online)
0

Tutorials
0

Projects/seminars
10

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge - Elementary knowledge in the field of electrical engineering, electronics, power electronics and electrical machines. Skills - The skill of effective self-education in a field related to the chosen major of studies, skill to make the right decisions when solving simple tasks and formulating problems in the field of widely understood electrical engineering. Competences - Student is aware of the widening his competence, demonstrate a willingness to work in a team, posse a skill to comply with the rules in force on the lecture and laboratory, have a skill to comply with the rules in force during lecture, project and laboratory classes

Course objective

The discussion of the latest achievements and application solutions of electricity conversion systems in Renewable Energy Sources (RES) and in broadly understood electromobility, including systems used in electric vehicles.

Course-related learning outcomes

Knowledge:
1. Student has basic knowledge in the field of renewable energy sources and electromobility.
2. Student posses ordered knowledge about construction, principles of operation and static operation and kinetic, electromagnetic energy converters and technical systems used in renewable energy systems and in mobile power systems (electromobility).
3. Student has knowledge of the construction and principles of operation of electronic and energy-electronic systems used in renewable energy and electromobility systems.
4. Student has ordered knowledge of used energy storage.
5. Student has basic knowledge of systems that monitor the charge status of chemical energy stores.
6. Student has ordered knowledge of systems controlling the process of loading and unloading chemical energy storage.
7. The student has a basic knowledge of automation (closed control systems).

Skills:
1. The student is able to design, build, run and test selected electricity conversion systems used in renewable energy and mobile electrical systems.
2. The student is able to use professional programming and simulation environments in the design process of selected energy conversion systems.

Social competences:
1. The student understands the importance of knowledge in solving problems and raising professional, personal and social competences.
2. The student is aware that in technology knowledge and skills quickly become obsolete.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lecture:
-assessment of knowledge and skills by the completion of a written test (solving problem),
-continuous evaluation for each lecture (rewarding activity and quality of the expression).
Laboratory:
- end test and rewarding of knowledge necessary to carry out subsequent tasks in class,
- continuous assessment of the student"s activity and the increase of his knowledge and skills, as well as social competences related to team work,
- assessment of knowledge and skills related to the implementation of tasks, assessment of reports on the completed task.
Project:
- assessment of knowledge and skills related to the implementation of project tasks,
- continuous evaluation of the student"s activity and level of his knowledge and skills.
Extra points for the activity in the classroom, and in particular for:
-discussion and proposition of additional aspects of the subjects,
-effectiveness of the application of the knowledge gained during solving the given problem,
-ability to work within a team, which performs the task detailed at the laboratory,

Programme content

Lectures:
Systems for converting various forms of energy into electricity. Primary energy sources and processing systems. Sommerfeld"s concept: energy and co-energy. Electromagnetic and mechanical systems - analogies. The principle of virtual work. Dynamics of electromechanical systems - the Hamilton principle and Lagrange equations. Wind, hydro, photovoltaic and fuel cells. Types and characteristics of hydro, wind and photovoltaic power plants. Electromechanical energy sources; rotary and linear generators - construction, operating principle, basic functional characteristics. Photovoltaic and chemical sources of electricity: photovoltaic panels and fuel cells. Electricity storage tanks. Mobile propulsion systems used in broadly understood traction. Converter systems coupling sources and receivers requiring electricity with various parameters - selected structures and their operating principle. Selected algorithms for controlling power electronic converters, including MPPT (Maximum Power Point Tracking). The problem of signal synchronization in power electronics converters dedicated to energy conversion in renewable energy systems. Control methods for power electronic converters to increase the efficiency of electricity

conversion.
Laboratory:
- Selection of elements for a photovoltaic electricity source coupled to the power grid, testing the shape of the voltage and current curve at the inverter output, problem of current and voltage harmonics, effective ways of eliminating disturbances
- Generator operation of an asynchronous machine: autonomous operation - selection of a capacitor, machine self-excitation conditions; operation on a separate network (island operation) - the problem of insufficient inductive reactive power.
- Synchronous machine generator work: autonomous work, networking.
- Peltier cell - source of cold and electricity; tests of acceptable temperature differences,
- Micro fuel cell - production of "fuel" by water distillation (photovoltaic energy source); load tests; measurements of emitted "pollutants".
- A rotational speed regulated power unit with a synchronous motor operating in dynamically changing load conditions; determination of basic functional properties.
- DC / DC imaging converter cooperating with a photovoltaic panel implementing the MPPT algorithm.
- Non-matching voltage inverter as a controlled voltage source in renewable energy systems.
- Grid inverter as a controlled current source enabling energy return to the AC network.
- System for monitoring the state of charge of selected types of rechargeable batteries.
- Rechargeable battery charging systems working in CV and CC mode.
- A converter system dedicated to cooperate with a synchronous generator enabling the increase of energy conversion efficiency
Project:
- Cost analysis resulting from the use of the publicly available power system - analysis of information contained in invoices received by the collective and individual electricity consumer.
- Balance justifying the economic efficiency of the construction of a hydro-power plant.
- Design of a low-power photovoltaic system cooperating with a publicly available distribution network.
- Design of a low-power backyard wind farm system working autonomously.
- Implementation of developed algorithms for monitoring battery charge status.
- Development of the structure and control algorithms for passive and active balancers dedicated to selected type of accumulator batteries.
- Cascade control in complex converter systems dedicated for renewable energy (e.g. selection of the structure and parameters of the control system).
- Selection of control structures and methods to limit leakage current in systems based on PV cells.
- Design of a converter system cooperating with a synchronous generator enabling energy return to the AC network

Teaching methods

Lectures - presentation of issues using multimedia, illustrated with examples given on a board, discussion of problem issues.
Laboratory - implementation of simulation and laboratory tests of electromagnetic fields in electrical devices.
project - implementation of projects, study visits in selected renewable energy facilities.

Bibliography

Basic
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Additional
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Breakdown of average student's workload

	Hours	ECTS
Total workload	80	3,00
Classes requiring direct contact with the teacher	35	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	45	2,00