COURSE DESCRIPTION CARD - SYLLABUS

Course name
Renewable energy sources [N2Eltech2>OZE]

Course

Field of study
Electrical Engineering

Year/Semester
1/1

Area of study (specialization)
Microprocessor Control Systems in Electrical Engineering

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
10

Laboratory classes
10

Other
0

Tutorials
0

Projects/seminars
10

Number of credit points

4,00

Coordinators

dr inż. Grzegorz Trzmiel
grzegorz.trzmiel@put.poznan.pl

Lecturers

Prerequisites

Basic knowledge of physics, electrical engineering and mathematics (general level). The ability to understand and interpret the knowledge passed on during classes. The ability to effectively self-educate in a field related to the chosen field of study. Awareness of the need to expand one's competences, readiness to cooperate as part of the team.

Course objective

To familiarize students with the construction, operating principles, capabilities, and design principles of systems utilizing renewable energy sources, particularly photovoltaics, electricity storage, and hybrid systems, particularly heat pumps. To present new opportunities in generating electricity using these technologies.

Course-related learning outcomes

Knowledge:
1.has an orderly and theoretically founded knowledge in the field of renewable energy sources,
2. knows and understands the phenomena and processes that allow the conversion of energy from

selected renewable energy sources into electricity,
3. is aware of the current state of development of renewable energy sources and prospective trends in Poland and in the world.

Skills:
1.can obtain information from literature, databases and other sources, analyze and interpret it, draw conclusions, justify opinions,
2.can work independently and in a team, use properly selected methods and devices in terms of electrical parameters and characteristics,
3. is able to carry out the necessary design calculations, interpret the obtained results, draw conclusions.

Social competences:
1.can work individually and cooperate in a group,
2. is aware of the importance and understanding of non-technical aspects and effects of engineering activities, including its impact on the environment and the responsibility for the decisions made.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired in the course of the lecture is verified by completing the course lasting approx. 45-60 minutes, consisting of 10-15 questions (test and open), with different scores. Passing threshold: 50% of points. The issues on the basis of which the questions are developed will be sent to students by e-mail using the university's e-mail system.
The skills acquired during the laboratory classes are verified on the basis of: grades from reports on the exercises performed. In addition, the final assessment of laboratories takes into account: rewarding the knowledge necessary to implement the problems posed in a given area of laboratory tasks, activity in each class, rewarding the increase in the ability to use the learned principles and methods, assessment of knowledge and skills related to the implementation of the exercise task.
Design classes are assessed on the basis of activities during design classes and the completed project in accordance with the requirements specified by the teacher.
In addition, the student can earn additional points for activity during classes, and especially for: proposing to discuss additional aspects of the issue, the effectiveness of applying the acquired knowledge when solving a given problem, the ability to cooperate as part of a team practically implementing a detailed task in the laboratory and in a project task, comments related to improvement didactic materials, aesthetic diligence of the tasks developed as part of self-study.

Programme content

The module program covers issues related to the construction, principles of operation, cooperation and use of devices generating and storing energy using renewable energy sources. and the basis for calculating the economic profitability of using renewable energy sources.

Course topics

The lecture program covers the following topics:
Legal conditions for the use of renewable energy sources. Characteristics of selected renewable energy sources and devices enabling the conversion and storage of energy from renewable sources, primarily from a prosumer perspective: photovoltaics (PV), wind energy (TW), and electricity storage. Costs of electricity generation, transmission, and distribution. Estimation of energy yields and payback times. Statistical description of solar energy. Analytical and numerical modeling of PV modules (single-diode and dual-diode photovoltaic cell models, MPP tracker simulation). Types and use of irradiance measurement data in estimating energy obtained from PV modules. Application possibilities in various fields. Advantages, disadvantages, and limitations of various system solutions. Presentation of innovative solutions in the subject area, applied in the latest practical applications. The laboratory program includes the following topics:
Introduction to the structure, operating principles, and performance characteristics of various types of photovoltaic modules, wind turbines, and hybrid systems in various configurations and operating conditions. Planning measurement methodologies, measuring, and calculating characteristic parameters for the aforementioned devices.
The project program includes the following topics:

The course focuses on developing a hybrid on-grid generation system design utilizing PV modules and heat pumps. Specific tasks include:
- analysis of design assumptions and determining the overall system structure
- analysis of energy resources at the generation system location and determining its capacity
- selection of equipment (PV modules, inverters, optimizer systems, protection systems, cables, lightning and surge protection, monitoring)
- economic analysis and determination of the payback period
- development of design documentation, including the location of PV modules
- use of software designed for the analysis and design of renewable energy generation systems.

Teaching methods

Lecture: multimedia presentations containing drawings, diagrams, photos, supplemented with practical examples on the blackboard, slides and computer programs, which makes it easier to combine theory with practice. The lecture is supplemented with additional materials to be provided to students for independent study. Using students' knowledge of other subjects, initiating discussions, asking questions to increase student activity and independence.
Laboratories: team work (measurements) on physical positions modeling the work of renewable energy sources in the field of photovoltaics, wind energy, hybrid systems in cooperation with e.g. energy storage and charging regulators.
Projects: multimedia presentations and blackboard classes containing the necessary elements (drawings, charts, diagrams, patterns) in the process of designing renewable energy installations with PV, TW, energy storage and heat pumps. The use of dedicated software in the calculation and verification process.
Ongoing verification during classes of students' progress in terms of prepared projects, with comments enabling proper management of the course of work.

Bibliography

Basic:
1. Jastrzębska G., Ogniwa słoneczne. Budowa, technologia i zastosowanie, Wydawnictwa Komunikacji i Łączności, Warszawa, 2013.
2. Wolańczyk F., Elektrownie wiatrowe, Wydawnictwo KaBe, Krosno, 2009.
3. Lewandowski W.: Proekologiczne źródła energii odnawialnej, WNT, Warszawa 2012.
4. Corkish R., Sproul A., and others, Applied Photovoltaics, 3rd Edition , Taylor&Francis eBooks, 2013.
5. Haberlin H, Photovoltaics system design and practice, Wiley, 2013.
6. Jenkins D., Renewable Energy Systems, Earthscan Expert, 2013.
7. White S., Solar Photovoltaic Basics, Taylor&Francis Ltd, 2015.

Additional:
1. Paska J., Wytwarzanie energii elektrycznej, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2005.
2. Lubośny Z, Farmy wiatrowe w systemie elektroenergetycznym, Wydawnictwo WNT, Warszawa, 2013.
3. Kasprzyk L., Tomczewski A., Pietracho R., Mielcarek A., Nadolny Z., Tomczewski K., Trzmiel G., Alemany J., Optimization of a PV-Wind Hybrid Power Supply Structure with Electrochemical Storage Intended for Supplying a Load with Known Characteristics, Energies, vol. 13(22), 6143, 2020, https://doi.org/10.3390/en13226143
4. Głuchy D., Kurz D., Trzmiel G., The impact of shading on the exploitation of photovoltaic installations, Renewable Energy, vol. 153, p. 480-498, June 2020, DOI: https://doi.org/10.1016/j.renene.2020.02.010.
5. Trzmiel G., Analiza metod regulacji mocy w elektrowniach wiatrowych, Computer applications in electrical engineering vol. 89/2017, Poznan University of Technology Academic Journals Electrical Engineering, Poznań, 2017, str. 395-404.
6. Trzmiel G., Układy śledzące punkt maksymalnej mocy w inwerterach stosowanych w instalacjach fotowoltaicznych, Computer applications in electrical engineering vol. 87/2016, Poznan University of Technology Academic Journals - Electrical Engineering, Poznań, 2016, str. 23 - 36.
7. Trzmiel, G., Jajczyk, J., Kardas-Cinal, E., Chamier-Gliszczynski, N., Wozniak, W., Lewczuk, K. (2021). The
Condition of Photovoltaic Modules under Random Operation Parameters. Energies, vol. 14(24), 8358, 2021.
8. Internet: specialist literature, catalog cards, standards.

Breakdown of average student's workload

	Hours	ECTS
Total workload	105	4,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	75	3,00