# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Renewable energy sources [S1Eltech2>OZE]

## Course

Field of study
Electrical Engineering

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

## Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

## Number of credit points

2,00

## Coordinators

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

## Lecturers

## Prerequisites

Basic knowledge of physics, electrical engineering, and mathematics (at a general level). Ability to engage in effective self-education in a field related to the chosen field of study. Awareness of the need to expand one's competencies and willingness to collaborate within a team.

## Course objective

To familiarize students with the design, operating principles, and application possibilities of renewable energy sources, particularly in the areas of photovoltaics, wind power, and hydropower. Justification for the need to replace conventional sources with renewable ones, due to the depletion of the former and the growing environmental pollution. Presentation of new possibilities in the field of electricity generation.

## Course-related learning outcomes

Knowledge:
1. possesses structured and theoretically grounded knowledge of renewable energy sources,
2. knows and understands the phenomena and processes that enable the conversion of energy from renewable energy sources into electricity,
3. is familiar with the current state of renewable energy development and prospective trends in Poland

and worldwide.

Skills:
1. is able to obtain information from literature, databases, and other sources, analyze and interpret it, draw conclusions, and justify opinions.
2. is able to work independently and in a team, using appropriately selected methods and devices for electrical parameters and characteristics.
3. is able to interpret the obtained results and draw conclusions.

Social competences:
1. is able to work individually and collaboratively in a group,
2. is aware of and understands the importance and impact of non-technical aspects of engineering activities, including their impact on the environment and the associated responsibility for decisions made.

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired during the lecture is verified by an exam lasting approximately 60-90 minutes, consisting of 10-15 questions (multiple and open-ended), with various marks. Passing threshold: 50% of points. The topics that form the basis of the questions will be presented to students via the e-courses platform.
The skills acquired during laboratory classes are verified on the basis of: grades from reports on the exercises performed. In addition, the final laboratory grade will be based on: rewarding the knowledge necessary to solve the problems posed in the given laboratory area, active participation in each session, rewarding the increase in the ability to use the principles and methods learned, and assessing the knowledge and skills associated with completing the exercise.
In addition, students can earn additional points for their activity during classes, and in particular for: proposing to discuss additional aspects of the issue, effective application of acquired knowledge when solving a given problem, ability to cooperate within a team practically implementing a specific task in the laboratory, comments related to the improvement of teaching materials, aesthetic care of the developed tasks 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 energy using renewable energy sources: sun, wind and water.

## Course topics

The lecture program covers the following topics:
Justification for the need to use renewable energy sources. Legal framework. Characteristics of renewable energy sources. Characteristics of devices enabling the conversion and storage of energy from renewable energy sources: photovoltaics, wind power, and hydropower. Costs of electricity generation, transmission, and distribution. Impact of renewable energy sources on the natural environment. Estimating energy yield. Application possibilities in various fields. Advantages, disadvantages, and limitations of such solutions. Presentation of innovative solutions in the subject area, applied in the latest practical solutions.
The laboratory program includes the following topics:
Learning about the structure, operating principles, and performance characteristics of various types of photovoltaic modules, wind turbines, and fuel cells in various configurations and operating conditions. Planning measurement methodology, measurements and calculations of characteristic parameters of the above-mentioned devices.

## Teaching methods

Lecture: multimedia presentations containing drawings, diagrams, photos, supplemented with practical examples on the board, slides and computer programs, which facilitates the connection between theory and practice. The lecture is supplemented with additional materials provided to students for independent study. Students' knowledge of other subjects is utilized, discussions are initiated, and questions are asked to increase student engagement and independence.

Laboratories: teamwork (measurements) at physical stations modeling the operation of renewable energy sources in the areas of photovoltaics, wind energy, and hydrogen fuel cells, in conjunction with, for example, energy storage systems and charge controllers.

## Bibliography

Basic:
1. Yang P., Renewable Energy: Challenges and Solutions, Springer, 2024.
2. Jastrzębska G., Ogniwa słoneczne. Budowa, technologia i zastosowanie, Wydawnictwa Komunikacji i Łączności, Warszawa, 2013.
3. Wolańczyk F., Elektrownie wiatrowe, Wydawnictwo KaBe, Krosno, 2009.
4. Lewandowski W.: Proekologiczne źródła energii odnawialnej, WNT, Warszawa 2012.
5. Corkish R., Sproul A., and others, Applied Photovoltaics, 3rd Edition , Taylor&Francis eBooks, 2013.
6. Haberlin H, Photovoltaics system design and practice, Wiley, 2013.
7. Jenkins D., Renewable Energy Systems, Earthscan Expert, 2013.
8. White S., Solar Photovoltaic Basics, Taylor&Francis Ltd, 2015.

Additional:
1. Tytko R., Urządzenia i systemy energetyki odnawialnej, Kraków, 2019.
2. Zimny J., Odnawialne źródła energii w budownictwie niskoenergetycznym, Wydawnictwa Naukowo-Techniczne, Kraków-Warszawa, 2010.
3. Paska J., Wytwarzanie energii elektrycznej, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2005.
4. Lubośny Z, Farmy wiatrowe w systemie elektroenergetycznym, Wydawnictwo WNT, Warszawa, 2013.
5. 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
6. 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.
7. 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.
8. Trzmiel G., Determination of a mathematical model of the thin-film photovoltaic panel (CIS) based on measurement data. Eksploatacja i Niezawodnosc - Maintenance and Reliability 2017; 19 (4): 516-521, http://dx.doi.org/10.17531/ein.2017.4.4.
9. Internet: specialized literature on the subject, catalog cards, standards.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 57 | 2,00 |
| Classes requiring direct contact with the teacher | 32 | 1,00 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 25 | 1,00 |