COURSE DESCRIPTION CARD - SYLLABUS

Course name
Elective course E: Design and modeling of effective RES systems

Course

Field of study
Power Engineering

Year/Semester
4/7

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	15	0
Tutorials	Projects/seminars	
0	15	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
dr hab. inż. Andrzej Tomczewski

email: andrzej.tomczewski@put.poznan.pl

tel. 616652788

Wydział Automatyki, Robotyki i Elektrotechniki

ul. Piotrowo 3A, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Students starting this subject should have basic knowledge in the field of power engineering, renewable energy sources and numerical methods, as well as the ability to use a spreadsheet and programming in a high-level language, e.g. C ++, C #, Matlab environment.

Course objective

Providing students with knowledge related to modeling and designing highly effective power systems using renewable energy sources (RES). Developing students' skills to solve engineering problems in the selection of the structure of renewable energy generation systems adapted to the geographical location and load characteristics to achieve high efficiency.

Course-related learning outcomes

Knowledge

1. has knowledge of the design of generational systems using wind and photovoltaic sources

2. has knowledge of simple ways to model wind turbines and photovoltaic modules

3. has knowledge about the methods of improving the energy efficiency of RES generation systems, including hybrid systems

Skills

1. knows how to implement models of wind and solar systems in the programming environment

2. knows how to design highly efficient generation systems from renewable energy using simple, proprietary applications

3. knows how to take into account load curves and geographical location in the design process of effective renewable energy generation systems

Social competences

1. understands that knowledge and skills in the field of renewable energy sources are changing rapidly, therefore necessary systematic training

2. understands that the use of highly efficient RES generation systems contributes to reducing CO2 emissions to the environment

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 exam. The exam consists of 5-8 open questions that have points depending on the level of difficulty. Passing threshold: 50% of points. Exam issues are sent to the staroste by e-mail using the university e-mail system 2-3 weeks before the exam date.

Skills acquired as part of project classes are verified on the basis of ongoing monitoring of progress in the implementation of the computer system created in groups during classes and own work. Presentation of software in laboratory groups and answer to questions about the implemented computer system. Passing threshold: 50% of points.

Skills acquired as part of the laboratory are verified by passing, which lasts 3-4 teaching units. Students receive a power system model to perform, which they must create in the NEPLAN software, perform a system analysis and refer to its results. Maximum score for the credit is 70 points. Another 30 points can be obtained for attendance. The threshold for passing the subject is 50 out of 100 points.

Programme content

Lecture:

The use of wind speed and irradiance measurement data in modeling of wind turbines and PV panels. Elements of technical statistics in modeling of renewable energy elements and design of systems cooperating with SE (correlation, regression, time series analysis). Statistical description of wind and solar energy. Modeling renewable energy sources with particular emphasis on wind and solar power plants. Numerical implementation of selected renewable energy models (integration of e.g. Weibull probability density distribution, interpolation and approximation of wind turbine power characteristics, solving nonlinear equations - single diode and two diode photovoltaic model, MPP tracker simulation). Modeling of generative hybrid systems from RES and energy storages. Energy efficiency of RES systems, including hybrid systems. Designing highly efficient generation systems from RES: matching generation curves to load curves, applying stochastic optimization methods (Monte Carlo method, genetic algorithm) in the design of highly efficient hybrid RES power systems. The concept of using multi-criteria optimization in RES systems.

Laboratory:

To familiarize students with the commercial NEPLAN software, enabling a broadly understood analysis of the operation of the electrical system and its components. Creation of a power system model in the NEPLAN program. Calculation of power flow in the created network. Analysis of load and generation variability using manually defined profiles. Optimization of power flow to improve the selected criterion (eg "minimizing transmission losses"). To familiarize students with the problem of voltage stability of the system. Examine the voltage stability of the system and find the nodes most sensitive to load changes. Analysis of the impact of higher harmonics on the power system. Analysis of the impact of using higher harmonics filters on the operation of the power system. Introduction to programming using the free Ocatve software with the Matpower module installed, whose functionality partly overlaps with the NEPLAN program.

Project:

Development of a computer system supporting the process of designing renewable energy generation systems, taking into account geographical location (the use of various types of wind speed and irradiation measurement data, including those provided by IMiGW). Subsequent issues are:

- development and creation of basic data structures, implementation of a simple database of wind turbines and PV modules,

- preparing excel format files with measurement data (wind speeds) and loading them into IT structures, statistical processing of wind speed and irradiance,

- implementation of a solar-wind hybrid system model (solving nonlinear equations, MPP tracker software implementation, wind turbine power curve interpolation),

- implementation of a simple energy storage model,

- implementation of the calculation module for electricity generated in the system over a period of one year, After each project class, the application team completes the current stage at home.

Teaching methods

Lecture: multimedia presentation (including drawings, photos, animations) supplemented with examples given on the board, taking into account various aspects of the issues presented, including: economic and ecological, presenting a new topic preceded by a short reminder of the content of the previous lecture and related content known to students from other items.

Laboratory: multimedia presentations introducing the topic of classes, individual work on computers in the computer lab

Project: teamwork, computational experiments, use of tools enabling students to perform tasks at home (e.g. open source software).

Bibliography

Basic

1. Lubośny Z.: Elektrownie wiatrowe w systemie elektroenergetycznym, WNT, Warszawa 2006.

2. Kącki E.: Metody numeryczne dla inżynierów, WPŁ, Łódź 2003.

3. Praca zbiorowa pod red. M. Gałuszak, J. Paruch: Odnawialne i niekonwencjonalne źródła energii. Poradnik, Wydwnictwo TARBONUS, Tarnobrzeg 2008.

4. Jastrzębska G.: Ogniwa słoneczne. Budowa, technologia i zastosowanie, WKŁ, Warszawa 2014.

5. Boduch A.: Wstęp do programowania w języku C#, Wydawnictwo Helion, Gliwice 2006.

Additional

1. Tomczewski A., Kasprzyk L., Nadolny Z.: Reduction of Power Production Costs in a Wind Power Plant–Flywheel Energy Storage System Arrangement, Energies 2019, 12(10), 1942; https://doi.org/10.3390/en12101942

2. Pabis J., Spryngiel M., Laskowski J.: Inżynieria konwersji energii ze źródeł odnawialnych "OZE",Drukarnia D&D, Gliwice 2015.

3. Sharp J.: Microsoft Visual C# 2015 : krok po kroku, APN Promise, 2016

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,0
Classes requiring direct contact with the teacher	75	3,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)[1]	50	2,0

[1] delete or add other activities as appropriate