Wind power plants

Faculty of	**Mechanical and Power Engineering**
Name in English	**Wind power plants**
Name in Polish	**Energetyka wiatrowa**
Main field of study	**Power Engineering**
Specialization	**-**
Level of studies	**II level**
Form of studies	**full-time**
Kind of subject	**optional-specialization**
Subject code	**W09ENG-SM2355**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	Zaliczenie			Zaliczenie	
For group of courses mark final course with (X)					
Number of ECTS points	1			2	
including number of ECTS points for practical (P) classes				2	
including number of ECTS points for direct teacher-student contact (BU) classes	0,68			0,76	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	Fundamentals of fluid mechanics

SUBJECT OBJECTIVES

C1	Familiarization of students with principles of operation and construction of wind turbines
C2	Introduction to wind and terrain characteristics and their influence of wind turbine design and operation
C3	Introduction to blade element theory and aerodynamics of wind turbine
C4	Familiarization of students with economic and ecological aspects of wind turbines
C5	Providing basic knowledge about wind turbine farms and skills to select an optimal location for wind turbines

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
PEU_W01	knows and understands principles of wind turbine design, construction and operation
PEU_W02	knows and understands fundamental theories related to wind turbine operation
relating to skills:	
PEU_U01	Wind turbine blade design: determination of the range of Reynolds numbers of the blade, calculation of an optimal twist angle of the blade.
PEU_U02	Using Blade Element Method: calculation of the turbine power and aerodynamic forces, aerodynamic analysis of the designed blade.

PEU_U03	Determination of an optimal location for the designed wind turbine, calculation of an annual production of the wind turbine based on the Weibull distribution.
relating to social competences:	
PEU_K01	

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Wy1	Linear momentum theory for wind turbines, actuation disc model, Betz limit and theoretical efficiency of wind turbine.	2
Wy2	Angular momentum theory for wind turbine, introduction of tip speed ratio parameter and angular induction factor	2
Wy3	Blade element method	2
Wy4	Introduction to wind physics and mathematical description of main wind parameters related to wind power plants. Selection of a most optimal location for a wind turbine	2
Wy5	Control and regulation of wind turbine performance, passive and active control and regulation	2
Wy6	Vertical axis wind turbines	2
Wy7	Wind farms and mutual interaction of wind turbines. Final test.	3
Suma godzin		15

project		Number of hours
Pr1	Discussion of the project goal and scope.	1
Pr2	Introduction to Qblade software used for wind turbine design. Preliminary assumptions of individual projects: rated power, rated wind velocity, rpm, tip speed ratio.	2
Pr3	Design of wind turbine blade: determination of basic wind turbine rotor and blades parameters; Selection of aerodynamic airfoils.	2
Pr4	Wind turbine blade design: determination of the range of Reynolds numbers of the blade, calculation of an optimal twist angle of blades.	2
Pr5	Using Blade Element Method: calculation of aerodynamic forces, moments, power efficiency; Aerodynamic analysis of the designed blade.	2
Pr6	Determination of an optimal location for the designed wind turbine, calculation of annual electricity production of the wind turbine based on the Weibull distribution.	2
Pr7	Selection of other turbine components and basic stress and load analysis.	2
Pr8	Presentation of the project.	2
Suma godzin		15

TEACHING TOOLS USED	
N1	Lectures using multimedia presentation.
N2	Students own work - independent studies and preparation for final test.
N3	QBlade software
N4	Detailed list of things to do for the project with explanations.
N5	Partial presentations during each project class to show and discuss progress in the project

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
C1	PEU_W01, PEU_W02	Final test

C2	PEU_U01 -- PEU_U03	Grades for completed project stages

PRIMARY AND SECONDARY LITERATURE

Primary literature	
1	Burton T.: Wind Energy Handbook 3rd edition, Wiley, 2021
2	Manwell J.: Wind Energy Explained: Theory, Design and Application, Wiley, 2009
3	Burton T.: Wind Energy Handbook 2nd edition, Wiley, 2011
4	Malecha Z.: Aerodynamika turbin wiatrowych. Wybrane aspekty, Oficyna PWr, 2023
Secondary literaturę	
1	Ackermann T.: Wind Power in Power Systems, Wiley, 2005

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Imię i nazwisko:	Ziemowit Malecha
E-mail:	Ziemowit.malecha@pwr.edu.pl