PROGRAMME OF EDUCATION

FACULTY: MECHANICAL AND POWER ENGINEERING

MAIN FIELD OF STUDY: POWER ENGINEERING

in area of technical science

EDUCATION LEVEL: 2nd level, Master of Science

FORM OF STUDIES: full-time

PROFILE: general academic

SPECIALIZATION: **RENEWABLE SOURCES OF ENERGY**

LANGUAGE OF STUDY: polish

Content:
1. Assumed educational effects – attachment no. 1
2. Programme of studies – attachment no. 2

PROGRAMME OF STUDIES

1. Description

Number of semesters: 3	*Number ECTS points necessary to obtain qualifications:* 90
Prerequisites (particularly for second-level studies): 1st level qualifications and engineering skills necessary to continue education at 2nd level studies: knowledge of physics and mathematics that enables understanding of the fundamentals of physical phenomena used in the energetics and formulating and solving simple design tasks in the field of energetics, knowledge and skills in the field of mechanics, electronics, electrical , materials, metrology, fluid mechanics, thermodynamics and the basics of machine design, enabling taking of measurements, analysis and design of simple components and power systems, the ability to use to formulate and solve engineering tasks, and methods and experimental design, knowledge and skills in methods and techniques design, enabling the formulation of a simple engineering problem and develop the solution using appropriate computational tools, skills of interpretation, presentation and documentation of the experiment, and the presentation and documentation of the project tasks.	*Upon completion of studies graduate obtains* *professional degree of:* Master of Science 2nd level qualifications
Possibility of continuing studies: 3rd level doctoral studies	*Graduate profile, employability:* A graduate has the detailed knowledge and skills in the field of advanced technologies and processes, and methods for testing the operation of machinery and equipment in the power industry and related industries. He is prepared for the design, optimization and implementation of new energy technologies, in particular renewable energy sources and to work in the local governments and self-employment in the conditions of the functioning of the energy market and the principle of sustainable development. He knows a foreign language at B2+ level and a second foreign language at A1 or A2 level

Indicate connection with University's mission and its development strategy:	The training program is in accordance with mission of the university in the transfer of knowledge and skills to maintain high quality of education and the development of creative, critical and tolerant personality of students through the development and nurturing a strong sense of academic community based on intellectual and social communication of students and employees.

2. **Fields of science and scientific disciplines to which educational effects apply:** technical science

3. **Concise analysis of consistency between assumed educational effects and labour market needs:** The expected educational effect provide the growth of engineering competence obtained on the first degree of education, especially in terms of knowledge and skills, with particular emphasis on creativity in solving specific technical problems. The education program equips a graduate with the attributes thus enabling him to adapt to the rapidly changing requirements of the job market.

4. List of education modules:

4.1. List of obligatory modules:

4.1.1. List of general education modules

4.1.1.1. *Liberal-managerial subjects* **module** *(min. 3 ECTS points):*

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN0367	Marketing and Management	2					K2ENG_W06	30	90	3	1,5	T	Z			KO	Ob
		Total	2						30	90	3	1,5						

Altogether for general education modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes[1]
lec	cl	lab	pr	sem				
2					30	90	3	1,5

[1]BK – number of ECTS points assigned to hours of classes requiring direct contact of teachers with students

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

4.1.2. List of basic sciences modules

4.1.2.1. *Mathematics* module

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN0905	Probability theory	2					K2ENG_W01	30	90	3	1,5	T	E			PD	Ob
2	ESN0905	Probability theory		1				K2ENG_U05	15	30	1	0,75	T	Z		P	PD	Ob
3	ESN0502	Numerical methods	2					K2ENG_W02	30	90	3	1,5	T	E			PD	Ob
4	ESN0502	Numerical methods			2			K2ENG_U06	30	60	2	1,5	T	Z		P	PD	Ob
		Total	4	1	2				105	270	9	5,25						

4.1.2.2. *Physics* module

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN0200	Quantum Physics	2					K2ENG_W03	30	90	3	1,5	T	E			PD	Ob
		Total	2						30	90	3	1,5						

Altogether for basic sciences modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes[1]
lec	cl	lab	pr	sem				
6	1	2			135	360	12	6,75

[1]BK – number of ECTS points assigned to hours of classes requiring direct contact of teachers with students

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

4.1.3. List of main-field-of-study modules

4.1.3.1. *Obligatory main-field-of-study* module

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN0553	Mathematical Modelling of Energy Generation Installations	2					K2ENG_W05	30	60	3	1,5	T	E			K	Ob
2	ESN0553	Mathematical Modelling of Energy Generation Installations			4			K2ENG_U07	60	120	2	1,5	T	Z		P	K	Ob
3	ESN1115	New Generation Energy Technologies	2					K2ENG_W04	30	90	3	1,5	T	E			K	Ob
4	ESN1062	Energy Systems	2					K2ENG_W07	30	60	2	1	T	Z			K	Ob
5	ESN1062	Energy Systems		1				K2ENG_U08	15	30	1	0,75	T	Z		P	K	Ob
6	ESN1300	Environmental Management	2					K2ENG_W06 K2ENG_K03	30	60	2	1	T	Z			K	Ob
7	ESN1380	Diploma Seminar					2	K2ENG_U01 K2ENG_U02 K2ENG_K01 K2ENG_K03 K2ENG_K04 K2ENG_K05	30	60	2	1,5	T	Z		P	K	Ob
		Total	8	1	4		2		225	480	15	8,75						

Altogether (for main-field-of-study modules):

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes[1]
lec	cl	lab	pr	sem				
8	1	4		2	225	480	15	8,75

[1]BK – number of ECTS points assigned to hours of classes requiring direct contact of teachers with students

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

4.2. List of optional modules:

4.2.1. List of general education modules

4.2.1.1. *Liberal-managerial subjects* module *(min. 2 ECTS points):*

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	HSH100400BK	Humanities Course	1					K2ENG_W06 K2ENG_K02	15	60	2	1	T	Z	O		KO	W
		Total	1						15	60	2	1						

4.2.1.2 *Foreign languages* module *(min. 3 ECTS points):*

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	JZL100655BK	Foreign Language (continue) B2+ level		1				K2ENG_U04	15	30	1	0,75	T	Z	O	P	KO	W
2	JZL100710BK	Foreign Language (second), any level		3				K2ENG_U09	45	60	2	1,5	T	Z	O	P	KO	W
		Total		4					60	90	3	2,25						

4.2.1.1. *Sporting classes* module *(min. 1 ECTS points):*

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	WFW010000BK	Sporting Classes	1					K2ENG_K06	15	15	1	1	T	Z	O		KO	W
		Total	1						15	15	1	1						

[1]BK – number of ECTS points assigned to hours of classes requiring direct contact of teachers with students

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

Altogether for general education modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes[1]
lec	cl	lab	pr	sem				
1	5				90	165	6	4,25

4.2.2. List of main-field-of-study modules

4.2.2.1. *Individual master of science project* module *(min. 4 ECTS points):*

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN1364	Master Individual Student Project				4		K2ENG_U01 K2ENG_U03 K2ENG_K04 K2ENG_K05	60	120	4	1	T	Z		P	K	W
		Total				4			60	120	4	1						

4.2.2.2. *Master of science diploma dissertation* module *(min. 20 ECTS points):*

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN1430	Master Thesis						K2ENG_U01 K2ENG_U02 K2ENG_U03 K2ENG_K01 K2ENG_K04 K2ENG_K05		600	20	4	T	Z		P	K	W
		Total								600	20	4						

[1]BK – number of ECTS points assigned to hours of classes requiring direct contact of teachers with students

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

Altogether for main-field-of-study modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes[1]
lec	cl	lab	pr	sem				
			4		60	720	24	5

4.2.3. List of specialization modules

4.2.3.1. *Specialization subjects* module *(min. 30 ECTS points)*

No	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
1	ESN0193	Physics of the Renewable Energy	3					S2OZE_W01	45	90	3	1,5	T	Z			S	W
2	ESN0193	Physics of the Renewable Energy				2		S2OZE_U01	30	60	2	1,5	T	Z		P	S	W
3	ESN0193	Physics of the Renewable Energy					1	S2OZE_U02	15	30	1	0,75	T	Z		P	S	W
4	ESN0570	Fuel Cell and Technology of Hydrogen Production	2					S2OZE_W02	30	60	2	1	T				S	W
5	ESN0570	Fuel Cell and Technology of Hydrogen Production			1			S2OZE_U03	15	30	1	0,75	T	Z		P	S	W
6	ESN0180	Water Power Engineering	2					S2OZE_W03	30	60	2	1	T				S	W
7	ESN0180	Water Power Engineering		1				S2OZE_U04	15	30	1	0,75	T	Z		P	S	W
8	ESN0180	Water Power Engineering				2		S2OZE_U05	30	60	2	1,5	T	Z		P	S	W
9	ESN0303	Pollutants Emission Control	1					S2OZE_W04	15	30	1	0,5	T				S	W
10	ESN0303	Pollutants Emission Control			1			S2CCK_U06	15	30	1	0,75	T	Z		P	S	W
11	ESN0361	Refrigeration Heating Systems	1					S2OZE_W05	15	30	1	0,5	T				S	W
12	ESN0361	Refrigeration Heating Systems					1	S2OZE_U07 K2ENG_K04	15	30	1	0,75	T	Z		P	S	W
13	ESN0140	Wind Power Plants	1					S2OZE_W06	15	30	1	0,5	T				S	W
14	ESN0140	Wind Power Plants				2		S2OZE_U08	30	60	2	1,5	T	Z		P	S	W
15	ESN0150	Geothermal Power Engineering	1					S2OZE_W07	15	30	1	0,5	T				S	W
16	ESN0150	Geothermal Power Engineering		1				S2OZE_U09	15	30	1	0,75	T	Z		P	S	W
17	ESN1123	Power Production Systems and Technology From Biomass	2					S2OZE_W08	30	60	2	1	T				S	W
18	ESN1123	Power Production Systems and Technology From Biomass		1				S2OZE_U10	15	30	1	0,75	T	Z		P		W
19	ESN1123	Power Production Systems and Technology From Biomass					1	S2OZE_U11	15	30	1	0,75	T	Z		P	S	W

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[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

No	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes[1]			university-wide[4]	practical[5]	kind[6]	type[7]
20	ESN0203	Photo-thermal Energy Conversion System	1					S2OZE_W09	15	30	1	0,5	T				S	W
21	ESN0203	Photo-thermal Energy Conversion System					2	S2OZE_U12	30	60	2	1,5	T			P	S	W
		Total	14	3	2	9	2		450	900	30	19						

Altogether for specialization modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes[1]
lec	cl	lab	pr	sem				
14	3	2	9	2	450	900	30	19

4.3. Diploma dissertation module

Type of diploma dissertation	**magister**		
Number of diploma dissertation semesters	**Number of ECTS points**		**Code**
1	**20**		**ESN1430**
Character of diploma dissertation			
Experimental/project/ literature survey			
Number of BK[1] ECTS points	**4**		

[1]BK – number of ECTS points assigned to hours of classes requiring direct contact of teachers with students

[2]Traditional   –   enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses –   enter O

[5]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[6] KO – general education, PD – basic sciences, K – field-of-studies, S – specialization

[7] Optional – enter W, obligatory – enter Ob

5. **Ways of verifying assumed educational effects**

Type of classes	Ways of verifying assumed educational effects
lecture	examination, final test
class	progress test, final test, tasks valuating
laboratory	pretest, report from laboratory
project	project defence
seminar	participation in discussion, topic presentation, essay
diploma dissertation	prepared diploma dissertation

6. **Total number of ECTS points, which student has to obtain from classes requiring direct academic teacher-student contact (enter total** of ECTS points for courses/groups of courses denoted with code BK[1])
45,25 ECTS

7. **Total number of ECTS points, which student has to obtain from basic sciences classes**

Number of ECTS points for obligatory subjects	12
Number of ECTS points for optional subjects	0
Total number of ECTS points	12

8. **Total number of ECTS points, which student has to obtain from practical classes, including laboratory classes** (enter total number of ECTS points for courses/group of courses denoted with code P)

Number of ECTS points for obligatory subjects		8
including laboratory classes and projects	4	
Number of ECTS points for optional subjects		44
including:		
laboratory classes and projects	15	
diploma dissertation	20	
Total number of ECTS points		52

9. **Minimum number of ECTS points, which student has to obtain doing education modules offered as part of university-wide classes or other main field of study** (enter number of ECTS points for courses/groups of courses denoted with code OG)
 6 ECTS points

10. Total number of ECTS points, which student may obtain doing optional modules (min. 30% of total number of ECTS points)
60 ECTS points (66,7 %)

11. Range of the diploma exam

1.   Theoretical problems

1.1.   Quantum phenomena in nature (blackbody radiation, photoelectric effect, mass defect in nuclear transformations)
1.2.   Modeling of properties of substances
1.3.   Modeling of energy conversion processes. Exergy analysis
1.4.   Methods of mathematical modeling of power systems
1.5.   Fundamentals of hydrology - hydrology graphs, type of rivers, the concentration of energy
1.6.   Fundamentals of aero- power engineering - the use of wind energy, physics of the wind
1.7.   Fundamentals of helio- power engineering – efficiency of use of solar radiation
1.8.   Basics of fuel cells
1.9.   Thermodynamic base of operation of heat pumps
1.10.   Energy efficiency of refrigerating heating systems
1.11.   Real cycle of heat pump
1.12.   Processing of biomass - chemical and physical processes

2.   Construction and technological problems

2.1.   Water turbines and generators - design and system solutions
2.2.   Types of wind turbines and wind power systems construction
2.3.   Solar collectors - construction solutions
2.4.   Photovoltaic cells - construction solutions
2.5.   Heat pumps - construction solutions
2.6.   Support devices for heat pump systems
2.7.   Renewable energy in heating engineering
2.8.   Refrigerating heating systems for waste heat recovery
2.9.   Types of fuel cells and their characteristics
2.10.   Methods of hydrogen production and storage techniques
2.11.   Technologies of use of heat energy from geothermal water for the needs of the economy
2.12.   Power production system and technology from biomass
2.13.   Storage of energy - technical solutions

3.   Operational problems

3.1.   Diagnostics, security and reliability of power systems
3.2.   Management systems in the power industry
3.3.   Energy markets – marketing actions
3.4.   Environmental policy instruments used in the production of energy
3.5.   Clean technologies in the power industry
3.6.   Environmental aspects of the use of renewable energy sources
3.7.   Exploitation of water turbines
3.8.   Exploitation problems related to combustion and co-firing of biomass
3.9.   Emissions of pollutants control - continuous and periodic measurements, measuring apparatus
3.10.   The operating parameters of heating systems based on heat pumps
3.11.   Operating point of bivalent and monoenergetic heat pump
3.12.   The properties and characteristics of wind turbines

12.   Requirements concerning deadlines for crediting courses/groups of courses for all courses in particular modules

No.	Course code	Name of course	Crediting by deadline of... (number of semester)
	Faculty Council Resolution No 4/D/2008 of 19.09.2008	The condition for admission the student to the execution of the *master thesis* module is to pass all subjects in plan of studies in the semester prior to the semester of graduation	

13.   Plan of studies (attachment no. 1)