

PROGRAMME OF STUDIES

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: english

Content:

1. Plan of studies – attachment no. 1

PROGRAMME OF STUDIES

1. Description

<p><i>Number of semesters:</i></p> <p>3</p>	<p><i>Number ECTS points necessary to obtain qualifications:</i></p> <p>90</p>
<p><i>Prerequisites (particularly for second-level studies):</i></p> <p>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.</p>	<p><i>Upon completion of studies graduate obtains professional degree of:</i> Master of Science</p> <p>2nd level qualifications</p>
<p><i>Possibility of continuing studies:</i> 3rd level doctoral studies</p>	<p><i>Graduate profile, employability:</i> 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</p>
<p><i>Indicate connection with University's mission and its development strategy:</i></p>	<p>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</p>

	community based on intellectual and social communication of students and employees.
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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	ZMZ0135W	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

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

²Traditional – enter T, remote – enter Z

³Exam – 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)

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

⁵Practical 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	ESN0911	Probability Theory	2					K2ENG_W01	30	90	3	1,5	T	E			PD	Ob
2	ESN0911	Probability Theory		1				K2ENG_U05	15	60	2	1,5	T	Z		P	PD	Ob
3	ESN0503	Numerical Methods	2					K2ENG_W02	30	90	3	1,5	T	E			PD	Ob
4	ESN0503	Numerical Methods			2			K2ENG_U06	30	60	2	1,5	T	Z		P	PD	Ob
Total			4	1	2				105	300	10	6						

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	ESN0199	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	390	13	7,5

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

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

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⁷Optional – 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	ESN0554	Mathematical Modelling of Energy Generation Installations	2					K2ENG_W05	30	90	3	1,5	T	E			K	Ob
2	ESN0554	Mathematical Modelling of Energy Generation Installations			4			K2ENG_U07	60	60	2	1,5	T	Z		P	K	Ob
3	ESN1116	New Generation Energy Technologies	2					K2ENG_W04	30	90	3	1,5	T	E			K	Ob
4	ESN1063	Energy Systems	2					K2ENG_W08	30	60	2	1	T	Z			K	Ob
5	ESN1063	Energy Systems		1				K2ENG_U08	15	30	1	0,75	T	Z		P	K	Ob
6	ESN1381	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			6	1	4		2		195	390	13	7,75						

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				
6	1	4		2	195	390	13	7,75

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³Exam – 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)

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

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

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⁷Optional – 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. 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	HSN10050BK	Humanities Course	1					K2ENG_W06 K2ENG_K02 K2ENG_K06	15	60	2	1	T	Z	O		KO	W
2	ZSN100500BK	Management Course	1					K2ENG_W06 K2ENG_K02 K2ENG_K05	15	30	1	0,5	T	Z			KO	W
Total			2						30	90	3	1,5						

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:

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

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³Exam – 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)

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

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

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⁷Optional – 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				
2	4				90	180	5	3,75

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	ESN1365	Master Individual Student Project				4		K2ENG_U01 K2ENG_U03 K2ENG_K01 K2ENG_K04	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	ESN1431	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						

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

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

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⁷Optional – 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	ESN0192	Physics of the Renewable Energy	2					S2RSE_W01	30	60	2	1	T	Z			S	W
2	ESN0192	Physics of the Renewable Energy				2		S2RSE_U01	30	60	2	1,5	T	Z		P	S	W
3	ESN0192	Physics of the Renewable Energy					1	S2RSE_U02	15	30	1	0,75	T	Z		P	S	W
4	ESN0571	Fuel Cell and Technology of Hydrogen Production	2					S2RSE_W02	30	60	2	1	T	Z			S	W
5	ESN0571	Fuel Cell and Technology of Hydrogen Production			1			S2RSE_U03	15	30	1	0,75	T	Z		P	S	W
6	ESN0182	Water Power Engineering	2					S2RSE_W03	30	60	2	1	T	Z			S	W
7	ESN0182	Water Power Engineering				2		S2RSE_U04	30	60	2	1,5	T	Z		P	S	W
8	ESN1124	Power Production Systems and Technology from Biomass	2					S2RSE_W08	30	60	2	1	T	Z			S	W
9	ESN1124	Power Production Systems and Technology from Biomass		1				S2RSE_U10	15	30	1	0,75	T	Z		P	S	W
10	ESN1124	Power Production Systems and Technology from Biomass				1		S2RSE_U11	15	30	1	0,75	T	Z		P	S	W
11	ESN1196	Thermonuclear Power Generation	2					S2RSE_W04	30	60	2	1	T	Z			S	W
12	ESN1196	Thermonuclear Power Generation		1				S2RSE_U06	15	30	1	0,75	T	Z		P	S	W
13	ESN1196	Thermonuclear Power Generation				1		S2RSE_U07	15	60	2	1,5	T	Z		P	S	W
14	ESN0362	Refrigeration Heating Systems	1					S2RSE_W05	15	30	1	0,5	T	Z			S	W
15	ESN0362	Refrigeration Heating Systems			1			S2RSE_U07 K2ENG_K04	15	30	1	0,75	T	Z		P	S	W
16	ESN0141	Wind Power Plants	1					S2RSE_W06	15	30	1	0,5	T	Z			S	W
17	ESN0141	Wind Power Plants				2		S2RSE_U08	30	60	2	1,5	T	Z		P	S	W
18	ESN0151	Geothermal Power Engineering	1					S2RSE_W07	15	30	1	0,5	T	Z			S	W
19	ESN0151	Geothermal Power Engineering		1				S2RSE_U10	15	30	1	0,75	T	Z		P	S	W

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

⁵Practical 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 cours e/gro up of cours es	Way ³ of crediti ng	Course/group of courses			
			lec	cl	l a b	p r	s e m		ZZU	CNPS	total	BK classes 1			univers ity- wide ⁴	practical ⁵	kind ⁶	type ⁷
20	ESN0204	Photothermal Energy Conversion System	1					S2RSE_W09	15	30	1	0,5	T	Z			S	W
21	ESN0204	Photothermal Energy Conversion System					2	S2RSE_U12	30	60	2	1,5	T	Z		P	S	W
Total			14	3	2	8	3		450	930	31	19,75						

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	8	3	450	930	31	19,75

4.3. Diploma dissertation module

Type of diploma dissertation	magister		
Number of diploma dissertation semesters	Number of ECTS points	Code	
1	20	ESN1431	
Character of diploma dissertation			
Experimental/project/ literature survey			
Number of BK ¹ ECTS points	4		

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³Exam – 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)

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

⁵Practical 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 BK¹)
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	13
Number of ECTS points for optional subjects	0
Total number of ECTS points	13

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 including laboratory classes and projects	9 4
Number of ECTS points for optional subjects including: laboratory classes and projects diploma dissertation	44 14 20
Total number of ECTS points	53

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)
5 ECTS points

**10. Total number of ECTS points, which student may obtain doing optional modules (min. 30% of total number of ECTS points)
61 ECTS points (67,8 %)**

11. Range of the diploma exam

1. Theoretical problems

- 1.1. Quantum effects – used in energy production (blackbody radiation, PV effect, mass defect)
- 1.2. Modelling of material properties
- 1.3. Modelling of energy conversion processes, exergy analysis
- 1.4. The base of hydrology – hydrological figures, energy concentration, types of river
- 1.5. Base of wind energy - wind physics, use of wind energy
- 1.6. The base of solar energy – efficiency of solar systems
- 1.7. The base of fuel cells system – thermal characteristic
- 1.8. The thermodynamics of heat pumps
- 1.9. The energetic efficiency of the refrigeration cycles
- 1.10. A heat pump real cycle
- 1.11. Biomass processing – physical and chemical processes
- 1.12. Energy storage processes

2. Construction and technological problems

- 2.1. Water turbines – constructions and systems
- 2.2. Wind turbines and wind plants
- 2.3. Solar collectors – constructions
- 2.4. PV cells – constructions
- 2.5. Heat pumps - constructions
- 2.6. Additional equipment of heat pump systems
- 2.7. Renewable sources of energy in thermal engineering
- 2.8. Waste heat recovery refrigerating systems
- 2.9. Fuel cells – types and characteristic
- 2.10. Hydrogen production and storage
- 2.11. Geothermal heat utilization technology
- 2.12. Technologies and systems of biomass utilization
- 2.13. Storage of energy – technical solutions

3. Operation problems

- 3.1. New generation energy technologies
- 3.2. Power systems - diagnostics, security, reliability
- 3.3. Management systems in energy sector
- 3.4. Energy market – marketing
- 3.5. Environmental policy – instruments
- 3.6. Renewable sources of energy – environmental aspects
- 3.7. Water turbine – operation conditions
- 3.8. Biomass combustion and co-combustion – operation problems
- 3.9. Test methods in geothermal heat systems
- 3.10. Operating parameters of heating systems based on heat pumps
- 3.11. The working point of bivalent and mono-energetic heat pump

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

<i>No.</i>	<i>Course code</i>	<i>Name of course</i>	<i>Crediting by deadline of... (number of semester)</i>
	Faculty Council Resolution No 4/D/2008 of 19.09.2008	The condition for admission the student to the execution of the <i>master thesis</i> 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)