

PROGRAMME OF EDUCATION

FACULTY: MECHANICAL AND POWER ENGINEERING

MAIN FIELD OF STUDY: POWER ENGINEERING

in area of technical science

EDUCATION LEVEL: 2nd level, magister inżynier

FORM OF STUDIES: full-time

PROFILE: general academic

LANGUAGE OF STUDY: polish

Content:

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

Refrigerating, Heating and Air-Conditioning	2
Power Engineering and Air Protection	14
Nuclear Power Engineering	26
Renewable Sources of Energy	38

Faculty Council Resolution of 26.09.2012

In effect since 01.10.2012

Edited adjustment_April 2014

PROGRAMME OF STUDIES – specialization REFRIGERATING, HEATING AND AIR-CONDITIONING**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: magister inżynier</i></p> <p><i>2nd level qualifications</i></p>
<p><i>Possibility of continuing studies: 3rd level doctoral studies</i></p>	<p><i>Graduate profile, employability:</i> Graduate has a knowledge and skills in the field of advanced technologies and processes, and methods for testing the operation of machinery and equipment in the energy industry and related industries. Is prepared for design, optimization and implementation of new energy technologies, in particular in the field of thermal comfort in rooms. Is prepared to work with government authorities and independent economic activity in terms of the functioning of the energy market and</p>

	the implementation of the principle of sustainable development. He knows a foreign language at level B2 + and a second foreign language at A1 or A2 level.
<i>Indicate connection with University's mission and its development strategy:</i>	The program of education is consistent with the 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 by developing and nurturing a strong sense of academic community based on communication and social rights 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 education effects provide engineering competencies gained on the first level of education, especially in terms of knowledge and skills, with particular emphasis on creativity in solving specific technical problems. The programme of education equips graduates with the attributes 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. 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	ESN0365	Marketing and Management	2					K2ENG_W07	30	60	2	1	T	Z			KO	Ob
		Total	2						30	60	2	1						

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

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	60	2	1

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	ESN0910	Probability theory	2					K2ENG_W01	30	90	3	1,5	T	E			PD	Ob
2	ESN0910	Probability theory		1				K2ENG_U05	15	60	2	1,5	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	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	ESN0200	Quantum Physics	2					K2ENG_W03	30	90	3	1,5	T	E			PD	Ob
Total			2						30	90	3	1,5						

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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

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

⁷Optional – enter W, obligatory – enter Ob

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

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

4.1.3.1. Obligatory main-field-of-study modules

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	ESN0550	Mathematical modelling of energy generation installations	2					K2ENG_W05	30	60	2	1	T	E			K	Ob
2	ESN0550	Mathematical modelling of energy generation installations			4			K2ENG_U07	60	120	4	3	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_K02	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	16	9,75						

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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

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

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				
8	1	4		2	225	480	16	9,75

4.2 List of optional modules

4.2.1 List of general education modules

4.2.1.1. Liberal-managerial subjects modules (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	HSN100200BK	Humanities course	1					K2ENG_W06 K2ENG_K02	15	30	1	0,5	T	Z	O		KO	W
		Total	1						15	30	1	0,5						

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	JZL100655BK	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						

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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

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

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				
1	4				75	120	4	2,75

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

4.2.3.1. Individual master of science project module (min. 5 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	ESN1362	Individual master of science project				4		K2ENG_U01 K2ENG_U03 K2ENG_K04 K2ENG_K05	60	150	5	3,75	T	Z		P	K	W
Total						4			60	150	5	3,75						

4.2.3.2. 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 of science diploma dissertation						K2ENG_U01 K2ENG_U02 K2ENG_U03 K2ENG_K01 K2ENG_K04 K2ENG_K05		600	20	4	T	Z		P	K	W
Total						4				600	20	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

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

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	750	25	7,75

4.2.4. List of specialization modules

4.2.4.1 Specialization Refrigerating, Heating And Air-Conditioning modules (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 creditin g	Course/group of courses			
			lec	cl	l a b	p r	s e m		ZZU	CNPS	total	BK class es ¹			univers ity- wide ⁴	practical ⁵	kind ⁶	type ⁷
1	ESN0241	Thermal energy management	1					S2CCK_W02	15	30	1	0,5	T	Z			S	W
2	ESN0241	Thermal energy management		1				S2CCK_U02	15	30	1	0,75	T	Z		P	S	W
3	ESN1152	Thermodynamic basis of heating engineering	2					S2CCK_W10	30	60	2	1	T	Z			S	W
4	ESN1073	Refrigerating systems	2					S2CCK_W01	30	60	2	1	T	Z			S	W
5	ESN1073	Refrigerating systems		1				S2CCK_U08	15	30	1	0,75	T	Z		P	S	W
6	ESN1073	Refrigerating systems			2			S2CCK_U01	30	60	2	1,5	T	Z		P	S	W
7	ESN1024	Sorption energetic systems	2					S2CCK_W06	30	60	2	1	T	Z			S	W
8	ESN1024	Sorption energetic systems		1				S2CCK_U03	15	30	1	0,75	T	Z		P	S	W
9	ESN1024	Sorption energetic systems				1		S2CCK_U07	15	30	1	0,75	T	Z		P	S	W
10	ESN0557	Heat carriers and accumulators	1					S2CCK_W11	15	30	1	0,5	T	Z			S	W
11	ESN0303	Pollutants emission control	1					S2CCK_W04	15	30	1	0,5	T	Z			S	W
12	ESN0303	Pollutants emission control			1			S2CCK_U05 K2ENG_K03	15	30	1	0,75	T	Z		P	S	W
13	ESN0251	Installations for environment protection - optimalization and exploitation	1					S2CCK_W08	15	30	1	0,5	T	Z			S	W
14	ESN0251	Installations for environment protection - optimalization and exploitation					1	S2CCK_U09 K2ENG_K01 K2ENG_K02 K2ENG_K03	15	30	1	0,75	T	Z		P	S	W
15	ESN1074	Power Systems Based on Renewable and Waste Energy	1					S2CCK_W09	15	30	1	0,5	T	Z			S	W
16	ESN1074	Power Systems Based on Renewable and Waste Energy		1				S2CCK_U06	15	30	1	0,75	T	Z		P	S	W
17	ESN1245	Ventilation and air-conditioning	2					S2CCK_W07	30	60	2	1	T	Z			S	W
18	ESN1245	Ventilation and air-conditioning		1				S2CCK_U11	15	30	1	0,75	T	Z		P		W
19	ESN0275	Heating and air-condition installation	1					S2CCK_W03	15	30	1	0,5	T	Z			S	W
20	ESN0275	Heating and air-condition installation					1	S2CCK_U04	15	30	1	0,75	T	Z		P	S	W
21	ESN0277	Cryogenic installations	2					S2CCK_W12	30	60	2	1	T	Z			S	W
22	ESN0277	Cryogenic installations				1		S2CCK_U12	15	30	1	0,75	T	Z		P	S	W
23	ESN0822	Heat pumps and heat transformers	1					S2CCK_W05 K2ENG_K02	15	30	1	0,5	T	Z			S	W
24	ESN0822	Heat pumps and heat transformers					1	S2CCK_U10	15	30	1	0,75	T	Z		P	S	W
Total			17	5	3	3	2		450	900	30	18,2 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

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

⁷Optional – enter W, obligatory – enter Ob

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				
17	5	3	3	2	450	900	30	18,25

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 BK¹ ECTS points	4	

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	6	11
Number of ECTS points for optional subjects including laboratory classes and projects <i>diploma dissertation</i>	11	41
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)**

4 ECTS points

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

59 ECTS points (66 %)

11. Range of diploma dissertation

1. Theoretical issues

- 1.1 Quantum phenomena in nature (blackbody radiation, photoelectric effect, mass defect in nuclear transformations)
- 1.2 Modeling of properties of the substance.
- 1.3 Modeling of energy conversion processes. Exergy analysis.
- 1.4 Irreversible processes in the refrigeration cycle. Thermodynamic analysis and graphical representation on phase diagrams.
- 1.5 Principles of increasing entropy in the refrigeration cycle.
- 1.6 Methods of balancing of low-temperature systems.
- 1.7 Phase transitions of homogeneous substances and mixtures.
- 1.8 Changes of physical and thermodynamic parameters that occur during phase transitions of the first and the second kind .
- 1.9 Two and multi-component solutions (based on eutectic mixtures).
- 1.10 Expansion of gases. Polytropic transitions of an ideal gas.
- 1.11 Joule-Thomson effect. Inversion curve.
- 1.12 The Linde's cooling cycle on p-v, T-s, log p-h diagrams; its parameters. The analytical and graphical description of internal and external losses.

2. Design and technological issues

- 2.1 Compressors in refrigeration systems, their construction, operation, efficiency and performance, collaboration, connection methods.
- 2.2 Basic constructions of heat exchangers for vapor compression sorption, adsorption refrigeration systems, principles of their selection.
- 2.3 Refrigeration and air conditioning systems: direct, indirect, pressure, gravity and pump based - construction & applications.
- 2.4 Apparatus and heat exchangers for industrial absorption systems.
- 2.5 Refrigerators and freezers - methods of construction, heat balance, moisture penetration, choice of insulation, protecting soil from freezing in the cold store.
- 2.6 Heat pumps, construction and use, energy balance, the lower and upper heat source.
- 2.7 Analysis of the compression process in a multi-stage compressor.
- 2.8 Aspects of durability of heat exchangers in implementing systems transcritical cycles
- 2.9 Methods of elimination of the pollution produced during combustion from heat exchangers
- 2.10 Thermal calculations for cryogenic installations.
- 2.11 Regenerative heat exchangers in the Clausius-Rankine cycle.
- 2.12 Classification of liquefiers and cryogenic coolers based on the type of heat exchanger used.

3. Operational Issues

- 3.1 Clean energy technologies.
- 3.2 Diagnostics, security and reliability of energy systems.
- 3.3 Energy Management Systems.
- 3.4 Energy markets – marketing strategies.
- 3.5 Environmental policy instruments that are used in the production of energy.
- 3.6 Heat and cold transfer fluids: glycols, saline, ice slurry.
- 3.7 The realistic vapor compression refrigeration cycle.
- 3.8 The realistic absorption refrigeration cycle.
- 3.9 Draw and describe the measurement system of a vapor compression refrigerator.
- 3.10 Natural and synthetic refrigerants, physical, chemical and thermodynamic principles of selection, safety conditions.
- 3.11 Control of emissions – continuous and periodic measurements, measuring apparatus.
- 3.12 The problems of obtaining and maintaining cryogenic temperatures.
- 3.13 Adjustment of the operation of HVAC system.
- 3.14 Methods of control and regulation of parameters of the conditioned air.

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)

PROGRAMME OF STUDIES – specialization POWER ENGINEERING AND AIR PROTECTION**2. Description**

<i>Number of semesters::3</i>	<i>Number ECTS points necessary to obtain qualifications: 90</i>
<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</i></p> <p><i>professional degree of: magister inżynier</i></p> <p>2nd level qualifications</p>
<p><i>Possibility of continuing studies: 3rd level doctoral studies</i></p>	<p><i>Graduate profile, employability:</i> Graduate has a knowledge and skills in the field of advanced technologies and processes, and methods for testing the operation of machinery and equipment in the energy industry and related industries. Is prepared for design, optimization and implementation of new energy technologies, in particular renewable energy sources and to work in government bodies and to conduct business. Has the knowledge and skills in</p>

	terms of minimizing the destructive impact of combustion processes of fuels on the environment through the use of advanced technologies of energy production and integrated environmental systems. He knows a foreign language at level B2 + and a second foreign language at A1 or A2 level.
<i>Indicate connection with University's mission and its development strategy:</i>	The programme of education is consistent with the 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 by developing and nurturing a strong sense of academic community based on communication and social rights of students and employees.

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

6. Concise analysis of consistency between assumed educational effects and labour market needs: The expected education effects provide engineering competencies gained on the first level of education, especially in terms of knowledge and skills, with particular emphasis on creativity in solving specific technical problems. The programme of education equips graduates with the attributes enabling him to adapt to the rapidly changing requirements of the job market.

7. List of education modules:

7.1. List of obligatory modules:

4.1.1 List of general education modules

4.1.1.1. 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	ESN0365	Marketing and Management	2					K2ENG_W06	30	60	2	1	T	Z			KO	Ob
		Total	2						30	60	2	1						

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

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	60	2	1

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	ESN0910	Probability theory	2					K2ENG_W01	30	90	3	1,5	T	E			PD	Ob
2	ESN0910	Probability theory		1				K2ENG_U05	15	60	2	1,5	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	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	ESN0200	Quantum Physics	2					K2ENG_W03	30	90	3	1,5	T	E			PD	Ob
Total			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

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

⁷Optional – enter W, obligatory – enter Ob

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

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

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

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	ESN0550	Mathematical modelling of energy generation installations	2					K2ENG_W05	30	60	2	1	T	E			K	Ob
2	ESN0550	Mathematical modelling of energy generation installations			4			K2ENG_U07	60	120	4	3	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_W08	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_K02	30	60	2	1	T	Z			K	Ob
7	ESN1380	Master 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	16	9,75						

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

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

⁷Optional – enter W, obligatory – enter Ob

Altogether for *Obligatory 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	16	9,75

4.2 List of optional modules

4.2.1 List of general education modules

4.2.1.1 Liberal-managerial subjects modules (*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	HSN100200BK	Humanities Course	1					K2ENG_W07 K2ENG_K02	15	30	1	0,5	T	Z	O		KO	W
		Total	1						15	30	1	0,5						

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 (continuation) level B2+		1				K2ENG_U04	15	30	1	0,75	T	Z	O	P	KO	W
2	JZL100655BK	Foreign Language (next language), any level		3				K2ENG_U09	45	60	2	1,5	T	Z	O	P	KO	W
		Total		4					60	90	3	2,25						

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

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

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				
1	4				75	120	4	2,75

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

4.2.3.1. Projekt indywidualny magisterski module (min. 5 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	Se m		ZZU	CNPS	total	BK classes ¹			university-wide ⁴	practical ⁵	kind ⁶	type ⁷
1	ESN1362	Master Individual Student Project				4		K2ENG_U01 K2ENG_U03 K2ENG_K04 K2ENG_K05	60	150	5	2	T	Z		P	K	W
Total						4			60	150	5	2						

4.2.3.2. Praca dyplomowa magisterska 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	Se m		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						

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

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

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	750	25	6

4.2.4. List of specialization modules

4.2.4.1 Specialization subjects (Power Engineering and Air Protection) modules (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 credi- ting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK class es ¹			univer- sity- wide ⁴	practical ₅	kind ⁶	type ⁷
1	ESN0560	Gas dedusting	2					S2ENA_W01	30	60	2	1	T	Z			S	W
2	ESN0560	Gas dedusting					2	S2ENA_U01	30	60	2	1,5	T	Z		P	S	W
3	ESN0920	Reduction of pollution removal	2					S2ENA_W02	30	60	2	1	T	Z			S	W
4	ESN0920	Reduction of pollution removal		2				S2ENA_U02 K2ENG_K02 K2ENG_K04 K2ENG_K05	30	60	2	1,5	T	Z		P	S	W
5	ESN0022	Control Systems in Power Engineering	1					S2ENA_W03	15	30	1	0,5	T	Z			S	W
6	ESN0022	Control Systems in Power Engineering					1	S2ENA_U03	15	30	1	0,75	T	Z		P	S	W
7	ESN1140	Coal Combustion Technologies	2					S2ENA_W04	30	60	2	1	T	Z			S	W
8	ESN1140	Coal Combustion Technologies		1				S2ENA_U04	15	30	1	0,75	T	Z		P	S	W
9	ESN0570	Fuel cell and technology of hydrogen Production	2					S2ENA_W05	30	60	2	1	T	Z			S	W
10	ESN0570	Fuel cell and technology of hydrogen Production			1			S2ENA_U05	15	30	1	0,75	T	Z		P	S	W
11	ESN0540	Measurements of gas pollutants	1					S2ENA_W06	15	30	1	0,5	T	Z			S	W
12	ESN0540	Measurements of gas pollutants			2			S2ENA_U06	30	60	2	1,5	T	Z		P	S	W
13	ESN0530	Metrology in dust engineering	1					S2ENA_W07	15	30	1	0,5	T	Z			S	W
14	ESN0530	Metrology in dust engineering			2			S2ENA_U07 K2ENG_K01K2 ENG_K03	30	60	2	1,5	T	Z		P	S	W
15	ESN0590	Low Emission Furnaces	1					S2ENA_W08	15	30	1	0,5	T	Z			S	W
16	ESN0590	Low Emission Furnaces			1			S2ENA_U08	15	30	1	0,75	T	Z		P	S	W
17	ESN1310	Fuels Gasification	2					S2ENA_W09	30	60	2	1	T	Z			S	W
18	ESN1310	Fuels Gasification		1				S2ENA_U09	15	30	1	0,75	T	Z		P	S	W
19	ESN0145	Energy Use of Biofuels	2					S2ENA_W10	30	60	2	1	T	Z			S	W
20	ESN0145	Energy Use of Biofuels		1				S2ENA_U10	15	30	1	0,75	T	Z		P	S	W
Total			16	5	6	3			450	900	30	18,5						

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

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

⁷Optional – enter W, obligatory – enter Ob

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				
16	5	6	3		450	900	30	18.5

4.3 Diploma dissertation module

Type of diploma dissertation	magister inżynier		
Number of diploma dissertation semesters	Number of ECTS points		Code
1	20		ESN1430
Character of diploma dissertation			
Experimental/project/ literature survey			
Number of BK1 ECTS points	4		

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)

45,5 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 and projects	6	11
Number of ECTS points for optional subjects including laboratory and projects diploma dissertation	14 20	42
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 O)

4 ECTS points

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

59 ECTS points (66 %)

11. Range of diploma dissertation

1. Zagadnienia teoretyczne

- 1.1. Zjawiska kwantowe w przyrodzie (promieniowanie ciała doskonale czarnego, efekt fotoelektryczny, defekt masy w przemianach jądrowych)
- 1.2. Modelowanie własności substancji
- 1.3. Modelowanie procesów konwersji energii. Analiza egzergetyczna.
- 1.4. Metody modelowania matematycznego systemów energetycznych

- 1.5. Warunki powstawania zanieczyszczeń w procesach spalania paliw
 - 1.6. Procesy przetwarzania paliw stałych na paliwa gazowe i ciekłe
 - 1.7. Katalizatory w technice oczyszczania spalin
 - 1.8. Sztuczne sieci neuronowe
 - 1.9. Zasady realizacji redukcji zanieczyszczeń gazowych
 - 1.10. Technologie spalania paliw stałych
 - 1.11. Zasady użytkowania paliw w aspekcie sprawności procesu energetycznego i ochrony środowiska
 - 1.12. Metody kontroli emisji zanieczyszczeń środowiska
 - 1.13. Ekonomiczne aspekty ochrony środowiska
- 2. Zagadnienia konstrukcyjno-technologiczne**
- 2.1. Technologie termicznej utylizacji odpadów
 - 2.2. Bloki energetyczne na nadkrytyczne parametry pary
 - 2.3. Konstrukcja palników i przedpalenisk do jednoczesnej redukcji tlenków siarki i tlenków azotu
 - 2.4. Konstrukcja palenisk do spalania odpadów ciekłych i stałych
 - 2.5. Układy gazowo-parowe
 - 2.6. Technologie oxy (OEC) i wysokotemperaturowe (HiTAC)
 - 2.7. Systemy kogeneracyjne i trigeneracyjne z wykorzystaniem OZE
 - 2.8. Energia odpadowa procesów produkcyjnych – możliwości i sposoby zagospodarowania
 - 2.9. Techniczne możliwości wykorzystania odpadów rolniczych, przemysłowych i komunalnych w produkcji energii cieplnej i elektrycznej
 - 2.10. Technika odpylania gazów, sposoby realizacji, stosowane urządzenia.
- 3. Zagadnienia eksploatacyjne**
- 3.1. Diagnostyka, bezpieczeństwo i niezawodność systemów energetycznych
 - 3.2. Systemy zarządzania w energetyce
 - 3.3. Rynki energii – działania marketingowe
 - 3.4. Instrumenty polityki ekologicznej wykorzystywane w procesie produkcji energii
 - 3.5. Metody regulacji parametrów pracy bloku energetycznego
 - 3.6. Kontrola emisji zanieczyszczeń – pomiary okresowe i ciągłe, aparatura pomiarowa
 - 3.7. Optymalizacja urządzeń i instalacji ochrony środowiska
 - 3.8. Zagadnienia związane z użytkowaniem paliw: składowanie, ochrona środowiska, zastępowanie paliw
 - 3.9. Zasada pracy i eksploatacji palenisk niskoemisyjnych.
 - 3.10. Instalacje ochrony środowiska, rozwiązania techniczne, eksploatacja i optymalizacja ich pracy

3.11. Urządzenia i metody realizacji miernictwa w technice pyłowej

3.12. Urządzenia i metody realizacji miernictwa zanieczyszczeń gazowych

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)

PROGRAMME OF STUDIES – specialization NUCLEAR POWER ENGINEERING**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</i></p> <p><i>professional degree of:</i> magister inżynier</p> <p>2nd level qualifications</p>
<p><i>Possibility of continuing studies:</i> 3rd level doctoral studies</p>	<p><i>Graduate profile, employability:</i> Graduate has a knowledge and skills in the field of advanced technologies and processes, and methods for testing the operation of machinery and equipment in the energy industry and related industries. Graduate is prepared for the design, optimization and implementation of new energy technologies, in particular in the field of nuclear energy and for work in the local government and self-business in the conditions of the functioning of the energy market and the principle of sustainable development. He knows a foreign language at</p>

	level B2 + and a second foreign language at A1 or A2 level.
<i>Indicate connection with University's mission and its development strategy:</i>	The programme of education is consistent with the 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 by developing and nurturing a strong sense of academic community based on communication and social rights 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 education effects provide engineering competencies gained on the first level of education, especially in terms of knowledge and skills, with particular emphasis on creativity in solving specific technical problems. The programme of education equips graduates with the attributes 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. 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	ESN0365	Marketing and Management	2					K2ENG_W06	30	60	2	1	T	Z			KO	Ob
		Total	2							60	2	1						

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

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	60	2	1

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	ESN0910	Probability theory	2					K2ENG_W01	30	90	3	1,5	T	E			PD	Ob
2	ESN0910	Probability theory		1				K2ENG_U05	15	60	2	1,5	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	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	ESN0200	Quantum Physics	2					K2ENG_W03	30	90	3	1,5	T	E			PD	Ob
Total			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

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

⁷Optional – enter W, obligatory – enter Ob

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

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

4.1.3.1. Obligatory main-field-of-study modules

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	ESN0550	Mathematical modelling of energy generation installations	2					K2ENG_W05	30	60	2	1	T	E			K	Ob
2	ESN0550	Mathematical modelling of energy generation installations			4			K2ENG_U07	60	120	4	3	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_K02	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	16	9,75						

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

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

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				
8	1	4		2	225	480	16	9,75

4.2 List of optional modules

4.2.1 List of general education modules

4.2.1.1. Liberal-managerial subjects modules (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	HSN100200BK	Humanities course	1					K2ENG_W06 K2ENG_K02	15	30	1	0,5	T	Z	O		KO	W
		Total	1						15	30	1	0,5						

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	JZL100655BK	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						

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

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

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				
1	4				75	120	4	2,75

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

4.2.3.1. Individual master of science project module (min. 5 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	ESN1362	Individual master of science project				4		K2ENG_U01 K2ENG_U03 K2ENG_K04 K2ENG_K05	60	150	5	4	T	Z		P	K	W
Total						4			60	150	5	4						

4.2.3.2. 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 of science diploma dissertation						K2ENG_U01 K2ENG_U02 K2ENG_U03 K2ENG_K01 K2ENG_K04 K2ENG_K05		600	20	2	T	Z		P	K	W
Total						4				600	20	2						

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

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

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	750	25	6

4.2.4. List of specialization modules

4.2.4.1 Specialization Nuclear Power Engineering modules (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 crediti ng	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK class es ¹			univers ity- wide ⁴	practical ⁵	kind ⁶	type ⁷
1	ESN0878	Heat transfer and mass flow in nuclear reactors	2					S2ENJ_W01	30	60	2	1	T	Z			S	W
2	ESN0878	Heat transfer and mass flow in nuclear reactors		1				S2ENJ_U01	15	30	1	0,75	T	Z		P	S	W
3	ESN0206	Nuclear physics and reactor theory	2					S2ENJ_W02	30	60	2	1	T	Z			S	W
4	ESN0206	Nuclear physics and reactor theory		1				S2ENJ_U02	15	30	1	0,75	T	Z		P	S	W
5	ESN0167	Thermonuclear power generation	2					S2ENJ_W03	30	60	2	1	T	Z			S	W
6	ESN0167	Thermonuclear power generation		1				S2ENJ_U03	15	30	1	0,75	T	Z		P	S	W
7	ESN0915	Radioisotopes and ionizing radiation protection	2					S2ENJ_W08	30	60	2	1	T	Z			S	W
8	ESN0915	Radioisotopes and ionizing radiation protection			2			S2ENJ_U07	30	60	2	1,5	T	Z		P	S	W
9	ESN0102	Nuclear fuel cycle	2					S2ENJ_W05	30	60	2	1	T	Z			S	W
10	ESN0102	Nuclear fuel cycle		1				S2ENJ_U05	15	30	1	0,75	T	Z		P	S	W
11	ESN0922	Nuclear reactors (PWR, BWR, HWR, HTR, FBR)	3					S2ENJ_W06	45	90	3	1,5	T	Z			S	W
12	ESN0922	Nuclear reactors (PWR, BWR, HWR, HTR, FBR)			3			S2ENJ_U06	45	90	3	2,25	T	Z		P	S	W
13	ESN0415	Nuclear machinery and equipment	2					S2ENJ_W07	30	60	2	1	T	Z			S	W
14	ESN0265	Materials Engineering	2					S2ENJ_W04	30	60	2	1	T	Z			S	W
15	ESN0265	Materials Engineering			2			S2ENJ_U04	30	60	2	1,5	T	Z		P	S	W
16	ESN0045	Nuclear safety and security	1					S2ENJ_W09	15	30	1	0,5	T	Z			S	W
17	ESN0045	Nuclear safety and security					1	S2ENJ_U08	15	30	1	0,75	T	Z		P	S	W
Total			18	4	7		1		450	900	30	18						

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

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

⁷Optional – enter W, obligatory – enter Ob

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				
18	4	7		1	450	900	30	18

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	

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 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 and projects	6	11
Number of ECTS points for optional subjects including laboratory and projects <i>diploma dissertation</i>	12 20	40
Total number of ECTS points		50

- 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)

4 ECTS points

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

59 ECTS points (66 %)

11. Range of diploma dissertation

1.Zagadnienia teoretyczne

- 1.13 Defekt masy i energia wiązania.
- 1.14 Nuklidy rozszczepialne i ich zasoby.
- 1.15 Reakcja rozszczepienia.
- 1.16 Spowalnianie i termalizacja neutronów.
- 1.17 Podstawowe kryteria wyboru chłodziwa do chłodzenia reaktora.
- 1.18 Rodzaje i źródła promieniowania jonizującego.
- 1.19 Klasyfikacja i składowanie odpadów promieniotwórczych z elektrowni jądrowych.
- 1.20 Najważniejsze modele fizyczne stosowane do opisu zachowań plazmy w różnych warunkach.
- 1.21 Perspektywa wykorzystania w energetyce reakcji syntezy jądrowej zachodzącej w gorącej plazmie.
- 1.22 Materiały stosowane w energetyce jądrowej – specyficzne warunki pracy.
- 1.23 Główne zasady i techniki ochrony radiologicznej

1.24 Analiza przypadków ciężkich awarii reaktorów jądrowych.

1.25 Tendencje rozwoju energetyki jądrowej.

2. Zagadnienia konstrukcyjno-technologiczne

2.13 Budowa elektrowni jądrowej z reaktorem PWR – obieg chłodzenia i konwersji energii

2.14 Budowa elektrowni jądrowej z reaktorem BWR – obieg chłodzenia i konwersji energii

2.15 Budowa elektrowni jądrowej z reaktorem HWR – obieg chłodzenia i konwersji energii

2.16 Budowa elektrowni jądrowej z reaktorem HTR – obieg chłodzenia i konwersji energii

2.17 Budowa elektrowni jądrowej z reaktorem FBR – obieg chłodzenia i konwersji energii

2.18 Oddziaływanie promieniowania na materię. Defekty strukturalne – charakterystyka i powstawanie.

2.19 Podstawowe kryteria doboru materiałów dla elektrowni jądrowych.

2.20 Konstrukcja elementów paliwowych.

2.21 Wytwornice pary – budowa i zasada działania.

2.22 Stabilizator ciśnienia w obiegu pierwotnym reaktora – budowa i zasada działania.

2.23 Detektory poziomu promieniowania.

2.24 Detektory strumienia neutronów w rdzeniu reaktora.

2.25 Urządzenia i instalacje do wzbogacania uranu.

3. Zagadnienia eksploatacyjne

3.1. Sterowanie pracą reaktora jądrowego.

3.2. Aktywne i pasywne systemy bezpieczeństwa.

3.3. Ocena i weryfikacja poziomu bezpieczeństwa elektrowni jądrowych.

3.4. Klasyfikacja awarii reaktora jądrowego, procedury postępowania po zaistnieniu awarii.

3.5. Przeładunek paliwa jądrowego w reaktorze.

3.6. Gospodarka wypalonym paliwem jądrowym – przechowywanie, recykling.

3.7. Gospodarka odpadami nisko i wysokoaktywnymi.

3.8. Bezpieczeństwo transportu odpadów radioaktywnych.

3.9. Kontrola poziomu promieniowania w elektrowni i jej otoczeniu.

3.10. Budowa i obsługa podstawowych przyrządów dozymetrycznych.

3.11. Spektrometria promieniowania beta i gamma – identyfikacja nieznanego źródła.

3.12. Obliczanie dawek promieniowania.

3.13. Rezerwowe źródła zasilania energią elektryczną.

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 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)

PROGRAMME OF STUDIES – specialization RENEWABLE SOURCES OF ENERGY**1. Description**

<i>Number of semesters: 3</i>	<i>Number ECTS points necessary to obtain qualifications: 90</i>
<p><i>Prerequisites (particularly for second-level studies):</i></p> <p>first degree qualifications and skills necessary to continue the engineering education at the secondary level studies:</p> <p>knowledge of physics and mathematics that enables understanding of the fundamentals of physical phenomena used in the energy sector and to formulate and solve simple design tasks in the field of energy, knowledge and skills in the field of mechanics, electronics, electrical engineering, materials science, metrology, fluid mechanics, thermodynamics and the basics of machine design, enabling the measurement, analysis and design of simple components and of power systems, skill to formulate and solve engineering tasks, methods and experimental design, knowledge and skills in methodology and design techniques to enable formulation of a simple engineering problems and develop the solution using appropriate tools information, skills in interpretation, presentation and documentation of the experimental results, and the presentation and documentation of the project tasks.</p>	<p><i>Upon completion of studies graduate obtains professional degree of: magister inżynier</i></p> <p><i>2nd level qualifications</i></p>
<i>Possibility of continuing studies: third level PhD studies</i>	<i>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</i>

	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
<i>Indicate connection with University's mission and its development strategy:</i>	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. 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	ESN0365	Marketing and management	2					K2ENG_W06	30	60	2	1	T	Z			KO	Ob
		Total	2						30	60	2	1						

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

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	60	2	1

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	ESN0910	Probability theory	2					K2ENG_W01	30	90	3	1,5	T	E			PD	Ob
2	ESN0910	Probability theory		1				K2ENG_U05	15	60	2	1,5	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	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	ESN0200	Quantum Physics	2					K2ENG_W03	30	90	3	1,5	T	E			PD	Ob
Total			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

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

⁷Optional – enter W, obligatory – enter Ob

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

4.1.3 List of main-field-of-study modules

4.1.3.1 Obligatory main-field-of-study modules

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	ESN0550	Mathematical modelling of energy generation installations	2					K2ENG_W05	30	60	2	1	T	E			K	Ob
2	ESN0550	Mathematical modelling of energy generation installations			4			K2ENG_U07	60	120	4	3	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_W08	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_K02	30	60	2	1	T	Z			K	Ob
7	ESN1380	Master 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	16	9,75						

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

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

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				
8	1	4		2	225	480	16	9,75

4.2 List of optional modules

4.2.1 List of general education modules

4.2.1.1 Liberal-managerial subjects modules (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	HMH100200BK	Humanities	1					K2ENG_W06 K2ENG_K02	15	30	1	0,5	T	Z	O		KO	W
		Total	1						15	30	1	0,5						

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, B2+ level		1				K2ENG_U04	15	30	1	0,75	T	Z	O	P	KO	W
2	JZL100655BK	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						

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

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

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				
1	4				75	120	4	2,75

4.2.2 List of main-field-of-study modules

4.2.2.1 Master individual student project module (min. 5 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	ESN1362	Master individual student project				4		K2ENG_U01 K2ENG_U03 K2ENG_K01 K2ENG_K04	60	150	5	2	T	Z		P	K	W
Total						4			60	150	5	2						

4.2.2.2 Master thesis 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		W
Total										600	20	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

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

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	750	25	6

4.2.3 List of specialization modules

4.2.3.1 Specialization Renewable sources of energy modules (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
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						

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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

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

⁷Optional – enter W, obligatory – enter Ob

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, literature survey, project			
Number of BK¹ ECTS points		4	

5. Ways of verifying assumed educational effects

Type of classes	Ways of verifying assumed educational effects
lecture	examination, progress/final test
class	progress/final test
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)

46 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 laboratory and project subject	6	11
Number of ECTS points for optional subjects laboratory and project subject <i>master thesis</i>	16 20	44
Total number of ECTS points		55

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)

4 ECTS points

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

59 ECTS points (66%)

11. Range of diploma dissertation

1. Theoretical issues

- 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. Design and technological issues

- 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. Exploitation issues

- 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

<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 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)