

## **PROGRAMME OF EDUCATION**

**FACULTY: MECHANICAL AND POWER ENGINEERING**

**MAIN FIELD OF STUDY: POWER ENGINEERING**

in area of technical science

**EDUCATION LEVEL: 2nd level**

**FORM OF STUDIES: full-time**

**PROFILE: general academic**

**SPECIALIZATION: RENEWABLE SOURCES OF ENERGY**

**LANGUAGE OF STUDY: English**

Content:

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

Faculty Council Resolution of 26.09.2012

In effect since 01.10.2012

Edited adjustment\_April 2014

## PROGRAMME OF STUDIES

## 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>1<sup>st</sup> level qualifications and skills necessary to continue the education at the secondary level studies: 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 this field, knowledge and skills in the field of mechanics, electronics, electrical engineering, materials science, metrology, fluid mechanics, thermodynamics and the basics of machine design, that enable the making measurement, analysis and design of power systems and its components, and formulate and solve engineering and design tasks; knowledge and skills in methodology and design techniques, enabling the formulation of a simple engineering problem and develop the solution using appropriate tools; skills of interpretation, presentation and documentation of the experiment, and the presentation and documentation of the tasks of a project.</p>	<p><i>Upon completion of studies graduate obtains</i></p> <p><i>professional degree of: Master engineer</i></p> <p>2nd level qualifications</p>
<i>Possibility of continuing studies: 3<sup>rd</sup> degree PhD studies</i>	<p><i>Graduate profile, employability:</i></p> <p>Has knowledge and skills in the field of advanced technologies, processes and methods for testing the operation of machinery and equipment in the energy industry and related industries. It is prepared for the design, optimization and implementation of new energy technologies, in particular in ensuring the indoor thermal</p>

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

	comfort. It is designed to work in business and in the self-government and in the range of energy sector. He knows a foreign language at level B2 + and a second foreign language at A1 or A2.
<i>Indicate connection with University's mission and its development strategy:</i>	The training program is consistent with the mission of the university in the transfer of knowledge and skills to maintain high quality of education and the building of creative, critical and tolerant students attitude, by developing and nurturing a sense of academic community based on based on communication and social rights of students and employees.

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

**3. Concise analysis of consistency between assumed educational effects and labour market needs:** The assumed increase in education will provide the increase of 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 training program equips graduates with the attributes thus enabling them to adapt to the rapidly changing requirements of the labor market

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

## 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 point		Form <sup>2</sup> of course/group of courses	Way <sup>3</sup> of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes <sup>1</sup>			university-wide <sup>4</sup>	practical <sup>5</sup>	kind <sup>6</sup>	type <sup>7</sup>
1	ZMZ1572	Marketing and Management	2					K2ENG_W07	30	60	2	1	T	Z			KO	Ob
2	ZMZ1569	Business Modelling	1					K2ENG_W06	15	30	1	0,5	T	Z			KO	Ob
3	ZMZ1570	Process Management	1					K2ENG_K02 K2ENG_K05	15	30	1	0,5	T	Z			KO	Ob
Total			4						60	120	4	2						

#### 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 <sup>1</sup>
lec	cl	lab	pr	sem				
4					60	120	4	2

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> 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 <b>GK</b> )	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of creditin g cl	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	łącz-na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
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	ESN0501	Numerical Methods	2					K2ENG_W02	30	90	3	1.5	T	E			PD	Ob
4	ESN0501	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 <b>GK</b> )	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of creditin g cl	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	łącz-na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
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 <sup>1</sup>
lec	cl	lab	pr	sem				
6	1	2			135	390	13	7.5

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup>Optional – enter W, obligatory – enter Ob

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

### 4.1.3.1 Obligatory main-field-of-study modules

No	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol <b>GK</b> )	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of crediting cl	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	łącz-na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
1	ESN0552	Mathematical Modelling of Energy Generation Installations	2					K2ENG_W05	30	60	2	1	T	E			K	Ob
2	ESN0552	Mathematical Modelling of Energy Generation Installations			4			K2ENG_U07	60	120	4	3	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
7	ESN1381	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			6	1	4		2		195	420	14	8.75						

### 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 <sup>1</sup>
lec	cl	lab	pr	sem				
6	1	4		2	195	420	14	8.75

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

## 4.2 List of optional modules

### 4.2.1 List of general education modules

#### 4.2.1.1 Liberal-managerial subjects modules (*min. 1 ECTS points*):

No	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol <b>GK</b> )	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of creditin g cl	Course/group of courses			
			l e c	cl	l a b	p r	s e m		ZZU	CNPS	łącz- na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
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 <b>GK</b> )	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of creditin g cl	Course/group of courses			
			l e c	cl	l a b	p r	s e m		ZZU	CNPS	łącz- na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
1	JZL100655BK	Foreign Language (continuation) level B+		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						90	3	2.25						

#### 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 <sup>1</sup>
lec	cl	lab	pr	sem				
1	4				75	120	4	2.75

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

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

#### 4.2.3.1. Master Individual Project module (min. 5 pkt ECTS):

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 point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of creditin g cl	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	łącz-na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
1	ESN1363	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						

#### 4.2.3.2. Master Thesis module (min. pkt ECTS):

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 point		Form <sup>2</sup> of course/group of courses lec	Way <sup>3</sup> of creditin g cl	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	łącz-na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
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						

#### 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 <sup>1</sup>
lec	cl	lab	pr	sem				
			4		60	750	25	6

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup>Optional – enter W, obligatory – enter Ob



## 4.2.4.1 List of specialization modules

### 4.2.4.1 Specialization subjects (e.g. whole specialization) 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 point		Form <sup>2</sup> of course/ group of courses lec	Way <sup>3</sup> of credit g cl	Course/group of courses			
			lec	cl	l a b	p r	s e m		ZZU	CNPS	łącz- na	zajęc BK <sup>1</sup>			lab	pr	sem	typ <sup>7</sup>
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
8	ESN0182	Water Power Engineering					2	S2RSE_U04	30	60	2	1.5	T	Z		P	S	W
9	ESN1195	Thermonuclear Power Generation	2					S2RSE_W04	30	60	2	1	T	Z			S	W
10	ESN1195	Thermonuclear Power Generation		1				S2RSE_U06	15	30	1	0.75	T	Z		P	S	W
11	ESN1195	Thermonuclear Power Generation					1	S2RSE_U07	15	30	1	0.75	T	Z		P	S	W
12	ESN0362	Refrigeration Heating Systems	1					S2RSE_W05	15	30	1	0.5	T	Z			S	W
13	ESN0362	Refrigeration Heating Systems			1			S2RSE_U07 K2ENG_K04	15	30	1	0.75	T	Z		P	S	W
14	ESN0141	Wind Power Plants	1					S2RSE_W06	15	30	1	0.5	T	Z			S	W
15	ESN0141	Wind Power Plants					2	S2RSE_U08	30	60	2	1.5	T	Z		P	S	W
16	ESN0151	Geothermal Power Engineering	1					S2RSE_W07	15	30	1	0.5	T	Z			S	W
17	ESN0151	Geothermal Power Engineering		1				S2RSE_U10	15	30	1	0.75	T	Z		P	S	W
18	ESN1124	Power Production Systems and Technology from Biomass	2					S2RSE_W08	30	60	2	1	T	Z			S	W
19	ESN1124	Power Production Systems and Technology from Biomass		1				S2RSE_U10	15	30	1	0.75	T	Z		P	S	W
20	ESN1124	Power Production Systems and Technology from Biomass					1	S2RSE_U11	15	30	1	0.75	T	Z		P	S	W
21	ESN0204	Photothermal Energy Conversion System	1					S2RSE_W09	15	30	1	0.5	T	Z			S	W
22	ESN0204	Photothermal Energy Conversion System					2	S2RSE_U12	30	60	2	1.5	T	Z		P	S	W
Total			14	4	1	9	3		450	900	30	19						

### Altogether for specialization modules

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK classes <sup>1</sup>
lec	cl	lab	pr	sem				
14	4	1	9	3	450	900	30	19

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

### 4.3 Diploma dissertation module

Type of diploma dissertation	magister inżynier	
Number of diploma dissertation semesters	Number of ECTS points	Code
1	20	ESN1430
<b>Character of diploma dissertation</b>		
Experimental/project/literature survey		
Number of BK <sup>1</sup> ECTS points	4	

### 5. Ways of verifying assumed educational effects

Type of classes	Ways of verifying assumed educational effects
lecture	e.g. examination, progress/final test
class	e.g. progress/final test
laboratory	e.g. pretest, report from laboratory
project	e.g. project defence
seminar	e.g. participation in discussion, topic presentation, essay
training	e.g. report from training

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<sup>1</sup>)**  
**46 ECTS points**

### 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

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

**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>w tym praca dyplomowa</i>	14 20	43
Total number of ECTS points		54

**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 punktów ECTS**

**11. Range of diploma dissertation**

**1. Theoretical problems**

- 1.1. Quantum effects – used in energy production (blackbody radiation, PV effect, mass defect)
- 1.2. Modeling of material properties
- 1.3. Modeling 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

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

- 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

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob

- 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>
	Uchwała RW nr 4/D/2008 z dnia 19.09.2008	The students can realize the master thesis only when they receive a passing grade in all subjects of the semester leading up diploma semester	

## 13. Plan of studies (attachement no. 1)

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

<sup>2</sup>Traditional – enter T, remote – enter Z

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

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

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

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

<sup>7</sup> Optional – enter W, obligatory – enter Ob