

PROGRAMME OF EDUCATION

FACULTY: MECHANICAL AND POWER ENGINEERING

MAIN FIELD OF STUDY: POWER ENGINEERING

in area of technical science

EDUCATION LEVEL: 2nd level, Master of Science

FORM OF STUDIES: full-time

PROFILE: general academic

SPECIALIZATION: **NUCLEAR POWER ENGINEERING**

LANGUAGE OF STUDY: polish

Content:

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

Faculty Council Resolution of 30.09.2015

In effect since 01.10.2015

PROGRAMME OF STUDIES**1. Description**

<p><i>Number of semesters:</i> 3</p>	<p><i>Number ECTS points necessary to obtain qualifications:</i> 90</p>
<p><i>Prerequisites (particularly for second-level studies):</i> 1st level qualifications and engineering skills necessary to continue education at 2nd level studies: knowledge of physics and mathematics that enables understanding of the fundamentals of physical phenomena used in the energetics and formulating and solving simple design tasks in the field of energetics, knowledge and skills in the field of mechanics, electronics, electrical , materials, metrology, fluid mechanics, thermodynamics and the basics of machine design, enabling taking of measurements, analysis and design of simple components and power systems, the ability to use to formulate and solve engineering tasks, and methods and experimental design, knowledge and skills in methods and techniques design, enabling the formulation of a simple engineering problem and develop the solution using appropriate computational tools, skills of interpretation, presentation and documentation of the experiment, and the presentation and documentation of the project tasks.</p>	<p><i>Upon completion of studies graduate obtains professional degree of:</i> Master of Science 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 level B2 + and a second foreign language at A1 or A2 level.</p>
<p><i>Indicate connection with University's mission and its development strategy:</i></p>	<p>The programme of education is consistent with the mission of the University in the transfer of knowledge and skills to</p>

	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.
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- 2. Fields of science and scientific disciplines to which educational effects apply:** technical science
- 3. Concise analysis of consistency between assumed educational effects and labour market needs:** The expected 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. 3 ECTS points):

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

Altogether for general education modules:

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

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

4.1.2. List of basic sciences modules

4.1.2.1. Mathematics module

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

4.1.2.2. Physics module

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

Altogether for basic sciences modules:

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

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

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

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

4.1.3.1. Obligatory main-field-of-study module

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

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

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

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

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⁷Optional – enter W, obligatory – enter Ob

4.2. List of optional modules:

4.2.1. List of general education modules

4.2.1.1. Liberal-managerial subjects module (min. 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 creditin g	Course/group of courses			
			lec	cl	lab	pr	se m		ZZU	CNPS	total	BK class ¹ es			univers ity-wide ⁴	practical ⁵	kind ⁶	type ⁷
1	HSH100400BK	Humanities Course	1					K2ENG_W06 K2ENG_K02	15	60	2	1	T	Z	O		KO	W
		Total	1						15	60	2	1						

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

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

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

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol GK)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form ² of course/group of courses	Way ³ of creditin g	Course/group of courses			
			lec	cl	lab	pr	se m		ZZU	CNPS	total	BK class ¹ es			univers ity-wide ⁴	practical ⁵	kind ⁶	type ⁷
1	WFW010000BK	Sporting Classes		1				K2ENG_K06	15	15	1	1	T	Z	O		KO	W
		Total		1					15	15	1	1						

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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	5				90	165	6	4,25

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

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

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

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

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

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

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

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⁷Optional – enter W, obligatory – enter Ob

Altogether for main-field-of-study modules:

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

4.2.3. List of specialization modules

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

No	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol GK)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form ² of course/group of courses	Way ³ of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes ¹			university-wide ⁴	practical ⁵	kind ⁶	type ⁷
1	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						

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

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

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⁷Optional – enter W, obligatory – enter Ob

Altogether for 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)**
44,25 ECTS

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

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

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

Number of ECTS points for obligatory subjects including laboratory classes and projects	8 4
Number of ECTS points for optional subjects including: laboratory classes and projects diploma dissertation	40 11 20
Total number of ECTS points	48

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

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

11. Range of the diploma exam

1. Theoretical problems

- 1.1 Defekt masy i energia wiązania.
- 1.2 Nuklidy rozszczepialne i ich zasoby.
- 1.3 Reakcja rozszczepienia.
- 1.4 Spowalnianie i termalizacja neutronów.
- 1.5 Podstawowe kryteria wyboru chłodziwa do chłodzenia reaktora.
- 1.6 Rodzaje i źródła promieniowania jonizującego.
- 1.7 Klasyfikacja i składowanie odpadów promieniotwórczych z elektrowni jądrowych.
- 1.8 Najważniejsze modele fizyczne stosowane do opisu zachowań plazmy w różnych warunkach.
- 1.9 Perspektywa wykorzystania w energetyce reakcji syntezy jądrowej zachodzącej w gorącej plazmie.
- 1.10 Materiały stosowane w energetyce jądrowej – specyficzne warunki pracy.

- 1.11 Główne zasady i techniki ochrony radiologicznej
- 1.12 Analiza przypadków ciężkich awarii reaktorów jądrowych.
- 1.13 Tendencje rozwoju energetyki jądrowej.

2. Construction and technological problems

- 2.1 Budowa elektrowni jądrowej z reaktorem PWR – obieg chłodzenia i konwersji energii
- 2.2 Budowa elektrowni jądrowej z reaktorem BWR – obieg chłodzenia i konwersji energii
- 2.3 Budowa elektrowni jądrowej z reaktorem HWR – obieg chłodzenia i konwersji energii
- 2.4 Budowa elektrowni jądrowej z reaktorem HTR – obieg chłodzenia i konwersji energii
- 2.5 Budowa elektrowni jądrowej z reaktorem FBR – obieg chłodzenia i konwersji energii
- 2.6 Oddziaływanie promieniowania na materię. Defekty strukturalne – charakterystyka i powstawanie.
- 2.7 Podstawowe kryteria doboru materiałów dla elektrowni jądrowych.
- 2.8 Konstrukcja elementów paliwowych.
- 2.9 Wytwornice pary – budowa i zasada działania.
- 2.10 Stabilizator ciśnienia w obiegu pierwotnym reaktora – budowa i zasada działania.
- 2.11 Detektory poziomu promieniowania.
- 2.12 Detektory strumienia neutronów w rdzeniu reaktora.
- 2.13 Urządzenia i instalacje do wzbogacania uranu.

3. Operational problems

- 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 <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)