

PROGRAMME OF EDUCATION

FACULTY: MECHANICAL AND POWER ENGINEERING

MAIN FIELD OF STUDY: MECHANICAL ENGINEERING AND MACHINE BUILDING

in area of technical science

EDUCATION LEVEL: 2nd level, Master of Science

FORM OF STUDIES: full-time

PROFILE: general academic

SPECIALIZATION: **LOW TEMPERATURE 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

<i>Number of semesters:</i> 3	<i>Number ECTS points necessary to obtain qualifications:</i> 90
<p><i>Prerequisites (particularly for second-level studies):</i> Admission requirements (particularly in the case of the second cycle) degree qualifications and competence to continue education in college secondary education: knowledge of mathematics, physics and chemistry, enabling understanding of the fundamentals of mechanics, materials and principles of construction machinery, mechanical knowledge, strength of materials and construction of foundations, enabling the understanding and design of the basic machine components, the ability to use to formulate and solve engineering tasks analytical methods, simulation and experimental knowledge of fluid flow including all thermal processes, knowledge of the record structure using 2D CAD 3D and ability to communicate in English, and the presentation and documentation of the experiment, and the presentation and documentation of a project tasks.</p>	<p><i>Upon completion of studies graduate obtains</i> <i>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, employment opportunities: Graduates have the knowledge and skills in the following areas: engineering, design, manufacture and operation of machines and manufacturing systems and environmental technologies and safety. It is ready to use creative methods and technologies supporting the design, manufacture and operation of the equipment and the choice of materials engineering, management and development of production in industrial and process control, research in research institutes, management design companies in the field of construction machinery and technological processes of doing business. It has the necessary knowledge and skills in the design, testing and operation of machines and devices that generate low temperatures, corresponding to -35 ° C in cooling and in the range of 120 K (-153 ° C) fractions of</p>

	Kelvin in cryogenics, including for the technology, science and medicine. 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.

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 increase in education 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 training program equips graduates with the attributes thus enabling him to adapt to the rapidly changing requirements of the labor market.

4. List of education modules:

4.1. List of obligatory modules:

4.1.1. List of basic sciences modules

4.1.1.1. 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	MSN0616	Modelling and Optimization	1					K2MBM_W04	15	60	2	1	T	E			PD	Ob
2	MSN0616	Modelling and Optimization		2				K2MBM_U03	30	60	2	1,5	T	Z		P	PD	Ob
Total			1	2					45	120	4	2,5						

4.1.1.2. 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	MSN0462	Mechanics Analytical	2					K2MBM_W03	30	60	2	1	T	Z			PD	Ob
Total			2						30	60	2	1						

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				
3	2				75	180	6	3,5

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 main-field-of-study modules

4.1.2.1. 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	MSN1363	Modern Engineering Materials	1					K2MBM_W02	15	30	1	0,5	T	Z			K	Ob
2	MSN1363	Modern Engineering Materials			1			K2MBM_U02	15	30	1	0,75	T	Z		P	K	Ob
3	MSN1363	Modern Engineering Materials					1	K2MBM_U06	15	30	1	0,75	T	Z		P	K	Ob
4	MSN0530	Mechatronics and Control Systems	2					K2MBM_W01	30	90	3	1,5	T	E			K	Ob
5	MSN0530	Mechatronics and Control Systems			2			K2MBM_U01	30	60	2	1,5	T	Z		P	K	Ob
6	MSN1492	Integrated Production Systems	2					K2MBM_W06	30	60	2	1	T	Z			K	Ob
7	MSN1492	Integrated Production Systems			1			K2MBM_U05	15	30	1	0,75	T	Z		P	K	Ob
8	MSN1560	Diploma Seminar					2	K2MBM_U06 K2MBM_U07 K2MBM_K01 K2MBM_K03 K2MBM_K04 K2MBM_K05	30	60	2	1,5	T	Z		P	K	Ob
Total			5		4		3		180	390	13	8,25						

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				
5		4		3	180	390	13	8,25

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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

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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. 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	HSN100400BK	Humanities Course	1					K2MBM_W07 K2MBM_K02	15	60	2	1	T	Z	O		KO	W
2	ZSN100400BK	Management Course	2					K2MBM_W08 K2MBM_K05	30	90	3	1,5	T	Z	O		KO	W
Total			3						45	150	5	2,5						

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				K2MBM_U08	15	30	1	0,75	T	Z	O	P	KO	W
2	JZL100710BK	Foreign Language (second), any level		3				K2MBM_U09	45	60	2	1,5	T	Z	O	P	KO	W
Total				4					60	90	3	2,25						

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

No.	Course/group of courses code	Name of course/group of courses (denote group of courses with symbol GK)	Weekly number of hours					Field-of-study educational effect symbol	Number of hours		Number of ECTS points		Form ² of course/group of courses	Way ³ of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	total	BK classes ¹			university-wide ⁴	practical ⁵	kind ⁶	type ⁷
1	WFW010000BK	Sporting Classes		1				K2MBM_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				
3	5				120	255	9	5,75

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

4.2.2.1. Technical safety 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		Technical Safety:																
	MSN0033	Failure Analysis of Machine and Devices	2					K2MBM_W05	30	60	2	1	T	Z			K	W
	MSN0033	Failure Analysis of Machine and Devices			1			K2MBM_U04	15	30	1	0,75	T	Z		P	K	W
	MSN0034	Failure Analysis of Machine and Devices	2					K2MBM_W05	30	60	2	1	T	Z			K	W
	MSN0034	Failure Analysis of Machine and Devices			1			K2MBM_U04	15	30	1	0,75	T	Z		P	K	W
		Total	2		1				45	90	3	1,75						

4.2.2.2. Individual master of science project module (min. 6 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	MSN1534	Master Individual Student Project				6		K2MBM_U07 K2MBM_K01 K2MBM_K04 K2MBM_K05	90	180	6	1	T	Z		P	K	W
		Total				6			90	180	6	1						

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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

4.2.2.3. 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	MSN1610	Master Thesis						K2MBM_U07 K2MBM_K01 K2MBM_K04 K2MBM_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 ¹
lec	cl	lab	pr	sem				
2		1	6		135	870	29	6,75

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

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

⁷ Optional – enter W, obligatory – enter Ob

4.2.3. List of specialization modules

4.2.3.1. Specialization subjects module (min. 33 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 class ¹ es			university-wide ⁴	practical ⁵	kind ⁶	type ⁷
1	MSN1227	Thermodynamic Fundamentals of Low Temperature Engineering	2					S2INN_W01	30	60	2	1	T	Z			S	W
2	MSN1227	Thermodynamic Fundamentals of Low Temperature Engineering					1	S2INN_U01	15	30	1	0,75	T	Z		P	S	W
3	MSN0344	Cryogenics	2					S2INN_W02	30	60	2	1	T	E			S	W
4	MSN0344	Cryogenics		2				S2INN_U02	30	60	2	1,5	T	Z		P	S	W
5	MSN0344	Cryogenics			2			S2INN_U03	30	60	2	1,5	T	Z		P	S	W
6	MSN0162	Absorption and Compressor Refrigeration	2					S2INN_W03	30	60	2	1	T	E			S	W
7	MSN0162	Absorption and Compressor Refrigeration		1				S2INN_U04	15	30	1	0,75	T	Z		P	S	W
8	MSN0162	Absorption and Compressor Refrigeration			2			S2INN_U05	30	60	2	1,5	T	Z		P	S	W
9	MSN0411	Low Temperature Materials, Refrigerants and Cryogenic Fluids	2					S2INN_W04	30	60	2	1	T	Z			S	W
10	MSN0621	Standards and Design Codes	1					S2INN_W05	15	30	1	0,5	T	Z			S	W
11	MSN0272	Computer Aided Designing of Low Temperature Devices			2			S2INN_U06	30	60	2	1,5	T	Z		P	S	W
12	MSN1052	Energy Conversion Systems	2					S2INN_W06	30	60	2	1	T	E			S	W
13	MSN1052	Energy Conversion Systems				2		S2INN_U07	30	60	2	1,5	T	Z		P	S	W
14	MSN1351	Low Temperature Devices and Installation	1					S2INN_W07	15	30	1	0,5	T	Z			S	W
15	MSN1351	Low Temperature Devices and Installation				3		S2INN_U08	45	90	3	2,25	T	Z		P	S	W
16	MSN1152	Gas and Cryogenic Technologies	1					S2INN_W08	15	30	1	0,5	T	Z			S	W
17	MSN1152	Gas and Cryogenic Technologies					1	S2INN_U09	15	30	1	0,75	T	Z		P	S	W
18	MSN1053	Cryogenic Systems	1					S2INN_W09	15	30	1	0,5	T	Z			S	W
19	MSN1053	Cryogenic Systems					1	S2INN_U10	15	30	1	0,75	T	Z		P	S	W
20	MSN0615	Applied Superconductivity	1					S2INN_W10	15	30	1	0,5	T	Z			S	W
21	MSN0622	Numerical Analysis of Flow Phenomena			1			S2INN_U11	15	30	1	0,75	T	Z		P	S	W
Total			15	3	7	6	2		495	990	33	21						

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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				
15	3	7	6	2	495	990	33	21

4.3. Diploma dissertation module

Type of diploma dissertation	magister		
Number of diploma dissertation semesters	Number of ECTS points		Code
1	20		MSN1610
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	6
Number of ECTS points for optional subjects	0
Total number of ECTS points	6

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	7 4
Number of ECTS points for optional subjects including: laboratory classes and projects diploma dissertation	49 20 20
Total number of ECTS points	56

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)
9 ECTS points

10. Total number of ECTS points, which student may obtain doing optional modules (min. 30% of total number of ECTS points)
71 ECTS points (79 %)

11. Range of the diploma exam

1. Theoretical problems

- 1.1. Unattainability of absolute zero and its consequences
- 1.2. Relations between temperature and energy
- 1.3. Entropy minimization method of the optimization of thermal processes and equipment
- 1.4. Linde's refrigeration cycle and The basic parameters and their representation on lgp-h diagram. The comparison with the Carnot cycle
- 1.5. The differences between the theoretical and real compressor refrigeration cycle. Interpretation on lgp-h diagram
- 1.6. Compression – work, heat, optimalization of the proces and its importance for cooling and cryogenic cycles
- 1.7. Cogeneration and trigeneration – definition and application
- 1.8. Isentropic expansion, throttling, free exhaustion, description and comparison of the processes
- 1.9. Joule-Thomson liquefaction and refrigeration cycle, depiction on T-s diagram, energy balance, liquefaction and refrigeration capacity

- 1.11. Principles of operation and flow diagrams of cryogenic refrigerators
- 1.12. Methods for achievement of temperatures below 1 K
- 1.13. Thermodynamic base for separation of gas mixtures
- 1.14. Superconductivity_its definition and description of the phenomenon
- 1.15. Application of vacuum in cryogenic devices

2. Construction and technological problems

- 2.1. Heat exchangers used in cryogenics devices
- 2.2. Thermal insulations in cooling and cryogenics devices
- 2.3. Air rectification installation - flow diagrams
- 2.4. Materials used in cryogenic devices
- 2.5. Characterization of cryogenic constructions of one- and multi-channel pipelines
- 2.6. Liquefied gas vessels – characteristics of construction and design basis
- 2.7. Construction of helium flowing-by and fill-in cryostats
- 2.8. Construction of the cryogenic Stirling refrigerator
- 2.9. Construction of the cryogenic Gifforda-McMachona refrigerator
- 2.10. Construction of the cryogenic vacuum pumps
- 2.11. Sorts of compressor refrigerators and their basis construction parameters

3. Operational problems

- 3.1. Principles of safely usage of cryogenic media
- 3.2. Principles of cryostabilization of superconducting magnets with liquid helium
- 3.3. Principles of cryostabilization of superconducting magnets with overcritical liquid helium
- 3.4. Lubrication of moving parts in cryogenics devices
- 3.5. Energy demands and thermodynamical efficiency of cryogenic devices
- 3.6. Application of superfluid helium
- 3.7. Principles of the operation of high efficient cryogenic vacuum pumps
- 3.8. Basic principles of application of natural and synthetic cooling media in refrigeration systems
- 3.9. Basic principles of working parameters control of the compressor refrigerator system
- 3.10. Possibilities of application of absorption devices in systems of cogeneration and trigeneration

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)