

# PROGRAMME OF EDUCATION

FACULTY OF MECHANICAL AND POWER ENGINEERING

MAIN FIELD OF STUDY: Mechanical Engineering and Machine Building

in area of technical science

EDUCATION LEVEL: 2nd level, master studies

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

|                                                     |    |
|-----------------------------------------------------|----|
| <b>Process Systems Engineering</b> .....            | 2  |
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| <b>Low Temperature Engineering</b> .....            | 23 |
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Faculty Council Resolution of 26.09.2012

In effect since 01.10.2012

Edited adjustment\_April 2014

**PROGRAMME OF STUDIES – specialization PROCESS SYSTEMS ENGINEERING****1. Description**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Number of semesters:3</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <i>Number ECTS points necessary to obtain qualifications: 90</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <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. | <i>Upon completion of studies graduate obtains professional degree of: Master of Science</i><br>2 <sup>nd</sup> level qualifications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Possibility of continuing studies:</i><br>The third degree PhD studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <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 |

|                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                           | <p>business. Graduate has knowledge and skills in the design, testing and operation of equipment and systems for process engineering unit operations such as filtration, sedimentation, mixing, air pollution control, rectification, crystallization, extraction and adsorption. Graduate is able to control the processes of production and processing of substances including fuel, raw materials, water, food, pharmaceuticals and waste. 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 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.</p>                                                                                                                                                         |

**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 main-field-of-study modules

##### 4.1.1.1 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 <sup>2</sup> of course/group of courses | Way <sup>3</sup> of creditin g | 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     | MSN0462                      | Mechanics analytical                                                     | 2                      |    |     |    |     | K2MBM_W03                                                                  | 30              | 60   | 2                     | 1                       | T                                            | Z                              |                              |                        | K                 | Ob                |
| 2     | MSN1363                      | Modern engineering materials                                             | 1                      |    |     |    |     | K2MBM_W02                                                                  | 15              | 30   | 1                     | 0,5                     | T                                            | Z                              |                              |                        | K                 | Ob                |
| 3     | MSN1363                      | Modern engineering materials                                             |                        |    | 1   |    |     | K2MBM_U02                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                              |                              | P                      | K                 | Ob                |
| 4     | MSN1363                      | Modern engineering materials                                             |                        |    |     |    | 1   | K2MBM_U06                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                              |                              | P                      | K                 | Ob                |
| 5     | MSN0530                      | Mechatronics and Control Systems                                         | 2                      |    |     |    |     | K2MBM_W01                                                                  | 30              | 90   | 3                     | 1,5                     | T                                            | E                              |                              |                        | K                 | Ob                |
| 6     | MSN0530                      | Mechatronics and Control Systems                                         |                        |    | 2   |    |     | K2MBM_U01                                                                  | 30              | 60   | 2                     | 1,5                     | T                                            | Z                              |                              | P                      | K                 | Ob                |
| 7     | MSN0613                      | Modelling and Optimization                                               | 1                      |    |     |    |     | K2MBM_W04                                                                  | 15              | 60   | 2                     | 1                       | T                                            | E                              |                              |                        | K                 | Ob                |
| 8     | MSN0613                      | Modelling and Optimization                                               |                        |    | 2   |    |     | K2MBM_U03                                                                  | 30              | 90   | 3                     | 2,25                    | T                                            | Z                              |                              | P                      | K                 | Ob                |
| 9     | MSN1492                      | Integrated Production Systems                                            | 2                      |    |     |    |     | K2MBM_W06                                                                  | 30              | 60   | 2                     | 1                       | T                                            | Z                              |                              |                        | K                 | Ob                |
| 10    | MSN1492                      | Integrated Production Systems                                            |                        |    | 1   |    |     | K2MBM_U05                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                              |                              | P                      | K                 | Ob                |
| 11    | MSN1560                      | Master Seminar                                                           |                        |    |     |    | 2   | K2MBM_U06<br>K2MBM_U07<br>K2MBM_K01<br>K2MBM_K03<br>K2MBM_K04<br>K2MBM_K05 | 30              | 60   | 2                     | 1,5                     | T                                            | Z                              |                              | P                      | K                 | Ob                |
| Total |                              |                                                                          | 8                      |    | 6   |    | 3   |                                                                            | 255             | 600  | 20                    | 12,50                   |                                              |                                |                              |                        |                   |                   |

<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

**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 |                           |                            |                             |                                                   |
| 8                     |    | 6   |    | 3   | 255                       | 600                        | 20                          | 12,50                                             |

## 4.2 List of optional modules

### 4.2.1 List of general education modules

#### 4.2.1.1 Liberal-managerial subjects modules (min. 2 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 points |                         | 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     | HSN100200BK                  | Humanities course                                                                | 1                      |    |     |    |     | K2MBM_W07<br>K2MBM_K02                   | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             | O                            |                        | KO                | W                 |
| 2     | ZSN100200BK                  | Management course                                                                | 1                      |    |     |    |     | K2MBM_W08                                | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             | O                            |                        | KO                | W                 |
| Total |                              |                                                                                  | 2                      |    |     |    |     |                                          | 30              | 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 <b>GK</b> ) | Weekly number of hours |    |     |    |     | Field-of-study educational effect symbol | Number of hours |      | Number of ECTS points |                         | 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     | JZL100655BK                  | Foreign language (continuation), level B2+                                       |                        | 1  |     |    |     | K2MBM_U08                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             | O                            | P                      | KO                | W                 |
| 2     | JZL100655BK                  | 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                    |                                              |                               |                              |                        |                   |                   |

<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

#### 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 |                           |                            |                             |                                                   |

|   |   |  |  |  |    |     |   |      |
|---|---|--|--|--|----|-----|---|------|
| 2 | 4 |  |  |  | 90 | 150 | 5 | 3,25 |
|---|---|--|--|--|----|-----|---|------|

## 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 <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     | MSN0033                      | Failure analysis of machine and devices                                  | 2                      |    |     |    |     | K2MBM_W05<br>K2MBM_K05                   | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | W                 |
| 2     | MSN0033                      | Failure analysis of machine and devices                                  |                        |    | 1   |    |     | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | W                 |
| 3     | MSN0032                      | Analysis of turbomachinery damages                                       | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | W                 |
| 4     | MSN0032                      | Analysis of turbomachinery damages                                       |                        |    | 1   |    |     | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | W                 |
| 5     | MSN0034                      | Failure Analysis of Machines and Devices                                 | 2                      |    |     |    |     | K2MBM_W05<br>K2MBM_K05                   | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | W                 |
| 6     | MSN0034                      | Failure Analysis of Machines 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 Module Master Individual Student Project (min. 9 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 <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     | MSN1532                      | Master Individual Student Project                                        |                        |    |     | 6  |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 | 90              | 270  | 9                     | 4                       | T                                            | Z                             |                              | P                      | K                 | W                 |
| Total |                              |                                                                          |                        |    |     | 6  |     |                                                  | 90              | 270  | 9                     | 4                       |                                              |                               |                              |                        |                   |                   |

### 4.2.2.3 Module Master Thesis (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 <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     | MSN1610                      | Master thesis                                                            |                        |    |     |    |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 |                 | 600  | 20                    | 4                       | T                                            | Z                             |                              | P                      | K                 | W                 |
| Total |                              |                                                                          |                        |    |     |    |     |                                                  |                 | 600  | 20                    | 4                       |                                              |                               |                              |                        |                   |                   |

<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

### 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 |                           |                            |                             |                                                   |
| 2                     |    | 1   | 6  |     | 135                       | 960                        | 32                          | 9,75                                              |

## 4.2.3 List of specialization modules

### 4.2.3.1 Process Systems Engineering modules (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 <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   | MSN0271                      | Computer control of engineering projects                                 | 1                      |    |     |    |     | S2IAP_W03                                | 15              | 30   | 1                     | 0,5                     |                                              | Z                             |                              |                        | S                 | W                 |
| 2   | MSN0271                      | Computer control of engineering projects                                 |                        |    | 2   |    |     | S2IAP_U03                                | 30              | 60   | 2                     | 1,5                     |                                              | Z                             |                              | P                      | S                 | W                 |
| 3   | MSN0280                      | Construction and Utilization of Process Apparatus                        | 1                      |    |     |    |     | S2IAP_W02                                | 15              | 30   | 1                     | 0,5                     |                                              | Z                             |                              |                        | S                 | W                 |
| 4   | MSN0280                      | Construction and Utilization of Process Apparatus                        |                        |    |     | 2  |     | S2IAP_U02                                | 30              | 60   | 2                     | 1,5                     |                                              | Z                             |                              | P                      | S                 | W                 |
| 5   | MSN0351                      | Crystallization and Crystallizers                                        | 2                      |    |     |    |     | S2IAP_W06                                | 30              | 60   | 2                     | 1                       |                                              | Z                             |                              |                        | S                 | W                 |
| 6   | MSN0351                      | Crystallization and Crystallizers                                        |                        |    | 1   |    |     | S2IAP_U08                                | 15              | 30   | 1                     | 0,75                    |                                              | Z                             |                              | P                      | S                 | W                 |
| 7   | MSN0600                      | Mixing and Mixers                                                        |                        |    |     | 1  |     | S2IAP_U05                                | 15              | 30   | 1                     | 0,75                    |                                              | Z                             |                              | P                      | S                 | W                 |
| 8   | MSN0600                      | Mixing and Mixers                                                        |                        |    |     |    | 1   | S2IAP_U06                                | 15              | 30   | 1                     | 0,75                    |                                              | Z                             |                              | P                      | S                 | W                 |
| 9   | MSN0651                      | Dynamic Operations in Process Engineering                                | 2                      |    |     |    |     | S2IAP_W01                                | 30              | 60   | 2                     | 1                       |                                              | E                             |                              |                        | S                 | W                 |
| 10  | MSN0651                      | Dynamic Operations in Process Engineering                                |                        |    | 2   |    |     | S2IAP_U01                                | 30              | 60   | 2                     | 1,5                     |                                              | Z                             |                              | P                      | S                 | W                 |
| 11  | MSN1230                      | Thermodynamics in Process Engineering                                    | 1                      |    |     |    |     | S2IAP_W04                                | 15              | 30   | 1                     | 0,5                     |                                              | E                             |                              |                        | S                 | W                 |
| 12  | MSN1230                      | Thermodynamics in Process Engineering                                    |                        | 1  |     |    |     | S2IAP_U04                                | 15              | 30   | 1                     | 0,75                    |                                              | Z                             |                              | P                      | S                 | W                 |
| 13  | MSN1410                      | Heat Exchangers and Evaporators                                          | 1                      |    |     |    |     | S2IAP_W05                                | 15              | 30   | 1                     | 0,5                     |                                              | Z                             |                              |                        | S                 | W                 |
| 14  | MSN1410                      | Heat Exchangers and Evaporators                                          |                        |    | 1   |    |     | S2IAP_U07                                | 15              | 30   | 1                     | 0,75                    |                                              | Z                             |                              | P                      | S                 | W                 |
| 15  | MSN0421                      | Suspension Separation Methods and Apparatus                              | 1                      |    |     |    |     | S2IAP_W10                                | 15              | 30   | 1                     | 0,5                     |                                              | Z                             |                              |                        | S                 | W                 |
| 16  | MSN0421                      | Suspension Separation Methods and Apparatus                              |                        | 1  |     |    |     | S2IAP_U13                                | 15              | 30   | 1                     | 0,75                    |                                              | Z                             |                              | P                      | S                 | W                 |

|       |         |                                                                        |    |   |    |   |           |     |     |    |      |  |   |  |   |   |   |
|-------|---------|------------------------------------------------------------------------|----|---|----|---|-----------|-----|-----|----|------|--|---|--|---|---|---|
| 17    | MSN0825 | Property Measurements of Solutions, Suspensions and Granular Materials | 2  |   |    |   | S2IAP_W09 | 30  | 60  | 2  | 1    |  | Z |  |   | S | W |
| 18    | MSN0825 | Property Measurements of Solutions, Suspensions and Granular Materials |    | 2 |    |   | S2IAP_U12 | 30  | 60  | 2  | 1,5  |  | Z |  | P | S | W |
| 19    | MSN0654 | Thermo-diffusional Operations in Process Engineering                   | 2  |   |    |   | S2IAP_W07 | 30  | 60  | 2  | 1    |  | E |  |   | S | W |
| 20    | MSN0654 | Thermo-diffusional Operations in Process Engineering                   |    | 2 |    |   | S2IAP_U09 | 30  | 60  | 2  | 1,5  |  | Z |  | P | S | W |
| 21    | MSN0654 | Thermo-diffusional Operations in Process Engineering                   |    |   | 1  |   | S2IAP_U10 | 15  | 30  | 1  | 0,75 |  | Z |  | P | S | W |
| 22    | MSN0880 | Complex Design of Process Engineering Systems                          | 2  |   |    |   | S2IAP_W08 | 30  | 60  | 2  | 1    |  | Z |  |   | S | W |
| 23    | MSN0880 | Complex Design of Process Engineering Systems                          |    |   | 1  |   | S2IAP_U11 | 15  | 30  | 1  | 0,75 |  | Z |  | P | S | W |
| Total |         |                                                                        | 15 | 2 | 10 | 5 |           | 495 | 990 | 33 | 21   |  |   |  |   |   |   |

<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

#### 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 |                           |                            |                             |                                                   |
| 15                    | 2  | 10  | 5  | 1   | 495                       | 990                        | 33                          | 21                                                |

### 4.3 Diploma dissertation module

|                                                                     |                              |             |
|---------------------------------------------------------------------|------------------------------|-------------|
| <b>Type of diploma dissertation</b>                                 | magister inżynier            |             |
| <b>Number of diploma dissertation semesters</b>                     | <b>Number of ECTS points</b> | <b>Code</b> |
| 1                                                                   | 20                           | MSN1610     |
| <b>Character of diploma dissertation</b>                            |                              |             |
| <b>Literature survey, project, computer program, eksperimental.</b> |                              |             |
| <b>Number of BK<sup>1</sup> ECTS points</b>                         | 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 BK<sup>1</sup>)**

**46,5 ECTS points**

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

|                                               |   |
|-----------------------------------------------|---|
| Number of ECTS points for obligatory subjects | 0 |
| Number of ECTS points for optional subjects   | 0 |
| Total number of ECTS points                   | 0 |

**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                       | 7        | 10 |
| Number of ECTS points for optional subjects including laboratory and projects including master thesis | 23<br>20 | 51 |
| Total number of ECTS points                                                                           |          | 61 |

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

**5 ECTS points**

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

**70 ECTS points**

**11. The scope of the final exam**

**1. Theoretical issues**

- 1.1. The movement of particles in a fluid and sedimentation velocity
- 1.2. The filtration process, the basic equation, filtration under constant pressure
- 1.3. Calculation of heat exchangers: the temperature distribution, heat flow balance equation
- 1.4. Calculation of power of mixing. The intensity of mixing
- 1.5. The penetration and mass transfer
- 1.6. Simple distillation, calculation of the composition of the distillate
- 1.7. The theoretical number of shelves in the rectification column
- 1.8. Balance calculations in the processes of adsorption and desorption
- 1.9. Theoretical background of the crystallization process
- 1.10. The essence of the adsorption process

**2. Construction issues**

- 2.1. Design types of sedimentation units
- 2.2. Filtration systems
- 2.3. Hydrocyclones and cyclones, design and principle of operation
- 2.4. Design and principle of operation of centrifuges
- 2.5. Liquid mixers, design, types of mixers
- 2.6. Design types of heat exchangers
- 2.7. Evaporators, design types and principle of operation
- 2.8. Crystallizers, design types and principle of operation

- 2.9. Scrubbers, with shelves and scrubbing media
- 2.10. Air pollution control systems

**3. Exploitation issues**

- 3.1. The method of determining the size distribution of granular materials
- 3.2. Cooperation of solid–liquid separation units (filters, hydrocyclones, sedimentation tanks)
- 3.3. Compensation of thermal expansion in heat exchangers
- 3.4. Optimal filtration time
- 3.5. Preparation of suspensions in mixers
- 3.6. Two phase flow gas-liquid through packed column
- 3.7. Selection of the gas velocity in the column with shelves
- 3.8. The choice of crystallization method and the type of the crystallizer
- 3.9. Application of absorption-desorption processes
- 3.10. Application of adsorption process in industry

**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...<br/>(number of semester)</i> |
|------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
|            | Uchwała RW nr 4/D/2008 z dnia 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 ENGINEERING OF AVIATION****1. Description**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Number of semesters:</i> 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <i>Number ECTS points necessary to obtain qualifications:</i><br>90                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <i>Prerequisites (particularly for second-level studies):</i> qualifications and competence of engineering degree and to continue education in college the second degree: knowledge of mathematics, physics and chemistry, enabling understanding of the fundamentals of mechanics, materials and principles of construction machinery, knowledge of mechanics, 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 and 3D CAD, the ability to communicate in English and the presentation and documentation of the experiment, and the presentation and documentation of the tasks of a project | <i>Upon completion of studies graduate obtains professional degree of:</i> magister inżynier<br><br>2nd level qualifications                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Possibility of continuing studies:</i><br>The third degree PhD studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <i>Graduate profile, employability:</i> 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. They are 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 |

|                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                           | <p>in the field of construction machinery and technological processes of doing business. They have the necessary knowledge and skills in the design, testing and operation of aircraft with particular emphasis on planning, organization and control of the process of aircraft maintenance, repair and overhaul them. They knows a foreign language at level B2 + and a second foreign language at A1 or A2.</p> |
| <p><i>Indicate connection with University's mission and its development strategy:</i></p> | <p>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 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 staff</p>                                          |

**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 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 main-field-of-study modules

##### 4.1.1.1 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 points |                         | 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     | MSN0530                      | Mechatronics and Control Systems                                                 | 2                      |    |     |    |     | K2MBM_W01                                                                  | 30              | 90   | 3                     | 1,5                     | T                                            | E                             |                              |                        | K                 | Ob                |
| 2     | MSN0530                      | Mechatronics and Control Systems                                                 |                        |    | 2   |    |     | K2MBM_U01<br>K2MBM_K03<br>K2MBM_K04<br>K2MBM_K05                           | 30              | 60   | 2                     | 1,5                     | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 3     | MSN1363                      | Modern engineering materials                                                     | 1                      |    |     |    |     | K2MBM_W02                                                                  | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             |                              |                        | K                 | Ob                |
| 4     | MSN1363                      | Modern engineering materials                                                     |                        |    | 1   |    |     | K2MBM_U02                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 5     | MSN1363                      | Modern engineering materials                                                     |                        |    |     |    | 1   | K2MBM_U06                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 6     | MSN0462                      | Mechanics analytical                                                             | 2                      |    |     |    |     | K2MBM_W03                                                                  | 30              | 60   | 2                     | 1                       | T                                            | Z                             |                              |                        | K                 | Ob                |
| 7     | MSN0613                      | Modelling and Optimization                                                       | 1                      |    |     |    |     | K2MBM_W04                                                                  | 15              | 60   | 2                     | 1                       | T                                            | E                             |                              |                        | K                 | Ob                |
| 8     | MSN0613                      | Modelling and Optimization                                                       |                        |    | 2   |    |     | K2MBM_U03                                                                  | 30              | 90   | 3                     | 2,25                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 9     | MSN1492                      | Integrated Production Systems                                                    | 2                      |    |     |    |     | K2MBM_W06                                                                  | 30              | 60   | 2                     | 1                       | T                                            | Z                             |                              |                        | K                 | Ob                |
| 10    | MSN1492                      | Integrated Production Systems                                                    |                        |    | 1   |    |     | K2MBM_U05                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 11    | MSN1560                      | Master Seminar                                                                   |                        |    |     |    | 2   | K2MBM_U06<br>K2MBM_U07<br>K2MBM_K01<br>K2MBM_K03<br>K2MBM_K04<br>K2MBM_K05 | 30              | 60   | 2                     | 1,5                     | T                                            | Z                             |                              | P                      | K                 | Ob                |
| Total |                              |                                                                                  | 10                     |    | 7   |    | 3   |                                                                            | 300             | 690  | 23                    | 12,5                    |                                              |                               |                              |                        |                   |                   |

<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

**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 |                           |                            |                             |                                                   |
| 10                    |    | 7   |    | 3   | 300                       | 690                        | 23                          | 12,5                                              |

## 4.2 List of optional modules

### 4.2.1 List of general education modules

#### 4.2.1.1 Liberal-managerial subjects modules (*min. 2 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 points |                         | 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     | ZSN100200BK                  | Management course                                                                | 1                      |    |     |    |     | K2MBM_W08                                | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             | O                            |                        | K                 | W                 |
| 2     | HSN100200BK                  | Humanities course                                                                | 1                      |    |     |    |     | K2MBM_W07<br>K2MBM_K02                   | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             | O                            |                        | K                 | W                 |
| Total |                              |                                                                                  | 2                      |    |     |    |     |                                          | 30              | 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 <b>GK</b> ) | Weekly number of hours |    |     |    |     | Field-of-study educational effect symbol | Number of hours |      | Number of ECTS points |                         | 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     | JZL100655BK                  | Foreign language (continuation), level B2+                                       |                        | 1  |     |    |     | K2MBM_U08                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             | O                            | P                      | KO                | W                 |
| 2     | JZL100655BK                  | 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                    |                                              |                               |                              |                        |                   |                   |

<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

### 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 |                           |                            |                             |                                                   |
| 2                     | 4  |     |    |     | 90                        | 150                        | 5                           | 3,25                                              |

## 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 <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     | MSN0033                      | Failure analysis of machine and devices                                  | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1                     | T                                                | Z                                |                         |    | K   | W                |
| 2     | MSN0033                      | Failure analysis of machine and devices                                  |                        |    | 1   |    |     | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                  | T                                                | Z                                |                         | P  | K   | W                |
| 3     | MSN0032                      | Analysis of turbomachinery damages                                       | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1                     | T                                                | Z                                |                         |    | K   | W                |
| 4     | MSN0032                      | Analysis of turbomachinery damages                                       |                        |    | 1   |    |     | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                  | T                                                | Z                                |                         | P  | K   | W                |
| 5     | MSN0034                      | Failure Analysis of Machine and Devices                                  | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1                     | T                                                | Z                                |                         |    | K   | W                |
| 6     | 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. Msc project design module (min. 9 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 <sup>2</sup> of course/group of courses | Way <sup>3</sup> of crediting g | 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     | MSN1532                      | Msc project design                                                       |                        |    |     |    | 6   |                                          | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 | 90   | 120                   | 9                       | 4                                            | T                               | Z                            |                        | P                 | K                 | W |
| Total |                              |                                                                          |                        |    |     |    | 6   |                                          |                                                  | 90   | 120                   | 9                       | 4                                            |                                 |                              |                        |                   |                   |   |



#### 4.2.2.3. 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 <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     | MSN1610                      | Diploma dissertation                                                     |                        |    |     |    |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 | 600             | 20   | 4                     | T                       | Z                                            |                               | P                            | K                      | W                 |                   |
| Total |                              |                                                                          |                        |    |     |    |     |                                                  | 600             | 20   | 4                     |                         |                                              |                               |                              |                        |                   |                   |

<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

#### 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 |                           |                            |                             |                                                   |
| 2                     |    | 1   | 6  |     | 135                       | 960                        | 32                          | 9,75                                              |

### 4.2.3 List of specialization modules

#### 4.2.3.1 Engineering of Aviation modules (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 <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   | MSN0080                      | Structure of aircrafts                                                   | 2                      |    |     |    |     | S2ILO_W02                                | 30              | 60   | 2                     | 1                       | T                                            | Z                             |                              |                        | S                 | W                 |
| 2   | MSN0080                      | Structure of aircrafts                                                   |                        | 1  |     |    |     | S2ILO_U03                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | S                 | W                 |
| 3   | MSN0269                      | Aircraft power systems                                                   | 1                      |    |     |    |     | S2ILO_W08                                | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             |                              |                        | S                 | W                 |
| 4   | MSN0269                      | Aircraft power systems                                                   |                        |    |     | 1  |     | S2ILO_U04                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | S                 | W                 |
| 5   | MSN0790                      | Bases of the theory of oscillation                                       | 2                      |    |     |    |     | S2ILO_W03                                | 30              | 60   | 2                     | 1                       | T                                            | E                             |                              |                        | S                 | W                 |

|       |         |                                                 |    |   |   |   |   |           |     |     |    |      |   |   |  |   |   |   |
|-------|---------|-------------------------------------------------|----|---|---|---|---|-----------|-----|-----|----|------|---|---|--|---|---|---|
| 6     | MSN0790 | Bases of the theory of oscillation              |    | 1 |   |   |   | S2ILO_U05 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 7     | MSN0861 | Aviation law                                    | 1  |   |   |   |   | S2ILO_W06 | 15  | 30  | 1  | 0,5  | T | Z |  |   | S | W |
| 8     | MSN0861 | Aviation law                                    |    |   |   | 1 |   | S2ILO_U10 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 9     | MSN0910 | Design of propulsion units                      | 2  |   |   |   |   | S2ILO_W01 | 30  | 60  | 2  | 1    | T | E |  |   | S | W |
| 10    | MSN0910 | Design of propulsion units                      |    | 1 |   |   |   | S2ILO_U01 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 11    | MSN0910 | Design of propulsion units                      |    |   |   | 1 |   | S2ILO_U02 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 12    | MSN1281 | Durability and reliability of aircraft          | 2  |   |   |   |   | S2ILO_W07 | 30  | 60  | 2  | 1    | T | Z |  |   | S | W |
| 13    | MSN1371 | Selected problems on fluid mechanics            | 1  |   |   |   |   | S2ILO_W04 | 15  | 30  | 1  | 0,5  | T | Z |  |   | S | W |
| 14    | MSN1371 | Selected problems on fluid mechanics            |    | 1 |   |   |   | S2ILO_U06 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 15    | MSN1371 | Selected problems on fluid mechanics            |    |   | 1 |   |   | S2ILO_U07 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 16    | MSN0201 | Flight dynamics and aeroelasticity of aircrafts | 2  |   |   |   |   | S2ILO_W05 | 30  | 60  | 2  | 1    | T | E |  |   | S | W |
| 17    | MSN0201 | Flight dynamics and aeroelasticity of aircrafts |    |   |   | 2 |   | S2ILO_U08 | 30  | 60  | 2  | 1,5  | T | Z |  | P | S | W |
| 18    | MSN0490 | Helicopter flight mechanics                     | 2  |   |   |   |   | S2ILO_W09 | 30  | 60  | 2  | 1    | T | Z |  |   | S | W |
| 19    | MSN0490 | Helicopter flight mechanics                     |    | 1 |   |   |   | S2ILO_U11 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 20    | MSN0490 | Helicopter flight mechanics                     |    |   |   | 1 |   | S2ILO_U12 | 15  | 30  | 1  | 0,75 | T | Z |  | P | S | W |
| 21    | MSN0562 | Numerical methods in design of constructions    |    |   |   | 4 |   | S2ILO_U09 | 60  | 120 | 4  | 3    | T | Z |  | P | S | W |
| 22    | MSN1471 | Safety management in aviation                   | 2  |   |   |   |   | S2ILO_W10 | 30  | 60  | 2  | 1    | T | Z |  |   | S | W |
| Total |         |                                                 | 17 | 5 | 1 | 9 | 1 |           | 495 | 990 | 33 | 20,5 |   |   |  |   |   |   |

<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

#### 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 |                           |                            |                             |                                                   |
| 17                    | 5  | 1   | 9  | 1   | 495                       | 990                        | 33                          | 20,5                                              |

### 4.3 Diploma dissertation module

|                                                              |                       |         |
|--------------------------------------------------------------|-----------------------|---------|
| Type of diploma dissertation                                 | magister              |         |
| Number of diploma dissertation semesters                     | Number of ECTS points | Code    |
| 1                                                            | 20                    | MSN1610 |
| <b>Character of diploma dissertation</b>                     |                       |         |
| Experiment/Literature survey/Project, computer program, etc. |                       |         |
| 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              | examination/ final test                                |
| class                | progress/final test                                    |
| laboratory           | pretest, report from laboratory                        |
| project              | project defence                                        |
| seminar              | participation in discussion, topic presentation, essay |
| training             | report from training                                   |
| 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<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 | 0 |
| Number of ECTS points for optional subjects   | 0 |
| Total number of ECTS points                   | 0 |

**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<br>including laboratory classes and project                                        | 10<br>7        |
| Number of ECTS points for optional subjects<br>including laboratory classes and project<br><i>including diploma dissertation</i> | 49<br>20<br>20 |
| Total number of ECTS points                                                                                                      | 59             |

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

**5 ECTS points**

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

**67 ECTS points**

**11. Range of diploma dissertation**

**1. Teoretical issues**

- 1.1. Free and constrained systems, constraints, and their classification
- 1.2. Construction and operation of computerized measuring systems
- 1.3. Flatter wings - symptoms, causes, methods of elimination

- 1.4. Divergence of an aircraft wing
- 1.5. Trust of helicopterer rotor with axial flow
- 1.6. Rotor torque reaction
- 1.7. Controllability of the helicopter
- 1.8. Aviation safety measures
- 1.9. Classification of air accidents
- 1.10. Redundant in aircraft construction

## **2. Structural Issues**

- 2.1. Analog-digital data acquisition systems
- 2.2. Sensors in data acquisition systems
- 2.3. Buffeting vibration of aircraft structures
- 2.4. Vibration type Shimmy
- 2.5. Methodology preliminary calculations one gas-dynamic flow turboengine
- 2.6. Methodology preliminary calculations two gas-dynamic flow turboengine
- 2.7. Construction and operation of an aircraft air conditioning system
- 2.8. Construction and operation of aircraft fuel systems
- 2.9. Construction and operation of aircraft hydraulic systems
- 2.10. Construction materials used in the construction of aircraft

## **3. Operational Issues**

- 3.1. Development of reliable methods in the design of aircraft
- 3.2. The rules controlling the efficiency of systems: fuel, hydraulic and pneumatic
- 3.3. Methods of air accident investigation
- 3.4. Characteristics of physical phenomena that affect the aging of technical objects
- 3.5. The types of aircraft stability
- 3.6. Issues fatigue strength of aircraft components
- 3.7. Reliability models
- 3.8. Flight Crew Licensing
- 3.9. Rescue flights
- 3.10. Characterization methods of handling aircraft

**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<br/>deadline of...<br/>(number of<br/>semester)</i> |
|------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
|            | Faculty Council<br>Resolution<br>nr 4/D/2008 of<br>19.09.2008 | Student to be admitted to the execution module thesis is to pass all subjects in the curriculum in the semester prior to the semester of graduation |                                                                     |

**13. Plan of studies (attachment no. 1)**

**PROGRAMME OF STUDIES – specialization LOW TEMPERATURE ENGINEERING****1. Description**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Number of semesters:</i> 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <i>Number ECTS points necessary to obtain qualifications:</i> 90                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <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. | <i>Upon completion of studies graduate obtains professional degree of:</i> magister inżynier<br>2 <sup>nd</sup> level qualifications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>Possibility of continuing studies:</i> 3 <sup>rd</sup> level study, PhD study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <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 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 educational modules

### 4.1. List of obligatory modules

#### 4.1.1. List of general education modules

##### 4.1.1.1 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 <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     | MSN0462                      | Mechanics analytical                                                     | 2                      |    |     |    |     | K2MBM_W03                                                                  | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | Ob                |
| 2     | MSN1363                      | Modern engineering materials                                             | 1                      |    |     |    |     | K2MBM_W02                                                                  | 15              | 30   | 1                     | 0,50                    | T                                            | Z                             |                              |                        | K                 | Ob                |
| 3     | MSN1363                      | Modern engineering materials                                             |                        |    | 1   |    |     | K2MBM_U02                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 4     | MSN1363                      | Modern engineering materials                                             |                        |    |     |    | 1   | K2MBM_U06                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 5     | MSN0530                      | Mechatronics and Control Systems                                         | 2                      |    |     |    |     | K2MBM_W01                                                                  | 30              | 90   | 3                     | 1,50                    | T                                            | E                             |                              |                        | K                 | Ob                |
| 6     | MSN0530                      | Mechatronics and Control Systems                                         |                        |    | 2   |    |     | K2MBM_U01<br>K2MBM_K03<br>K2MBM_K04<br>K2MBM_K05                           | 30              | 60   | 2                     | 1,50                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 7     | MSN0613                      | Modelling and Optimization                                               | 1                      |    |     |    |     | K2MBM_W04                                                                  | 15              | 60   | 2                     | 1,00                    | T                                            | E                             |                              |                        | K                 | Ob                |
| 8     | MSN0613                      | Modelling and Optimization                                               |                        |    | 2   |    |     | K2MBM_U03                                                                  | 30              | 90   | 3                     | 2,25                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 9     | MSN1492                      | Integrated Production Systems                                            | 2                      |    |     |    |     | K2MBM_W06                                                                  | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | Ob                |
| 10    | MSN1492                      | Integrated Production Systems                                            |                        |    | 1   |    |     | K2MBM_U05                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 11    | MSN1560                      | Seminarium dyplomowe                                                     |                        |    |     |    | 2   | K2MBM_U06<br>K2MBM_U07<br>K2MBM_K01<br>K2MBM_K03<br>K2MBM_K04<br>K2MBM_K05 | 30              | 60   | 2                     | 1,50                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| Total |                              |                                                                          | 8                      |    | 6   |    | 3   |                                                                            | 255             | 600  | 20                    | 12,50                   |                                              |                               |                              |                        |                   |                   |

<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

## 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 |                           |                            |                             |                                                   |
| 10                    |    | 7   |    | 3   | 255                       | 600                        | 20                          | 12,50                                             |

## 4.2 List of optional modules

### 4.2.1 List of general education modules

#### 4.2.1.1 Module *Humanities-Management courses (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 <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     | HSN100200BK                  | Humanities course                                                        | 1                      |    |     |    |     | K2MBM_W07<br>K2MBM_K02                   | 15              | 30   | 1                     | 0,50                    | T                                            | Z                             | O                            |                        | KO                | W                 |
| 2     | ZSN100200BK                  | Management course                                                        | 1                      |    |     |    |     | K2MBM_W08                                | 15              | 30   | 1                     | 0,50                    | T                                            | Z                             | O                            |                        | KO                | W                 |
| Total |                              |                                                                          | 2                      |    |     |    |     |                                          | 30              | 60   | 2                     | 1,00                    |                                              |                               |                              |                        |                   |                   |

#### 4.2.1.2 Module *foreign language (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 <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     | JZL100655BK                  | Foreign language (continuation), level B2+                               |                        | 1  |     |    |     | K2MBM_U08                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             | O                            | P                      | KO                | W                 |
| 2     | JZL100655BK                  | Foreign language (second), any level                                     |                        | 3  |     |    |     | K2MBM_U09                                | 45              | 60   | 2                     | 1,50                    | T                                            | Z                             | O                            | P                      | KO                | W                 |
| Total |                              |                                                                          |                        | 4  |     |    |     |                                          | 60              | 90   | 3                     | 2,25                    | 3                                            |                               |                              |                        |                   |                   |

<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

## Altogether for optional 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 |                           |                            |                             |                                                   |
| 2                     | 4  |     |    |     | 90                        | 150                        | 5                           | 3,25                                              |

## 4.2.2. List of main – field – of – study modules

### 4.2.2.1. Module *Technical safety (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 <sup>2</sup> of course/group of courses | Way <sup>3</sup> of crediting | Course/group of courses      |                        |                   |                   |
|-------|------------------------------|--------------------------------------------------------------------------|------------------------|---|---|---|---|------------------------------------------|-----------------|------|-----------------------|-------------------------|----------------------------------------------|-------------------------------|------------------------------|------------------------|-------------------|-------------------|
|       |                              |                                                                          | w                      | ć | l | p | s |                                          | 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     | MSN0033                      | Failure analysis of machine and devices                                  | 2                      |   |   |   |   | K2MBM_W05<br>K2MBM_K05                   | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | W                 |
| 2     | MSN0033                      | Failure analysis of machine and devices                                  |                        |   | 1 |   |   | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | W                 |
| 3     | MSN0032                      | Analysis of turbomachinery damages                                       | 2                      |   |   |   |   | S2MUE_W05                                | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | W                 |
| 4     | MSN0032                      | Analysis of turbomachinery damages                                       |                        |   | 1 |   |   | S2MUE_U04                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | W                 |
| 5     | MSN0034                      | Failure Analysis of Machines and Devices                                 | 2                      |   |   |   |   | K2MBM_W05<br>K2MBM_K05                   | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | K                 | W                 |
| 6     | MSN0034                      | Failure Analysis of Machines 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. Module *Master Individual Student Project (min. 9 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 <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     | MSN1532                      | Master Individual Student Projecti                                       |                        |    |     | 6  |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 | 90              | 270  | 9                     | 4,00                    | T                                            | Z                             |                              | P                      | K                 | W                 |
| Total |                              |                                                                          |                        |    |     | 6  |     |                                                  | 90              | 270  | 9                     | 4,00                    |                                              |                               |                              |                        |                   |                   |

### 4.2.2.3. Module *Master Thesis* (min. 20 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 points |                         | Form <sup>2</sup> of course/group of courses | Way <sup>3</sup> of crediting | Course/group of courses      |                        |                   |                   |
|-------|------------------------------|--------------------------------------------------------------------------|------------------------|----|---|----|-----|--------------------------------------------------|-----------------|------|-----------------------|-------------------------|----------------------------------------------|-------------------------------|------------------------------|------------------------|-------------------|-------------------|
|       |                              |                                                                          | lec                    | cl | l | 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     | MSN1610                      | Master thesis                                                            |                        |    |   |    |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 |                 | 600  | 20                    | 4,00                    | T                                            | Z                             |                              | P                      | K                 | W                 |
| Total |                              |                                                                          |                        |    |   |    |     |                                                  | 600             | 20   | 4,00                  |                         |                                              |                               |                              |                        |                   |                   |

<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

### 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 |                           |                            |                             |                                                   |
| 2                     |    | 1   | 6  |     | 135                       | 960                        | 32                          | 9,75                                              |

## 4.2.3. List of specialization modules

### 4.2.3.1 Module *Low Temperature Engineering* (min. 33 ECTS points):

| No. | Course code /groups of courses | Name of course/course groups (groups of courses mark with a symbol GK) | Weekly number of hours |    |     |    |     | Field of study educational effect symbol | Number of hours |      | Number of ECTS points |                         | 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   | MSN1227                        | Thermodynamic Fundamentals of Low Temperature Engineering              | 2                      |    |     |    |     | S2INN_W01                                | 30              | 60   | 2                     | 1,00                    | T                                            | Z                             |                              |                        | S                 | W                 |
| 2   | MSN1227                        | Thermodynamic Fundamentals of Low                                      |                        |    |     |    | 1   | S2INN_U01                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | S                 | W                 |

|       |         | Temperature Engineering                                      |    |   |   |   |   |           |     |     |    |       |   |   |  |   |   |   |
|-------|---------|--------------------------------------------------------------|----|---|---|---|---|-----------|-----|-----|----|-------|---|---|--|---|---|---|
| 3     | MSN0344 | Cryogenics                                                   | 2  |   |   |   |   | S2INN_W02 | 30  | 60  | 2  | 1,00  | T | E |  |   | S | W |
| 4     | MSN0344 | Cryogenics                                                   |    | 2 |   |   |   | S2INN_U02 | 30  | 60  | 2  | 1,50  | T | Z |  | P | S | W |
| 5     | MSN0344 | Cryogenics                                                   |    |   | 2 |   |   | S2INN_U03 | 30  | 60  | 2  | 1,50  | T | Z |  | P | S | W |
| 6     | MSN0162 | Absorption and compressor refrigeration                      | 2  |   |   |   |   | S2INN_W03 | 30  | 60  | 2  | 1,00  | 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  | 1,50  | T | Z |  | P | S | W |
| 9     | MSN0411 | Low Temperature Materials, Refrigerants and Cryogenic Fluids | 2  |   |   |   |   | S2INN_W04 | 30  | 60  | 2  | 1,00  | T | Z |  |   | S | W |
| 10    | MSN0621 | Standards and Design Codes                                   | 1  |   |   |   |   | S2INN_W05 | 15  | 30  | 1  | 0,50  | T | Z |  |   | S | W |
| 11    | MSN0272 | Computer Aided Designing of Low Temperature Devices          |    |   | 2 |   |   | S2INN_U06 | 30  | 60  | 2  | 1,50  | T | Z |  | P | S | W |
| 12    | MSN1052 | Energy Conversion Systems                                    | 2  |   |   |   |   | S2INN_W06 | 30  | 60  | 2  | 1,00  | T | E |  |   | S | W |
| 13    | MSN1052 | Energy Conversion Systems                                    |    |   | 2 |   |   | S2INN_U07 | 30  | 60  | 2  | 1,50  | T | Z |  | P | S | W |
| 14    | MSN1351 | Low Temperature Devices and Installation                     | 1  |   |   |   |   | S2INN_W07 | 15  | 30  | 1  | 0,50  | 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  | 0,50  | 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  | 0,50  | 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  | 0,50  | 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 | 21,00 |   |   |  |   |   |   |

<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

### 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 |                           |                            |                             |                                                   |
| 15                    | 3  | 7   | 6  | 2   | 495                       | 990                        | 33                          | 21,00                                             |

### 4.3. Diploma dissertation module

|                                                               |                       |         |
|---------------------------------------------------------------|-----------------------|---------|
| Type of diploma dissertation                                  | Master's Dissertation |         |
| Number of diploma dissertation semesters                      | Number of points ECTS | Code    |
| 1                                                             | 20                    | MSN1610 |
| <b>Character of diploma dissertation</b>                      |                       |         |
| Experiment/Literature survey/ project, computer program, etc. |                       |         |
| 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                                   |
| Diploma dissertation | preparation of diploma work                                 |

### 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>)

**46,5 points of ECTS**

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

|                                               |   |
|-----------------------------------------------|---|
| Number of ECTS points for obligatory subjects | 0 |
| Number of ECTS points for optional subjects   | 0 |
| Total number of ECTS points                   | 0 |

**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<br>including laboratory and projects                                 | 7        | 10 |
| Number of ECTS points for optional subjects<br>including laboratory and projects<br><i>including master thesis</i> | 23<br>20 | 51 |
| Total number of ECTS points                                                                                        |          | 61 |

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

**5 ECTS points**

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

**70,00 points ECTS**

### **11. Range of diploma exams**

#### **1. Theoretical issues**

- 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 issues**

- 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. Exploitation issues**

- 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> |
|------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
|            | Uchwała RW nr 4/D/2008 z dnia 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 2)**

**PROGRAMME OF STUDIES – specialization POWER ENGINEERING MACHINES AND DEVICES****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> 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 professional degree of:</i> magister inżynier</p> <p>2nd level qualifications</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><i>Possibility of continuing studies:</i> studia III stopnia doktoranckie</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. Has the necessary</p> |

|                                                                                    |                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                    | knowledge and skills in the design, manufacture and testing and operation of the machinery and equipment used in the process of energy conversion and its distribution. 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 main- field - of - study modules

##### 4.1.1.1 Obligatory main-field – of – study modules (min. 20 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 points |                         | 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     | MSN0462                      | Mechanics analytical                                                             | 2                      |    |     |    |     | K2MBM_W03                                                                  | 30              | 60   | 2                     | 1                       | T                                            | Z                             |                              |                        | K                 | Ob                |
| 2     | MSN1363                      | Modern engineering materials                                                     | 1                      |    |     |    |     | K2MBM_W02                                                                  | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             |                              |                        | K                 | Ob                |
| 3     | MSN1363                      | Modern engineering materials                                                     |                        |    | 1   |    |     | K2MBM_U02                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 4     | MSN1363                      | Modern engineering materials                                                     |                        |    |     |    | 1   | K2MBM_U06                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 5     | MSN0530                      | Mechatronics and Control Systems                                                 | 2                      |    |     |    |     | K2MBM_W01                                                                  | 30              | 90   | 3                     | 1,5                     | T                                            | E                             |                              |                        | K                 | Ob                |
| 6     | MSN0530                      | Mechatronics and Control Systems                                                 |                        |    | 2   |    |     | K2MBM_U01                                                                  | 30              | 60   | 2                     | 1,5                     | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 7     | MSN0613                      | Modelling and Optimization                                                       | 1                      |    |     |    |     | K2MBM_W04                                                                  | 15              | 60   | 2                     | 1                       | T                                            | E                             |                              |                        | K                 | Ob                |
| 8     | MSN0613                      | Modelling and Optimization                                                       |                        |    | 2   |    |     | K2MBM_U03                                                                  | 30              | 90   | 3                     | 2,25                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 9     | MSN1492                      | Integrated Production Systems                                                    | 2                      |    |     |    |     | K2MBM_W06                                                                  | 30              | 60   | 2                     | 1                       | T                                            | Z                             |                              |                        | K                 | Ob                |
| 10    | MSN1492                      | Integrated Production Systems                                                    |                        |    | 1   |    |     | K2MBM_U05                                                                  | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | K                 | Ob                |
| 13    | MSN1560                      | Diploma seminar                                                                  |                        |    |     |    | 2   | K2MBM_U06<br>K2MBM_U07<br>K2MBM_K01<br>K2MBM_K03<br>K2MBM_K04<br>K2MBM_K05 | 30              | 60   | 2                     | 2                       | T                                            | Z                             |                              | P                      | K                 | Ob                |
| Total |                              |                                                                                  | 8                      |    | 6   |    | 3   |                                                                            | 255             | 600  | 20                    | 12,5                    |                                              |                               |                              |                        |                   |                   |

<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

### 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 |                           |                            |                             |                                                   |
| 8                     |    | 6   |    | 3   | 255                       | 600                        | 20                          | 12,5                                              |

## 4.2 List of optional modules

### 4.2.1 List of general education modules

#### 4.2.1.1 Liberal-managerial subjects modules (*min. 2 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 points |                         | 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     | HSN100200BK                  | Humanities course                                                                | 1                      |    |     |    |     | K2MBM_W07<br>K2MBM_K02                   | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             | O                            |                        | KO                | W                 |
| 2     | ZSN100200BK                  | Management course                                                                | 1                      |    |     |    |     | K2MBM_W08                                | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             | O                            |                        | KO                | W                 |
| Total |                              |                                                                                  | 2                      |    |     |    |     |                                          | 30              | 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 <b>GK</b> ) | Weekly number of hours |    |     |    |     | Field-of-study educational effect symbol | Number of hours |      | Number of ECTS points |                         | 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     | JZL100655BK                  | Foreign language (continuation), B2+ level                                       |                        | 1  |     |    |     | K2MBM_U08                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             | O                            | P                      | KO                | W                 |
| 2     | JZL100655BK                  | 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                    | 3                                            |                               |                              |                        |                   |                   |

<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

**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 |                           |                            |                             |                                                   |
| 2                     | 4  |     |    |     | 90                        | 150                        | 5                           | 3,25                                              |

**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 <b>GK</b> ) | Weekly number of hours |    |     |    |     | Field-of-study educational effect symbol | Number of hours |      | Number of ECTS points |                       | 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               | zajęć BK <sup>1</sup> |                                                  |                                  | lab                     | pr | sem | typ <sup>7</sup> |
| 1     | MSN0033                      | Failure analysis of machine and devices                                          | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1                     | T                                                | Z                                |                         |    | K   | W                |
| 2     | MSN0033                      | Failure analysis of machine and devices                                          |                        |    | 1   |    |     | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                  | T                                                | Z                                |                         | P  | K   | W                |
| 3     | MSN0032                      | Analysis of turbomachinery damages                                               | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1                     | T                                                | Z                                |                         |    | K   | W                |
| 4     | MSN0032                      | Analysis of turbomachinery damages                                               |                        |    | 1   |    |     | K2MBM_U04                                | 15              | 30   | 1                     | 0,75                  | T                                                | Z                                |                         | P  | K   | W                |
| 5     | MSN0034                      | Failure Analysis of Machine and Devices                                          | 2                      |    |     |    |     | K2MBM_W05                                | 30              | 60   | 2                     | 1                     | T                                                | Z                                |                         |    | K   | W                |
| 6     | 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. Msc project design module (min. 9 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 points |                         | Form <sup>2</sup> of course/group of courses | Way <sup>3</sup> of crediting g | 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     | MSN1532                      | Msc project design                                                               |                        |    |     | 6  |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 | 90              | 270  | 9                     | 4                       | T                                            | Z                               |                              | P                      | K                 | W                 |
| Total |                              |                                                                                  |                        |    |     | 6  |     |                                                  | 90              | 1270 | 9                     | 4                       |                                              |                                 |                              |                        |                   |                   |

#### 4.2.2.3. 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 <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     | MSN1610                      | Diploma dissertation                                                     |                        |    |     |    |     | K2MBM_U07<br>K2MBM_K01<br>K2MBM_K04<br>K2MBM_K05 | 600             | 20   | 4                     | T                       | Z                                            |                               | P                            | K                      | W                 |                   |
| Total |                              |                                                                          |                        |    |     |    |     |                                                  | 600             | 20   | 4                     |                         |                                              |                               |                              |                        |                   |                   |

<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

#### 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 |                           |                            |                             |                                                   |
| 2                     |    | 1   | 6  |     | 135                       | 960                        | 32                          | 9,75                                              |

### 4.2.3. List of specialization modules

#### 4.2.3.1 Power Engineering Machines and Devices 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 <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   | MSN0300                      | Boiler's design and equipment                                            | 1                      |    |     |    |     | S2MUE_W01                                | 15              | 30   | 1                     | 0,5                     | T                                            | E                             |                              |                        | S                 | W                 |
| 2   | MSN0300                      | Boiler's design and equipment                                            |                        |    |     | 2  |     | S2MUE_U06                                | 30              | 60   | 2                     | 1,5                     | T                                            | Z                             |                              | P                      | S                 | W                 |
| 3   | MSN0670                      | Burners and furnaces                                                     | 1                      |    |     |    |     | S2MUE_W02                                | 15              | 30   | 1                     | 0,5                     | T                                            | Z                             |                              |                        | S                 | W                 |
| 4   | MSN0670                      | Burners and furnaces                                                     |                        |    |     | 1  |     | S2MUE_U07                                | 15              | 30   | 1                     | 0,75                    | T                                            | Z                             |                              | P                      | S                 | W                 |
| 5   | MSN0850                      | Special pumps                                                            | 2                      |    |     |    |     | S2MUE_W03                                | 30              | 60   | 2                     | 1                       | T                                            | Z                             |                              |                        | S                 | W                 |

|       |         |                                                                 |    |   |   |   |   |                        |     |     |    |           |   |   |  |   |   |   |
|-------|---------|-----------------------------------------------------------------|----|---|---|---|---|------------------------|-----|-----|----|-----------|---|---|--|---|---|---|
| 6     | MSN0950 | Pipelines and armature                                          | 2  |   |   |   |   | S2MUE_W04              | 30  | 60  | 2  | 1         | T | Z |  |   | S | W |
| 7     | MSN0981 | Thermal engines                                                 | 1  |   |   |   |   | S2MUE_W05              | 15  | 30  | 1  | 0,5       | T | Z |  |   | S | W |
| 8     | MSN0981 | Thermal engines                                                 |    |   |   |   | 1 | S2MUE_U08<br>K2MBM_K04 | 15  | 15  | 1  | 0,75      | T | Z |  | P | S | W |
| 9     | MSN1320 | Turbines for Gas–steam Systems                                  | 2  |   |   |   |   | S2MUE_W06              | 30  | 60  | 2  | 1         | T | E |  |   | S | W |
| 10    | MSN1320 | Turbines for Gas–steam Systems                                  |    | 1 |   |   |   | S2MUE_U09              | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| 11    | MSN1310 | Turbines and hydroelectric power plants                         | 2  |   |   |   |   | S2MUE_W07              | 30  | 60  | 2  | 1         | T | Z |  |   | S | W |
| 12    | MSN1310 | Turbines and hydroelectric power plants                         |    | 1 |   |   |   | S2MUE_U10              | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| 13    | MSN1260 | Hydraulic transport                                             | 1  |   |   |   |   | S2MUE_W08              | 15  | 30  | 1  | 0,5       | T | Z |  |   | S | W |
| 14    | MSN1260 | Hydraulic transport                                             |    |   | 1 |   |   | S2MUE_U11              | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| 15    | MSN0070 | Investigation of hydraulic machinery                            | 1  |   |   |   |   | S2MUE_W09              | 15  | 30  | 1  | 0,5       | T | Z |  |   | S | W |
| 16    | MSN0070 | Investigation of hydraulic machinery                            |    |   | 2 |   |   | S2MUE_U01              | 30  | 60  | 2  | 1,5       |   |   |  | P | S |   |
| 17    | MSN0220 | Utilization of power engineering devices and machines           | 2  |   |   |   |   | S2MUE_W11              | 30  | 60  | 2  | 1         | T | E |  |   | S | W |
| 18    | MSN0220 | Utilization of power engineering devices and machines           |    | 1 |   |   |   | S2MUE_U02              | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| 19    | MSN0290 | Constructions Types of the Special Turbines                     | 2  |   |   |   |   | S2MUE_W11              | 30  | 60  | 2  | 1         | T | Z |  |   | S | W |
| 20    | MSN0290 | Constructions Types of the Special Turbines                     |    | 1 |   |   |   | S2MUE_U03              | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| 21    | MSN0330 | Boilers and Small Power                                         | 2  |   |   |   |   | S2MUE_W12              | 30  | 60  | 2  | 1         | T | Z |  |   | S | W |
| 22    | MSN0330 | Boilers and Small Power                                         |    | 1 |   |   |   | S2MUE_U04              | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| 23    | MSN1270 | Mechanical and pneumatically transportation of grainy materials | 1  |   |   |   |   | S2MUE_W13              | 15  | 30  | 1  | 0,5       | T | Z |  |   | S | W |
| 24    | MSN1270 | Mechanical and pneumatically transportation of grainy materials |    | 1 |   |   |   | S2MUE_U05<br>K2MBM_K04 | 15  | 30  | 1  | 0,75      | T | Z |  | P | S | W |
| Total |         |                                                                 | 20 | 6 | 3 | 3 | 1 |                        | 495 | 990 | 33 | 19,7<br>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

### 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 |                           |                            |                             |                                                   |
| 20                    | 6  | 3   | 3  | 1   | 495                       | 990                        | 33                          | 19,75                                             |



### 4.3. Diploma dissertation module

|                                           |                       |         |
|-------------------------------------------|-----------------------|---------|
| Type of diploma dissertation              | magister inżynier     |         |
| Number of diploma dissertation semesters  | Number of ECTS points | Code    |
| 1                                         | 20                    | MSN1610 |
| <b>Character of diploma dissertation</b>  |                       |         |
| Eksperymental, 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              | 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 BK<sup>1</sup>)

**45,25 ECTS points**

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

|                                               |   |
|-----------------------------------------------|---|
| Number of ECTS points for obligatory subjects | 0 |
| Number of ECTS points for optional subjects   | 0 |
| Total number of ECTS points                   | 0 |

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                       | 7  | 10        |
| Number of ECTS points for optional subjects including laboratory and projects including master thesis | 16 | 46        |
|                                                                                                       | 20 |           |
| <b>Total number of ECTS points</b>                                                                    |    | <b>56</b> |

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

**5 ECTS points**

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

**67 ECTS points**

11. **Range of diploma dissertation**

**1. Zagadnienia teoretyczne**

- 1.1. Przemiany i obiegi termodynamiczne (pravo- i lewobieżne), praca przemiany i obiegu
- 1.2. Równania zachowania w teorii i projektowaniu maszyn energetycznych
- 1.3. Przepływy ze sprężaniem i z rozprężaniem, oderwanie warstwy przyściennej,
- 1.4. Siły aerodynamiczne na profilu i metody ich wyznaczania teoria pojedynczego stopnia
- 1.5. Równanie podstawowe i równanie główne maszyny przepływowej – interpretacja
- 1.6. Sprawność stopnia i grupy stopni maszyny przepływowej
- 1.7. Rola rodzajów wymiany ciepła w elementach maszyn i urządzeń
- 1.8. Obliczenia ciepłno-przepływowe urządzeń energetycznych (kocioł, wymiennik, ...).
- 1.9. Czynniki dwufazowy – liczby kryterialne w procesach fluidyzacji i transportu
- 1.10. Współpraca elementów układu przepływowego (szeregowo, równoległa)

**2. Zagadnienia konstrukcyjne**

- 2.1. Materiały konstrukcyjne stosowane w budowie maszyn i urządzeń energetycznych
- 2.2. Podstawowe przypadki wytrzymałości elementów maszyn i urządzeń
- 2.3. Związek kinematyki przepływu w stopniu maszyny z konstrukcją układu łopatkowego
- 2.4. Specjalne konstrukcje kotłów i komór spalania
- 2.5. Specjalne konstrukcje maszyn wirnikowych
- 2.6. Moc graniczna turbiny parowej – sposoby jej podwyższania oraz wpływ na konstrukcję
- 2.7. Rodzaje uszczelnień, obliczanie dławicy labiryntowej
- 2.8. Zasady projektowania maszyny jedno- i wielostopniowej, znaczenie wyróżników
- 2.9. Konstrukcje i zasada działania parowników kotłów na parametry nadkrytyczne.
- 2.10. Konstrukcje i obliczenia przenośników mechanicznych i pneumatycznych.

### 3. Zagadnienia eksploatacyjne

- 3.1. Rola charakterystyki przepływowej w doborze i eksploatacji maszyny energetycznej .
- 3.2. Główne problemy związane z rozruchem i odstawianiem maszyn i urządzeń
- 3.3. Regulacja maszyn i urządzeń, podstawowe rodzaje regulatorów
- 3.4. Systemy monitoringu i akwizycji danych, czujniki i przetworniki analogowo-cyfrowe
- 3.5. Zjawisko pełzania i zmęczenie niskocyklowe elementów
- 3.6. Diagnostyka maszyn i urządzeń (cieplno-przepływowa, wibracyjna, termowizja)
- 3.7. Urządzenia transportu mechanicznego, hydraulicznego i pneumatycznego elektrowni
- 3.8. Typowe i nietypowe zjawiska w eksploatacji maszyn i urządzeń (kawitacja, pompaż, ..)
- 3.9. Możliwości ograniczania negatywnego oddziaływania elektrowni na środowisko
- 3.10. Rola elektrowni wodnych w systemie elektroenergetycznym

## 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...<br/>(number of semester)</i> |
|------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
|            | Uchwała RW<br>nr 4/D/2008<br>z dnia 19.09.2008 | Warunkiem dopuszczenia studenta do realizacji modułu <i>praca dyplomowa</i> jest zaliczenie wszystkich przedmiotów objętych planem studiów w semestrach poprzedzających semestr dyplomowy. |                                                             |

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