

# Doctoral School of the Faculty of Mechanical Engineering (3. cycle doctoral study programme)

## 1 General description of the programme

The doctoral school study programme lasts for 3 years and students need to accumulate 180 ECTS credits for its successful completion.

The objective of the doctoral school study programme is to educate and prepare the doctoral students - young researchers to carry out independent, creative, innovative and original research work in the broad field of Mechanical Engineering, with a possibility to specialise also in the fields of Design and Textile Materials and Environmental Engineering, and thereby contribute to nurturing innovative research mentality, which is a prerequisite for the development of a knowledge society. The research training within the framework of doctoral studies equips the doctoral students with superior theoretical and methodological knowledge to solve the most challenging problems in the fields of Mechanical Engineering, Design and Textile Materials and Environmental Engineering with completely new approaches. Through studies they develop the ability of independent and creative thinking about very complex issues, which will reinforce their innovative thinking.

The secondary objective of the doctoral school study programme is to expose the doctoral students to work in the industrial R&D departments, institutes and universities at home and abroad. With modern study program design that derives the academic content primarily from the scientific activity of teachers, and promoting creativity and independent work of doctoral students, the programme meets the public and industry expectations from higher education institutions and highly educated young researchers who complete the doctoral school study programme of the Faculty of Mechanical Engineering.

The study programme includes:

- Elective scientific courses (4 with 6 ECTS each, total of 24 ECTS), which allow doctoral students to get required theoretical and also professional knowledge, skills and techniques necessary for successful research of the defined research questions;
- Transferable skills courses (3 with 3 ECTS each, total of 9 ECTS), which better prepare doctoral students for research in both the academic and industrial setting;
- Individual research work (a total of 147 ECTS, of which in organized form a total of 27 ECTS), which also includes the presentation of the research results at the responsible departments at the end of the 1st and the 2nd year, a dissertation topic application

in the 3rd semester and the presentation and defense of doctoral thesis in the 6th semester of study.

The elective scientific courses are divided into the following 3 specialised scientific groups:

- Mechanical Engineering,
- Design and Textile Materials and
- Environmental Engineering.

The students have to choose at least 2/3 of elective courses from a list of available elective courses of the study program; the remaining 1/3 of courses can be chosen from other doctoral programmes offered at the Faculty of Mechanical Engineering, University of Maribor and other universities.

The graduates can obtain a specialised degree (declaration of a scientific field on doctorasl diploma certificate) in Mechanical Engineering, Design and Textile Materials or Environmental Engineering fields, if at least 3 out of 4 elective courses are chosen from the same specialised scientific group of elective scientific courses and the content of doctoral dissertation corresponds to specialised scientific field.

For successful completion of the study program it is imperative that every doctoral student has been assigned the research question and a mentor before enrolling in doctoral studies or one month after at the latest. Also the financing of the tuition fee and any material costs of individual research work at the faculty shall be agreed prior commencement of doctoral studies.

The achievement of study program objectives is primarily evaluated at the end of the study program, when doctoral students have to submit their doctoral dissertation and present and defend their research work at the public hearing in front of the examination committee.

## 2 Short description of the study modules

The doctoral school study programme does not contain study modules and doctoral students are free to choose any combination of available elective subjects to successfully solve the set research question under supervision of the mentor. However, they can a specialised degree (declaration of a scientific field on doctorasl diploma certificate) in Mechanical Engineering, Design and Textile Materials or Environmental Engineering fields, if at least 3 out of 4 elective courses are chosen from the same specialised scientific group of elective scientific courses and the content of doctoral dissertation corresponds to specialised scientific field.

## 3 General learning outcomes and competencies of the students

Through studies and research the doctoral students primarily acquire in-depth theoretical knowledge from a chosen field, defined by the set research question. However, they also

acquire the professional knowledge, skills and working methods to tackle the most challenging scientific and professional problems of modern engineering. With in-depth study of scientific methods and a variety of professional and applied study courses, the doctoral students develop the ability of abstract and associative thinking, synthesis of knowledge from a wide field of Mechanical Engineering and more specifically the fields of Design and Textile Materials and Environmental Engineering, managing the most demanding work systems and scientific research projects, the transfer of research results into practice and the development of innovative processes to solve engineering problems.

The doctoral students acquire adequate skills to solve the most challenging scientific and professional problems according to high standards of performance, which are a prerequisite for their training to become highly educated scientists and experts. While studying they develop abilities to search for new sources of knowledge and new solutions in scientific and technical fields, to develop new scientific methods in the broad spectrum of problems and new or changed circumstances and to assume responsibility for managing the most complex work processes and systems that require highly educated scientists and experts. The study process is designed to provide strong support to students for their scientific development through independent scientific research work under excellent supervision.

The doctoral graduates can develop and manage the state of the art research methods and procedures in the wider field of engineering. With critical professional self-assessment and responsibility they are capable of devising, developing and designing a new (superior) technologies and products, taking into account the professional excellence social usefulness, ethical responsibility, commitment to professional ethics and criteria for the environmental integrity of their creations. They are trained to use state of the art system concepts and principles of universality. At the same time they are able to carry out independent technical assessment based on scientific analysis and synthesis.

The students also acquire other skills, values, beliefs and positive self-esteem, which helps them to contribute significantly to the efficient use of resources for successful implementation of the most demanding tasks.

#### 4 The primary subject-specific learning outcomes and competencies of the students

The main subject-specific competencies obtained by the doctoral school study programme are:

- in-depth knowledge of selected scientific field of Mechanical Engineering and more specifically the fields of Design and Textile Materials and Environmental Engineering (eg. design of engineering systems, computer modelling and simulation of engineering systems, advanced experimenting, modelling of transport phenomena, energy and process engineering, intelligent processing and control systems,

advanced concepts of production management, materials technology, nonlinear mechanics etc.),

- an ability to find new sources of knowledge in the scientific and technical fields,
- an ability to plan, evaluate and produce the advanced technologies, innovative products and systems which have been or will be commercialized in the global markets,
- development and application of scientific methods in a broad spectrum of engineering problems,
- understanding of new technologies and processes,
- search for new solutions and scientific research approach to the development and production of advanced products that are associated with new techniques and cutting-edge technologies,
- an integrated approach to the development, optimization and manufacturing of most advanced products and components taking into account varying factors, e.g. functional characteristics, design, construction, installation, economics, management, maintenance, ecology etc.
- an ability to adapt the knowledge from other disciplines to the wider field of mechanical engineering,
- coherent management of the knowledge base and integrate knowledge from different fields,
- placement of new information and interpretations in the context of the fundamental discipline,
- understanding of the general structure of the basic discipline and coherence between its sub-disciplines,
- understanding and application of methods of critical analysis,
- the development and use of modern computing, information and communication technologies,
- teamwork management and control of communication within the organization and externally,
- ability for critical reflection.

## 5 General curriculum

The doctoral study programme of Doctoral School of the Faculty of Mechanical Engineering is divided into the following three years of studies:

### 1. YEAR:

| 1. semester                            |      |           | 2. semester   |         |           |
|--|------|-----------|---|---------|-----------|
| Course                                 | Type | ECTS      | Course  | Type    | ECTS      |
| Scientific and research work methods   | O    | 3         | Elective course 3   | I, P, M | 6         |
| Elective course 1                      | I    | 6         | Individual research work 2 with presentation of 1 <sup>st</sup> year research results | O, M    | 24 [3]    |
| Elective course 2                      | I    | 6         |   |         |           |
| Individual research work 1             | O    | 15        |   |         |           |
| <b>TOTAL</b>                           |      | <b>30</b> | <b>TOTAL</b>  |         | <b>30</b> |
| Organized study work                   |      | 15        | Organized study work  |         | 9         |
| Individual research work               |      | 15        | Individual research work  |         | 21        |
| Total organized study work 24 ECTS     |      |           |   |         |           |
| Total individual research work 36 ECTS |      |           |   |         |           |

Legend: O - compulsory; I – elective; P – transferrable skills; M - mobility

### 2. YEAR:

| 1. semester  |         |           | 2. semester   |      |           |
|--|---------|-----------|---|------|-----------|
| Course   | Type    | ECTS      | Course  | Type | ECTS      |
| Publishing of scientific results                                 | O, P    | 3         | Individual research work 4 with presentation of 2 <sup>nd</sup> year research results | O, M | 30 [3]    |
| Elective subject 4   | I, P, M | 6         |   |      |           |
| Individual research work 3 with a dissertation topic application | O, M    | 21 [6]    |   |      |           |
| <b>SKUPAJ</b>  |         | <b>30</b> | <b>SKUPAJ</b>   |      | <b>30</b> |
| Organized study work   |         | 15        | Organized study work  |      | 3         |
| Individual research work   |         | 15        | Individual research work  |      | 27        |

|  |
|--|
| Total organized study work 18 ECTS     |
| Total individual research work 42 ECTS |

Legend: O - compulsory; I – elective; P – transferrable skills; M - mobility

### 3. YEAR:

| 1. semester                                     |      |           | 2. semester   |      |           |
|---|------|-----------|---|------|-----------|
| Course  | Type | ECTS      | Course  | Type | ECTS      |
| Preparation and management of research projects | O, P | 3         | Individual research work 6 with doctoral dissertation | O, M | 30 [15]   |
| Individual research work 5                      | O, M | 27        |   |      |           |
| <b>SKUPAJ</b>                                   |      | <b>30</b> | <b>SKUPAJ</b>   |      | <b>30</b> |
| Organized study work                            |      | 3         | Organized study work                                  |      | 15        |
| Individual research work                        |      | 27        | Individual research work                              |      | 15        |
| Total organized study work 18 ECTS              |      |           |   |      |           |
| Total individual research work 42 ECTS          |      |           |   |      |           |

Legend: O - compulsory; I – elective; P – transferrable skills; M - mobility

Summation of the doctoral study programme of Doctoral School of the Faculty of Mechanical Engineering:

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|--|
| <b>Total organized study work: 24 + 18 + 18 = 60 ECTS</b>      |
| <b>Total individual research work: 36 + 42 + 42 = 120 ECTS</b> |
| <b>TOTAL STUDY PROGRAMME: 180 ECTS</b>                         |

## Detailed curriculum

| 1. year                            |                          |    |   |    |             |               |       |      |
|------------------------------------|--------------------------|----|---|----|-------------|---------------|-------|------|
| Subject                            | 1 <sup>st</sup> semester |    |   |    | Cont. hours | Individ. work | Hours | ECTS |
|                                    | L                        | S  | T | K  |             |               |       |      |
| <b>ELECTIVE SUBJECTS</b>           | 60                       | 60 | 0 | 0  | 120         | 240           | 360   | 12   |
| <b>SCIENTIFIC RESEARCH METHODS</b> | 15                       | 15 | 0 | 0  | 30          | 60            | 90    | 3    |
| <b>INDIVIDUAL RESEARCH WORK 1</b>  | 0                        | 0  | 0 | 50 | 50          | 400           | 450   | 15   |
| Together semester:                 | 75                       | 75 | 0 | 50 | 200         | 700           | 900   | 30   |

| Subject  | 2 <sup>nd</sup> semester |     |   |     | Cont. hours | Individ. work | Hours | ECTS |
|--|--------------------------|-----|---|-----|-------------|---------------|-------|------|
|  | L                        | S   | T | K   |             |               |       |      |
| <b>ELECTIVE SUBJECT</b>  | 30                       | 30  | 0 | 0   | 60          | 120           | 180   | 6    |
| <b>INDIVIDUAL RESEARCH WORK 2 WITH PRESENTATION OF 1. YEAR IRW RESULTS</b> | 0                        | 15  | 0 | 60  | 75          | 645           | 720   | 24   |
| Together semester:   | 30                       | 45  | 0 | 60  | 135         | 765           | 900   | 30   |
| Together year:   | 105                      | 120 | 0 | 110 | 335         | 1465          | 1800  | 60   |

| 2. year   |                          |    |   |    |             |               |       |      |
|---|--------------------------|----|---|----|-------------|---------------|-------|------|
| Subject   | 3 <sup>rd</sup> semester |    |   |    | Cont. hours | Individ. work | Hours | ECTS |
|   | L                        | S  | T | K  |             |               |       |      |
| <b>SCIENTIFIC PUBLISHING</b>  | 15                       | 15 | 0 | 0  | 30          | 60            | 90    | 3    |
| <b>ELECTIVE SUBJECT</b>   | 30                       | 30 | 0 | 0  | 60          | 120           | 180   | 6    |
| <b>INDIVIDUAL RESEARCH WORK 3 WITH APPROVED DOCTORAL DISSERTATION TOPIC</b> | 0                        | 15 | 0 | 90 | 105         | 525           | 630   | 21   |
| Together semester:  | 45                       | 60 | 0 | 90 | 195         | 705           | 900   | 30   |

| Subject  | 4 <sup>th</sup> semester |           |          |            | Cont. hours | Individ. work | Hours       | ECTS      |
|--|--------------------------|-----------|----------|------------|-------------|---------------|-------------|-----------|
|  | L                        | S         | T        | K          |             |               |             |           |
| <b>INDIVIDUAL RESEARCH WORK 4 WITH PRESENTATION OF 2. YEAR IRW RESULTS</b> | 0                        | 15        | 0        | 90         | 105         | 795           | 900         | 30        |
| Together semester:   | 0                        | 15        | 0        | 90         | 105         | 795           | 900         | 30        |
| <b>Together year:</b>  | <b>45</b>                | <b>75</b> | <b>0</b> | <b>180</b> | <b>300</b>  | <b>1500</b>   | <b>1800</b> | <b>60</b> |

| 3. year   |                          |    |   |    |             |               |       |      |
|---|--------------------------|----|---|----|-------------|---------------|-------|------|
| Subject   | 5 <sup>th</sup> semester |    |   |    | Cont. hours | Individ. work | Hours | ECTS |
|   | L                        | S  | T | K  |             |               |       |      |
| <b>PLANNING AND MANAGEMENT OF RESEARCH PROJECTS</b> | 15                       | 15 | 0 | 0  | 30          | 60            | 90    | 3    |
| <b>INDIVIDUAL RESEARCH WORK 5</b>                   | 0                        | 0  | 0 | 60 | 60          | 750           | 810   | 27   |
| Together semester:                                  | 15                       | 15 | 0 | 60 | 90          | 810           | 900   | 30   |

| Subject  | 6 <sup>th</sup> semester |            |          |            | Cont. hours | Individ. work | Hours       | ECTS       |
|--|--------------------------|------------|----------|------------|-------------|---------------|-------------|------------|
|  | L                        | S          | T        | K          |             |               |             |            |
| <b>INDIVIDUAL RESEARCH WORK 6 WITH DOCTORAL DISSERTATION</b> | 0                        | 15         | 0        | 120        | 135         | 765           | 900         | 30         |
| Together semester:   | 0                        | 15         | 0        | 120        | 135         | 765           | 900         | 30         |
| <b>Together year:</b>  | <b>15</b>                | <b>30</b>  | <b>0</b> | <b>180</b> | <b>225</b>  | <b>1575</b>   | <b>1800</b> | <b>60</b>  |
| <b>Together 3 years:</b>                                     | <b>165</b>               | <b>225</b> | <b>0</b> | <b>470</b> | <b>860</b>  | <b>4540</b>   | <b>5400</b> | <b>180</b> |

L – lectures, S – seminar; T – tutorial; K - konsultation

## MODUL MECHANICAL ENGINEERING

### Elective subjects (1st semester, 2nd semester, 3rd semester)

| Subject   | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |    | Cont. hours | Individ. work | Hours | ECTS |
|---|--|----|----|-------------|---------------|-------|------|
|   | L  | S  | T  |             |               |       |      |
| <b>ADVANCED MEASUREMENT SYSTEMS</b>                               | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>TESTING OF MATERIALS</b>                                       | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>MATERIALOGRAPHY</b>  | 15   | 5  | 0  | 20          | 160           | 180   | 6    |
| <b>LIGHT ALLOYS</b>   | 15   | 5  | 0  | 20          | 160           | 180   | 6    |
| <b>FUNCTIONAL MATERIALS</b>                                       | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>THEORY OF TECHNICAL SYSTEMS</b>                                | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>SELECTED TOPICS IN POWER ENGINEERING</b>                       | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>INTELLIGENT MACHINES AND SYSTEMS</b>                           | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>ADVANCED PRODUCTION PLANNING AND CONTROL SYSTEMS</b>           | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>ADVANCED SIMULATION TECHNIQUES AND PRODUCTION OPTIMIZATION</b> | 30   | 15 | 15 | 60          | 120           | 180   | 6    |



| Subject   | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |    | Cont. hours | Individ. work | Hours | ECTS |
|---|--|----|----|-------------|---------------|-------|------|
|   | L  | S  | T  |             |               |       |      |
| <b>ADVANCED COMPUTER AIDED TECHNOLOGIES</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>NEW PRODUCTION TECHNOLOGIES AND SYSTEMS</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>COMPUTER AIDED MANUFACTURING SYSTEMS AND PROCESSES</b>                                       | 12   | 18 | 0  | 30          | 150           | 180   | 6    |
| <b>COLLOIDAL SYSTEMS, NANOMATERIALS AND NANOTECHNOLOGY</b>                                      | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>DIMENSIONING ON THE SERVICE LIFE</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>DESIGN OF MODERN MACHINE DRIVES</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>STRUCTURE INTEGRITY</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>NONLINEAR FRACTURE MECHANICS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>ADVANCED METAL FORMING SYSTEMS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>BIOMECHANICS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>STABILITY AND DYNAMICS OF STRUCTURES*</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>SELECTED TOPICS IN EXPERIMENTAL METHODS</b>  | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>ADVANCED METHODS IN CFD</b>  | 20   | 10 | 0  | 30          | 150           | 180   | 6    |
| <b>SELECTED TOPICS IN HEAT TRANSFER</b>   | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>IN-DEPTH CONTENT OF PRODUCT DESIGN*</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>SURFACE PROPERTIES OF MATERIALS</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>MODELING OF PROCESSES IN AGGREGATES OF DRIVE SYSTEMS</b>                                     | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>STRUCTURAL TOPOLOGY OPTIMIZATION</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>INTELLIGENT MODELLING AND OPTIMIZATION OF MACHINING PROCESSES</b>                            | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>NUMERICAL METHODS FOR FATIGUE ANALYSIS OF MATERIALS</b>                                      | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>STRATEGIES AND METHODS OF MAINTENANCE</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>RENEWABLE MATERIALS AND TECHNOLOGIES*</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>KNOWLEDGE EVALUATION IN BUSINESS SYSTEMS</b>   | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>CREATIVE TECHNIQUES AND INNOVATION MANAGEMENT IN THE DEVELOPMENT OF PRODUCTS OR SERVICES</b> | 40   | 20 | 0  | 60          | 120           | 180   | 6    |

| Subject   | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |    | Cont. hours | Individ. work | Hours | ECTS |
|---|--|----|----|-------------|---------------|-------|------|
|   | L  | S  | T  |             |               |       |      |
| <b>INTEGRAL TRANSPORT</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>WAREHOUSING AND TRANSPORT SYSTEMS</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>HYDRAULIC AND PNEUMATIC SERVO SYSTEMS</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>STATISTICAL THERMODYNAMICS*</b>  | 35   | 10 | 15 | 60          | 120           | 180   | 6    |
| <b>MULTIPHASE SYSTEMS</b>   | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>3D HYDROGEL BIOMATERIALS AND BIOPRINTING</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>MANUFACTURING CELLS AND SYSTEMS</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>MODERN CONCEPTS IN PRODUCTION</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>PRODUCT DEVELOPMENT METHODOLOGY</b>  | 30   | 20 | 40 | 90          | 90            | 180   | 6    |
| <b>NUMERICAL ANALYSIS IN NONLINEAR FRACTURE MECHANICS</b>                               | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>SELECTED TOPICS IN PROCESS ENGINEERING</b>   | 15   | 15 | 30 | 60          | 120           | 180   | 6    |
| <b>SELECTED TOPICS IN TRANSPORT PHENOMENA</b>   | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>BOUNDARY AND DOMAIN APPROXIMATION METHODS</b>  | 30   | 15 | 15 | 60          | 120           | 180   | 6    |
| <b>NONLINEAR COMPUTATIONAL ENGINEERING ANALYSES</b>                                     | 15   | 15 | 0  | 30          | 150           | 180   | 6    |
| <b>IMPACT MECHANICS</b>   | 15   | 15 | 0  | 30          | 150           | 180   | 6    |
| <b>BIOMATERIALS</b>   | 12   | 3  | 0  | 15          | 165           | 180   | 6    |
| <b>DYNAMICS OF REACTING FLOW*</b>   | 30   | 20 | 10 | 60          | 120           | 180   | 6    |
| <b>APPLIED PHYSICAL METHODS*</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>ADVANCED FIBROUS MATERIALS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>OPTIMIZATION METHODS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>FLUID POWER MECHATRONIC SYSTEMS</b>  | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>CONTACT PROBLEMS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>MODELLING OF STRUCTURAL NONLINEARITIES</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>EXPERIMENTAL AND COMPUTATIONAL CHARACTERIZATION OF CELLULAR MATERIALS PROPERTIES</b> | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>DESIGN WITH CELLULAR MATERIALS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>JOINING OF ENGINEERING MATERIALS</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>PLANNING AND REALISATION OF JOINTS BY WELDING*</b>                                   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>ERGONOMIC ANALYSES AND SIMULATIONS</b>   | 30   | 15 | 15 | 60          | 120           | 180   | 6    |

| Subject   | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |    | Cont. hours | Individ. work | Hours | ECTS |
|---|--|----|----|-------------|---------------|-------|------|
|   | L  | S  | T  |             |               |       |      |
| <b>ADVANCED PRODUCTION SYSTEMS</b>                      | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>COUPLED PROBLEMS MODELING IN PROCESS ENGINEERING</b> | 30   | 5  | 25 | 60          | 120           | 180   | 6    |
| <b>SUSTAINABLE TECHNOLOGIES OF METALLIC MATERIALS</b>   | 15   | 5  | 0  | 20          | 160           | 180   | 6    |
| <b>THERMOMECHANICAL TREATMENTS OF MATERIALS</b>         | 17   | 3  | 0  | 20          | 160           | 180   | 6    |
| <b>INTELLIGENT MONITORING SYSTEMS</b>                   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |

\* the subject is not offered in the academic year 2021/2022

#### MODUL ENVIRONMENTAL ENGINEERING

Elective subjects (1st semester, 2nd semester, 3rd semester)

| Subject                                      | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |    | Cont. hours | Individ. work | Hours | ECTS |
|--|--|----|----|-------------|---------------|-------|------|
|  | L  | S  | T  |             |               |       |      |
| <b>ENVIRONMENTAL CONTROL</b>                 | 15   | 15 | 20 | 50          | 130           | 180   | 6    |
| <b>WASTE MANAGEMENT</b>                      | 45   | 15 | 0  | 60          | 120           | 180   | 6    |
| <b>ENVIRONMENTAL PARAMETERS MEASUREMENTS</b> | 45   | 15 | 0  | 60          | 120           | 180   | 6    |
| <b>ADVANCED WASTEWATER TREATMENT</b>         | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>ENVIRONMENTAL ENGINEERING*</b>            | 30   | 30 | 0  | 60          | 120           | 180   | 6    |
| <b>DYEING AND CLEANING OF WASTE WATER*</b>   | 30   | 30 | 0  | 60          | 120           | 180   | 6    |

\* the subject is not offered in the academic year 2021/2022

#### MODUL DESIGN AND TEXTILE MATERIALS

Elective subjects (1st semester, 2nd semester, 3rd semester)

| Subject   | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |   | Cont. hours | Individ. work | Hours | ECTS |
|---|--|----|---|-------------|---------------|-------|------|
|   | L  | S  | T |             |               |       |      |
| <b>ADVANCED HYBRID AND COMPOSITE MATERIALS</b>            | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>THEORY OF FABRIC ENGINEERING (SELECTED CHAPTERS)</b>   | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>COLOUR AND FUNCTIONAL MATERIALS*</b>                   | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>POLYSACCHARIDES AND FUNCTIONALIZATION OF MATERIALS</b> | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>MECHANICS OF FLEXIBLE FLAT STRUCTURES</b>              | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>THERMAL PHYSIOLOGICAL COMFORT OF CLOTHING*</b>         | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>ADVANCED TREATMENTS OF POLYMERIC MATERIALS</b>         | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>BIOTECHNOLOGICAL PROCESSES</b>                         | 30   | 30 | 0 | 60          | 120           | 180   | 6    |

| Subject   | 1 <sup>st</sup> 2 <sup>nd</sup> , 3 <sup>rd</sup> semester |    |   | Cont. hours | Individ. work | Hours | ECTS |
|---|--|----|---|-------------|---------------|-------|------|
|   | L  | S  | T |             |               |       |      |
| <b>RENEWABLE NANOMATERIALS</b>  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>NANOFIBROUS MATERIALS</b>  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>FUNCTIONAL DYES/PIGMENTS AND APPLICATIONS</b>                              | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>PATTERNMAKING AND VIRTUAL PROTOTYPING OF 3D TEXTILE FORMS</b>              | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>CONTEMPORARY FASHION AND DESIGN</b>  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>BIOPOLYMERS</b>  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>COMPUTER BASED TECHNOLOGIES FOR TEXTILE APPLICATIONS - SELECTED TOPICS</b> | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>MEDICAL AND HYGIENE MATERIALS</b>  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>FIBRE PRETREATMENT</b>   | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| THEORY OF DESIGN*   | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| COMMUNICATION ROLE OF CLOTHING*   | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| <b>ORGANIC CHEMISTRY - SELECTED CHAPTERS</b>                                  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |
| RECYCLING*  | 30   | 30 | 0 | 60          | 120           | 180   | 6    |

\* the subject is not offered in the academic year 2021/2022