

# Industrial Engineering

## 3. cycle doctoral study programme

### 1 General description of the programme

The doctoral study programme of the third cycle “Industrial Engineering” within University of Maribor with three partners: Faculty of Mechanical Engineering, Faculty of Civil Engineering, Transportation Engineering and Architecture and Faculty of Economics and Business.

The study programme lasts three years. A student has to acquire 180 ECTS points. The study programme is aligned with the Bologna directives, Salzburg principles for doctoral education and European University Association (EUA) principles and recommendations.

The doctoral study programme of the third cycle Industrial Engineering is the first and only real interdisciplinary study program in the field of industrial or engineering management at the University of Maribor and in Slovenia in general. During the study and research work, the student deals with challenges where technical aspects (from the field of mechanical engineering or civil engineering) are connected with economic and business aspects. The purpose of the study program is to create a profile of a Doctor of Science, which enables research and development and scientific work in a field that requires specific knowledge typical of industrial engineers and the intertwining of economic and technical knowledge.

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 Industrial 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 study programme includes:

- Elective scientific courses (3 with 6 ECTS each, total of 18 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;
- Basic knowledge and transferable skills courses (1 with 6 ECTS and 2 with 3 ECTS each, total of 12 ECTS), which better prepare doctoral students for research in both the academic and industrial setting;
- Individual research work (a total of 150 ECTS, of which in organized form a total of 30 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 defence of doctoral thesis in the 6th semester of study.

The students have to choose at least 2 elective courses from a list of available elective courses in the field of mechanical engineering and civil engineering and 1 elective course from the economic-business field. Students can also choose one subject from other doctoral programmes offered at the University of Maribor and other universities. Students have one mentor and one co-mentor depending on their research focus.

For successful completion of the study program it is imperative that every doctoral student has been assigned the research question and a mentor (and co-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.

Expert areas for Dr. Sc. in Industrial Engineering study programme are leading positions in engineering companies, in technical and commercial sectors of companies, project managers in industrial, construction and other companies, manager of research and development projects in various areas, top and middle management positions in companies, entrepreneur, product managers etc. The study programme is especially suitable for researcher from universities and other R&D institutions and employees in public sector.

## 2 Short description of the study modules

Industrial Engineering doctoral study programme does not include any study modules. However, it follows two fields: industrial engineering in the field of mechanical engineering and industrial engineering in the field of civil engineering.

## 3 General learning outcomes and competencies of the students

Postgraduate of the Doctoral study program Industrial Engineering is an expert with a broad and in-depth theoretical and methodological knowledge of solving complex problems in planning, managing and implementation of development, research and scientific tasks in the broad field of engineering and business as well as various employment positions. By implementing research methods, procedures and processes of the industrial engineering, self-critical assessment and responsibility he/she is capable of modelling, planning, designing, manufacturing and maintaining of complex products,

advanced machines and devices, modern planning and management of building construction processes, by considering professional excellence, usefulness to the society, ethical responsibility, commitment to professional ethics and standards of environmental sustainability of his/hers creations.

Students of Doctoral study program Industrial Engineering will be able to work on complex engineering, business and scientific tasks. The Dr. Sc. qualified experts with broad analytical and scientific knowledge will find employment in almost all branches of industry, R&D institutes, independent companies, design departments, as project engineers, product managers, construction managers, experts, consultants, managers and entrepreneurs.

The main general competencies are:

- Ability to solve concrete research problems in various technical fields through the integration of economic and business sciences as well as its related disciplines.
- Development of skills and abilities in the application of knowledge and integration of knowledge from the fields of technology and economics and business sciences in their specific research and work field.
- Ability to widely use standard research empirical methods in interdisciplinary technical and economic-business fields.
- Ability to design and implement original scientific solutions to given interdisciplinary technical and economic-business problems.
- Ability to develop new advanced technologies, innovative products and systems.
- Ability to use the latest computer, information and communication technology and technological systems in the professional field.
- Ability to plan and manage (research and development) projects and write project proposals under various national and European financial mechanisms.

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

The main subject-specific competencies that can be obtained by the doctoral Industrial Engineering study programme are:

- Mastering the scientific research methods necessary for a scientific approach to the study for the preparation of works that will meet the criteria for scientific work in terms of content and form.
- Scientific publication of scientific and research results of candidates for individual research works in recognized publications.
- Ability to prepare and manage research projects, as one of the key areas of work for which doctoral programs will be used, which represents the organized acquisition of transferable knowledge.

- In-depth mathematical knowledge of modelling engineering problems with the help of graph theory, mathematical modelling of decision-making, multivariate methods in decision-making analysis for conducting business and interdisciplinary research.
- Ability to use in deepening specialized scientific process construction in the professional fields of planning construction projects and optimization of construction processes.
- Ability to use knowledge and control of accounting methodologies for the management of construction processes and projects with management tools and analysis of implementation processes for comprehensive management of the value of projects and facilities.
- Ability to use, know and analyse the principles of sustainable planning of building construction and understanding of construction-physical processes through the construction of a building using modern numerical methods in engineering.
- Ability to use modern machining technologies and systems with an emphasis on the most commonly used manufacturing technologies in the industry, which are included in the concept of Industry 4.0.
- Knowledge of production management from product development, knowledge management and promotion of innovation-based development to the provision of appropriate ergonomics, warehouse and development and management of the production system. Knowledge of modern production concepts and their application in practice.
- Knowledge of the legality of business regarding the specifics and requirements of the wider business environment in terms of understanding the phenomenon of financial crises and economic growth and the consequences of economic policies, requires sustainable management in the (business) environment.
- Knowledge of the laws and specifics of individual but intertwining areas of the micro level of business, from the strategic-entrepreneurial level to the implementation project level, the integration of financial management processes, global marketing in internationalization, marketing of products-services-brands, management and cost accounting and digitization and e-commerce.

## 5 General curriculum

The doctoral study programme of Industrial Engineering is divided into the following three years of studies:

### 1. YEAR:

1. semester			2. semester		
Course	Type	ECTS	Course	Type	ECTS
Scientific Research Methods	O	6	Elective course 2	E	6
Elective course 1	E	6	Elective course 3	E	6
Individual research work 1	O	18	Individual research work 2 with presentation of 1 <sup>st</sup> year IRW results	O	18 [3]
<b>TOTAL</b>		<b>30</b>	<b>TOTAL</b>		<b>30</b>
Organized study work		12	Organized study work		15
Individual research work		18	Individual research work		15
Total organized study work 27 ECTS					
Total individual research work 33 ECTS					

Legend: O - obligatory; E – elective; P – transferrable skills

### 2. YEAR:

1. semester			2. semester		
Course	Type	ECTS	Course	Type	ECTS
Transferable knowledge 1 (Scientific publishing)	O, P	3	Individual research work 4 with presentation of 2 <sup>nd</sup> year IRW results	O	30 [6]
Individual research work 3 (with applying doctoral dissertation topic)	O	27 [9]			
<b>SKUPAJ</b>		<b>30</b>	<b>SKUPAJ</b>		<b>30</b>
Organized study work		12	Organized study work		6
Individual research work		18	Individual research work		24
Total organized study work 18 ECTS					
Total individual research work 42 ECTS					

**3. YEAR:**

1. semester			2. semester		
Course	Type	ECTS	Course	Type	ECTS
Transferable knowledge 2 (Planning and management of research projects)	O, P	3	Preparation and defense of doctoral dissertation	O	30 [12]
Individual research work 5	O	27			
<b>SKUPAJ</b>		<b>30</b>	<b>SKUPAJ</b>		<b>30</b>
Organized study work		3	Organized study work		12
Individual research work		27	Individual research work		18
Total organized study work 15 ECTS					
Total individual research work 45 ECTS					

Legend: O - obligatory; E – elective; P – transferrable skills

Summation of the doctoral study programme of Industrial Engineering

<b>Total organized study work: 27 + 18 + 15 = 60 ECTS</b>
<b>Total individual research work: 33 + 42 + 45 = 120 ECTS</b>
<b>TOTAL STUDY PROGRAMME: 180 ECTS</b>

## 6 Detailed curriculum

1. year								
Course	1 <sup>st</sup> semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
<b>Elective Course 1</b>	30	30	0	0	30	120	180	6
<b>Scientific Research Methods</b>	15	15	0	0	30	150	180	6
<b>Individual research work 1</b>	0	0	0	40	40	500	540	18
Together semester:	45	45	0	40	130	770	900	30

Course	2 <sup>nd</sup> semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
<b>Elective Course 2</b>	30	30	0	0	60	120	180	6
<b>Elective Course 3</b>	30	30	0	0	60	120	180	6
<b>Individual Research Work 2 with presentation of 1<sup>st</sup> year IRW results</b>	0	15	0	50	65	475	540	18
Together semester:	60	75	0	50	185	715	900	30
<b>Together year:</b>	<b>105</b>	<b>120</b>	<b>0</b>	<b>90</b>	<b>315</b>	<b>1485</b>	<b>1800</b>	<b>60</b>

2. year								
Course	3 <sup>rd</sup> semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
<b>Transferable knowledge 1 (Scientific Publishing)</b>	15	15	0	0	30	60	90	3
<b>Individual Research Work 3 (with applying doctoral dissertation topic)</b>	0	15	0	90	105	705	810	27
Together semester:	15	30	0	90	135	765	900	30

Course	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>15</b>	<b>45</b>	<b>0</b>	<b>180</b>	<b>240</b>	<b>1560</b>	<b>1800</b>	<b>60</b>

3. year								
Course	5 <sup>th</sup> semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
<b>Transferable knowledge 2 (Planning and Management of Research Projects)</b>	18	18	0	0	36	54	90	3
<b>Individual Research Work 5</b>	0	0	0	60	60	750	810	27
Together semester:	18	18	0	60	96	804	900	30

Course	6 <sup>th</sup> semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
<b>Preparation and defense of 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>18</b>	<b>33</b>	<b>0</b>	<b>180</b>	<b>231</b>	<b>1569</b>	<b>1800</b>	<b>60</b>
<b>Together 3 years:</b>	<b>138</b>	<b>198</b>	<b>0</b>	<b>450</b>	<b>786</b>	<b>4614</b>	<b>5400</b>	<b>180</b>

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

#### Elective Courses (1<sup>st</sup> semester and 2<sup>nd</sup> semester)

Course	1 <sup>st</sup> 2 <sup>nd</sup> semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Knowledge Based Engineering	30	30	0	60	120	180	6
Intelligent Machines and Systems	30	30	0	60	120	180	6
Intelligent Modelling and Optimization of Machining Processes	30	30	0	60	120	180	6
New Technologies and Systems	30	30	0	60	120	180	6
Modern Concepts in Production	30	30	0	60	120	180	6
Advanced Simulation Techniques and Production Optimization	30	15	15	60	120	180	6
Product Development and Innovation Management	30	30	0	60	120	180	6
Warehouse Systems in Logistics	30	30	0	60	120	180	6
Ergonomic Analyses and Simulations	30	15	15	60	120	180	6
Management of Computer Aided Technologies	30	30	0	60	120	180	6
Optimization Methods	30	30	0	60	120	180	6
Thermomechanical Treatments of Materials	17	3	0	20	160	180	6
Intelligent Monitoring Systems	30	30	0	60	120	180	6
Sensitivity analysis	30	30	0	60	120	180	6
Selected Topics in Optimization of Construction Processes	30	30	0	60	120	180	6
Advanced Scheduling of Construction Projects	30	30	0	60	120	180	6
Contemporary Monitoring Methods in Civil Engineering	45	0	15	60	120	180	6
Advanced Approach to Operations and Management of Project in Construction Industry	30	30	0	60	120	180	6
Numerical Methods in Building Physics	60	0	30	90	90	180	6
Advanced approaches to digitization and automation in construction industry	30	30	0	60	120	180	6
Research in the Field Of Sustainable Timber Buildings	30	30	0	60	120	180	6
Corporate Finance and Financial Management	8	0	0	8	172	180	6
Financial Crises and Economic Policy	8	0	0	8	172	180	6
Contemporary Issues in Product, Services and Brand Management	8	0	0	8	172	180	6
Global Marketing and Firm Internationalisation	8	0	0	8	172	180	6



Course	1 <sup>st</sup> 2 <sup>nd</sup> semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Project Based Business Operations and Project Management	8	0	0	8	172	180	6
Digital Transformation	8	0	0	8	172	180	6
Entrepreneurship and the Growth of Firms	8	0	0	8	172	180	6
Contemporary Theories of Economic Growth	8	0	0	8	172	180	6
Strategic Management	8	0	0	8	172	180	6
Sustainable Management and Entrepreneurial Environment Protection	8	0	0	8	172	180	6
Legal Status of Members of the Boards	8	0	0	8	172	180	6
Multivariate Methods in Business Analysis	8	0	0	8	172	180	6
Decision Analysis in Business Sciences	8	0	0	8	172	180	6