Mechanical Engineering, 2. cycle master study programme

1 General description of the programme

The master study programme of the second cycle “Mechanical Engineering“ lasts two years. A student has to acquire 120 ECTS points. The study programmes is aligned with the Bologna directives. It represents the basis for the doctoral study programme of the third cycle with the same name “Mechanical Engineering”.

The study programme is related to other study programmes in Europe. Three study programmes “Mechanical Engineering” from the high-ranked universities according to Shanghai university rankings) were taken for the basis and comparison: 1. Swiss federal Institute of technology (ETH) Zürich, Switzerland; The Technical University of Muenchen, Germany, Delft University of Technology, The Netherlands, and Vienna University of Technology, Austria.

The postgraduate master's study program of Mechanical Engineering is aimed to educate specialist-engineers with theoretical-scientific and special practical skills to work on most demanding engineering problems in companies, where the engineers are able to solved difficult and complex problems based on theoretical and practical solutions, procedures and methods. The university programme contains a balanced combination of knowledge that is in alignment with the recommendations of the European Society for Engineering Education (SEFI). It is intended to provide students with deep scientific knowledge of mechanical engineering, oriented towards practical solutions. The students will gain ability of abstract and associative study and analysis of problems in order to provide solutions and development of different discipline and transfer knowledge to practice. The students will learn how to effectively apply modern engineering tools to solve most demanding mechanical engineering problems. Such concept of the postgraduate master's study program is in accordance with common European orientation in higher education.

The postgraduate master's study program of Mechanical Engineering is intended to educate highly qualified engineers to work also in research and development institutes in companies and national research institutions. The contemporary based study program is adapted to reflect rich scientific research activity of academic staff at Faculty of Mechanical Engineering.

The 1st study year the students can select from one of three offered study fields: Power, process and environmental engineering, Engineering Design, Manufacturing technologies and systems. The first semester contains common scientific and technological basic courses in the amount of 30 ECTS; the 2nd semester contains compolsory courses from selected study field in the amount of 30 ECTS. Each study field in second year comprises 18 ECTS of compulsory courses and 12 ECTS of selective courses. In the spring semester (4th semester)

of the second study year students work on Master thesis task in the amount of 18 ECTS. The Master thesis work comprises scientific and research work on a certain chosen engineering problem. The students have to prepare the Master thesis and publicly present and defend it in front of an examination board. The Master thesis work significantly contributes to the final student M.Sc. classification. After finishing the studies they can continue their studies on PhD study programmes, which are also offered at our faculty.

2 Short description of the study modules

2.1 Power, process and environmental engineering

The students of this module gain the advanced theoretical and applied knowledge necessary for analysis of power and mass transport processes, thermal and hydraulic machinery and devices. In particular, in the area of power engineering this includes study of different types of machines and devices such as internal combustion engines, hydraulic machines, gas and steam turbines, steam boilers and HVAC systems. In the process engineering area the study focuses on unit operations characteristics, especially mechanical and thermal diffusion process technology. The environmental engineering focuses on different environmental technologies for the primary emission reduction of harmful substances at its source, elimination of pollutants from gases, water and ground and management of industrial and household waste. A special focus of the study is on the application of modern computational tools (CFD) and transport phenomena for the advanced engineering analyses in power, process and environmental engineering.

2.2 Engineering Design

The students of this study module gain the advanced theoretical and practical knowledge needed for modern design and analysis of structures and machines. They are trained to combine the basic knowledge with modern procedures and design methods of mechanical elements, parts, assemblies, structures and machines. The study is designed to teach the students how to work as a part of a design team on modern CAD equipment and how to effectively apply intelligent and expert systems in the design and analysis of structures and machines. The students are encouraged to develop and assess new concepts and practical approaches that help shorten the design processes and thus contribute towards product cost reduction.

2.3 Manufacturing technologies and systems

The study focuses on the in-depth knowledge of production processes and production process planning depending on the manufacturing tool and machine choice optimisation in view of production cost reduction. Particular attention is devoted to advanced understanding and use of control measurements of manufacturing machines that enable proper estimation of the state of the machine and its production readiness. Computer aided technologies, production automatisation, robot technology and other automatic or semi-automatic systems, which fulfil the target functions of the production technologies, are studied in detail, as these technologies are the basis of the intelligent manufacturing system development. On the system level, the students expand their theoretical knowledge of

operational research system analysis, deepen the knowledge of production management with its concepts of process simulation, scientific databases and results of experimental systems.

3 General learning outcomes and competencies of the students

Postgraduate of the Masters of science study program Mechanical 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 mechanical engineering as well as various employment positions. By implementing research methods, procedures and processes of the mechanical engineering and by professional review, self-critical assessment and responsibility he/she is capable of modelling, planning, designing, manufacturing and maintaining of complex products, advanced machines and devices, 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 master study program will be able to work on complex engineering and scientific tasks. The M.Sc. qualified engineers will have deeper knowledge and increased skills to solve most difficult engineering problems in industry and also the ability to work as a part of research teams. They will be able to seek new knowledge sources and apply most current scientific and research methods for practical solutions of different engineering problems. They will be able to accept the leadership responsibilities and transfer the results of scientific work to practical problems. The broad mechanical engineering orientation of the study program will generate creative and innovative potential of students.

The M.Sc. qualified engineers 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, experts, consultants, managers and research team members.

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

The main subject-specific competencies that are obtained by the Master of science study programme of MECHANICAL ENGINEERING are:

- an ability to use and deepen the knowledge in specific fields of mechanical engineering: power, process and environmental engineering, engineering design, production technologies and systems as well as engineering computer modelling,
- an ability to introduce new technological processes and production facilities,

- an ability to apply and upgrade computer-aided design for advanced design and optimization procedures,
- an ability to apply and upgrade processes and tools for modelling, optimisation and simulation of processes, machines, devices, manufacturing methods, products and production facilities,
- an ability to design, develop and upgrade machines, devices and facilities for the power, process and environmental engineering,
- an ability to analyse processes in process and environmental engineering and production engineering,
- an ability to devise, develop and apply the modern production technologies, production automatisation and new production concepts,
- an ability to evaluate information, material and energy flows by devising, designing, assembly, disassembly and maintenance of products,
- an ability for synthesis of the current production methods and technologies, based on analysing, evaluating and judging of existing production methods and technologies,
- an ability to systematically organise and manage a production process,
- an ability to analyse quality of products by applying appropriate measurements and quality assurance,
- an ability to conduct and evaluate measures for flawless functioning, maintenance, and environmental correctness of products during their total life-time,
- an ability for interdisciplinary understanding of the activities in the production systems,
- an ability to permanently develop skills by application of knowledge on the specific professional area,
- an ability to apply modern computer, information and communication technologies in the assessment procedures in specific professional area,
- knowledge and deeper understanding of historical developments in mechanical engineering and its disciplines.

5 General curriculum

The postgraduate master study program of Mechanical Engineering takes two years (4. semesters) in total amount of 120 ECTS credit points. The 1st study year the students can select from one of three offered study fields:

1. Energy, Process and Environmental Engineering
2. Engineering Design
3. Manufacturing Technologies and Systems

Master study programme of Mechanical Engineering is divided into the following two parts:

Part	Part of study	Duration	ECTS credits
1	Joint courses and Module courses	1 year (2 semesters)	60
2	Module courses	1 year (2 semesters)	60
	Total:	**2 years**	**120**

6 Detailed curriculum

1. year							
Subject	1st semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Selected topics in Mathematics	45	15	15	75	105	180	6
Selected topics in Mechanics	45	0	30	75	105	180	6
Advanced Engineering Materials	45	15	15	75	105	180	6
Methodology of Experimental Work	45	0	30	75	105	180	6
Numerical Modelling and Computer Simulations	45	0	30	75	105	180	6
Together semester:	225	30	120	375	525	900	30

1. year – modul Power, process and environmental engineering							
Subject	2nd semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Energy and Environment	30	0	30	60	120	180	6
HVAC	30	15	15	60	120	180	6
Thermodynamics of Mixtures	45	0	15	60	120	180	6
Computational Fluid Dynamics (CFD)	40	5	15	60	120	180	6
3D Modelling	30	10	20	60	120	180	6
Together semester:	175	30	95	300	600	900	30
Together year:	**400**	**60**	**215**	**675**	**1125**	**1800**	**60**

1. year – modul Engineering Design							
Subject	2nd semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Systematic Mechanical Designing	30	15	15	60	120	180	6
Virtual Engineering Systems	30	10	20	60	120	180	6
Computational solid Mechanics	30	15	15	60	120	180	6
3D Modelling	30	10	20	60	120	180	6
Energy and Environment	30	0	30	60	120	180	6
Together semester:	150	50	100	300	600	900	30
Together year:	**375**	**80**	**220**	**675**	**1125**	**1800**	**60**

1. year – modul Manufacturing technologies and systems							
Subject	2nd semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Advanced Technological Systems	30	15	15	60	120	180	6
Production Systems	30	15	15	60	120	180	6
Modelling of Manufacturing and Production Systems	30	15	15	60	120	180	6
Machine Learning in Engineering	30	15	15	60	120	180	6

3D Modelling	30	10	20	60	120	180	6
Together semester:	150	70	80	300	600	900	30
Together year:	**375**	**100**	**200**	**675**	**1125**	**1800**	**60**

2. year – modul Power, process and environmental engineering

Subject	3rd semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Computer Simulations of Transport Phenomena	30	15	15	60	120	180	6
Transport Phenomena	45	0	15	60	120	180	6
Combustion and Ecology	35	5	20	60	120	180	6
Internal Combustion Engines	30	0	30	60	120	180	6
Process Engineering	40	0	20	60	120	180	6
Together semester:	180	20	100	300	600	900	30

Subject	4th semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
Elective subjects* (modul elective subjects/general elective subjects)	40	10	30	-	80	280	360	12
Master`s Thesis	-	-	-	10	10	530	540	18
Together semester:	40	10	30	10	90	810	900	30
Together year:	**220**	**30**	**130**	**10**	**390**	**1410**	**1800**	**60**
Together 2 years:	**620**	**90**	**345**	**10**	**1065**	**2535**	**3600**	**120**

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

2. year – modul Engineering Design

Subject	3rd semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Goal Driven Product Development	45	10	20	75	105	180	6
Joining of Structural Elements	30	10	35	75	105	180	6
Internal Transport and Logistics	30	10	35	75	105	180	6
Fatigue Strength of Structures	30	15	30	75	105	180	6
Structural Mechanics	45	0	30	75	105	180	6
Together semester:	180	45	150	375	525	900	30

Subject	4th semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
Elective subjects** (modul elective subjects/general elective subjects)	40	10	30	-	80	280	360	12
Master`s Thesis	-	-	-	10	10	530	540	18
Together semester:	40	10	30	10	90	810	900	30
Together year:	**220**	**55**	**180**	**10**	**465**	**1335**	**1800**	**60**
Together 2 years:	**595**	**135**	**400**	**10**	**1140**	**2460**	**3600**	**120**

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

2. year – modul Manufacturing technologies and systems							
Subject	3rd semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Integrated Manufacturing Systems	45	10	20	75	105	180	6
Advanced Machining and Forming Systems	45	0	30	75	105	180	6
Mechatronics Systems	45	10	20	75	105	180	6
Production Systems' Design	30	15	30	75	105	180	6
Dimension and Shape Measurement	30	10	35	75	105	180	6
Together semester:	195	45	135	375	525	900	30

Subject	4th semester				Cont. hours	Individ. work	Hours	ECTS
	L	S	T	K				
Elective subjects*** (modul elective subjects/general elective subjects)	40	10	30	-	80	280	360	12
Master`s Thesis	-	-	-	10	10	530	540	18
Together semester:	40	10	30	10	90	810	900	30
Together year:	**235**	**55**	**165**	**10**	**465**	**1335**	**1800**	**60**
Together 2 years:	**610**	**155**	**365**	**10**	**1140**	**2460**	**3600**	**120**

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

Elective subjects

2. year – modul **Power, process and environmental engineering – elective subjects* -**							
Subject	4th semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Hydraulic Machinery	20	5	15	40	140	180	6
Heating and Cooling Systems	25	5	10	40	140	180	6
Turbulent and Multiphase Flow	20	5	15	40	140	180	6
Single and Two Phase Heat Exchangers	25	5	10	40	140	180	6
Experimental Methods in Power and Process Engineering	20	5	15	40	140	180	6
Safety and Reliability in Engineering	25	5	10	40	140	180	6

2. year – modul **Engineering Design – elective subjects** -**							
Subject	4th semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Dimensioning of Lightweight Structures	30	10	0	40	140	180	6
Road and Rail Vehicles	30	10	0	40	140	180	6
Welded Structures	20	10	10	40	140	180	6
Robots and Robotisation	30	0	10	40	140	180	6
Modelling of Dynamical Systems	30	0	10	40	140	180	6
Computational Solid Dynamics	20	10	10	40	140	180	6

2. year – modul **Manufacturing technologies and systems – elective subjects*** -**							
Subject	4th semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Intelligent Manufacturing Systems	15	20	5	40	140	180	6
Additive Technologies and 3D Printing	30	0	10	40	140	180	6
Production and Project Management	20	10	10	40	140	180	6
Product Development, Technology and Innovation Management	20	10	10	40	140	180	6
Methods and Tools for Quality Assurance	20	10	10	40	140	180	6
Mechatronic Control and Servo Systems	20	5	15	40	140	180	6

2. year – General elective subjects							
Subject	4th semester			Cont. hours	Individ. work	Hours	ECTS
	L	S	T				
Development oF Engineering Software	20	0	20	40	140	180	6
Engineering Visualization	20	0	20	40	140	180	6
Product Development Economics	20	10	10	40	140	180	6
Materials Technology	24	0	16	40	140	180	6
Project Work	0	15	0	15	165	180	6