

**UNIVERSITY OF BANJA LUKA
FACULTY OF MECHANICAL ENGINEERING**



**UNDERGRADUATE AND GRADUATE STUDIES
CURRICULA**

(Bachelor of Science)
(Master of Science)

February, 2012
Second edition

1. GENERAL

The following studies have been administered at the Faculty of Mechanical Engineering, University of Banja Luka since 1 October 2007:

		ECTS
Doctor of Science – Mechanical Engineering (corresponding study program)	Doctoral studies	480
		450
		420
		390
		360
		330
Master of Science – Mechanical Engineering (corresponding study program)	Graduate studies	300
		270
		240
		210
Bachelor of Science - Mechanical Engineering (corresponding study program)	Undergraduate studies	180
		150
		120
		90
		60
		30

The undergraduate diploma (180 ECTS) shall contain the following title: **BACHELOR OF SCIENCE – MECHANICAL ENGINEERING – 180 ECTS**. The Diploma Supplement contains the list of completed subjects. A dash and particular field of study are added next to the title that a student has earned by opting for the given study program.

The graduate diploma (120 ECTS) shall contain the following academic title: **MASTER OF SCIENCE IN MECHANICAL ENGINEERING – corresponding study program**. The Diploma Supplement contains the list of completed subjects. A dash and particular field of study are added next to the title that a student has earned by opting for the given study program.

The Doctoral diploma (180 ECTS) shall contain the following title: **DOCTOR OF SCIENCE – MECHANICAL ENGINEERING - corresponding study program**. The Diploma Supplement contains the date of enrollment, field of research, the list of completed subjects, data on teaching experience, published papers and project participation; and the date of thesis defense, doctoral thesis title, mentor’s name as well as names of committee members at the end. This title is equivalent to the Doctor of Philosophy (**Ph.D.**) abroad.

The following study programs are administered at the Faculty of Mechanical Engineering:

- PRODUCTION ENGINEERING
- ENERGY AND TRANSPORTATION ENGINEERING
- MECHATRONICS
- INDUSTRIAL ENGINEERING AND MANAGEMENT
- SAFETY AT WORK

UNDERGRADUATE STUDIES
CURRICULA
(Bachelor of Science)

2. CURRICULA FOR THE I, II AND III SEMESTER

The I, II and III semester curriculum is the same for all study programs.

The first year curriculum - I semester

Sem.	No.	COURSE	Hours L + E	ECTS points
I	1.	Mathematics I	3 + 3	7
	2.	Mechanics I	2 + 2	6
	3.	Descriptive Geometry	2 + 2	4
	4.	Production Technologies	2 + 1	4
	5.	Materials I	3 + 3	5
	6.	Labor Law	2 + 0	4
	7.	English Language I/ Sports	0 + 2	
Total			14+11	30

The first year curriculum - II semester

Sem.	No.	COURSE	Hours L + E	ECTS points
II	1.	Mathematics II	3 + 2	7
	2.	Strength of Materials	3 + 3	8
	3.	Engineering Graphics	2 + 2	5
	4.	Information Technology	2 + 2	6
	5.	Physics	2 + 2	4
	6.	English Language II/ Sports	0 + 2	
Total			12+11	30

The second year curriculum - III semester

Sem.	No.	COURSE	Hours L + E	ECTS points
III	1.	Mechanics II	4 + 3	8
	2.	Mathematics III	2 + 2	6
	3.	Machine Elements I	3 + 2	6
	4.	Electrical Engineering	3 + 2	6
	5.	Industrial Management	2 + 1	4
	6.	English Language III	0 + 2	
Total			14+10	30

3. CURRICULA FOR STUDY PROGRAMS (IV, V and VI semester)

3.1. PRODUCTION ENGINEERING

Production engineering encompasses all production technologies as well as related fields such as: design of tools and machines, preparation and management of production, design of technological processes and systems, automation and robotization of production, etc. Production Engineering offers a wide range of courses relevant to the profession while these courses provide further study of metal cutting and plasticity forming, welding and heat treatment, design of technological processes for metal cutting, metal forming, welding and heat treatment, design of machining, metal forming and non-conventional technological processes (water jet, laser and plasma cutting, rapid prototyping), design of modern machine tools and flexible technological systems by applying the finite element method (FEM), programming of CNC machine tools, design of tools and accessories by using CATIA and SolidWorks software, application of modern software through product design (CAD, CAE), technological processes (CAPP, CAM), simulation of machining processes using computers (CAE), factory communication systems for acquisition and exchange of information.

By choosing particular elective courses, students can study mechanical wood processing.

Production Engineering engineers can find employment in various production companies in metal industry (design of products and their parts, production technology), all other industry branches where there is a high degree of automation (food, chemical, graphic, wood industry, etc.), research-development centers, institutes, design companies that deal with research and development of new technologies and products, companies that deal with production of tools, machines and equipment in metal industry. In particular, one of the advantages is working on maintenance of machine systems in practically all companies and institutions.

After they complete the undergraduate studies, students gain the professional title as follows:

Bachelor of Science – Mechanical Engineering, Production Engineering

The second year curriculum - IV semester

Sem.	No.	COURSE	Hours L + E	ECTS points
IV	1.	Programming	2 + 2	5
	2.	Thermodynamics	3 + 2	6
	3.	Fluid Mechanics	3 + 2	6
	4.	Machine elements II	3 + 2	6
	5.1	Materials II	2 + 2	5
	5.2	Wood Science ¹		
	6.	Industrial Practice	4 weeks	2
	Optional	English Language IV	0 + 2	
Total			17+12	30

The third year curriculum - V semester

Sem.		No.	COURSE	Hours L + E	ECTS points
V	Compulsory	1.	Metal Cutting Technology	2 + 2	6
		2.	Metal Forming Technology	2 + 2	6
		3.	Metrology	2 + 2	6
		4.1	Hydraulics and Pneumatics	2 + 2	4
	4.2	Primary Wood Processing ¹			
	Elective (2)	1.	Product Development	2 + 2	4
		2.	Tribology	2 + 2	4
		3.	Introduction to Design	2 + 2	4
		4.	Transport Technology	2 + 2	4
		5.	Surface Wood Processing ¹	2 + 2	4
		6.	Veneer and Plywood ¹	2 + 2	4
		7.	Chemical Wood Processing ¹	2 + 2	4
		Optional	Technical English Language I	0 + 2	
Total				12+12	30

¹ For Mechanical Wood Processing study program

The third year curriculum - VI semester

Sem.		No.	COURSE	Hours L + E	ECTS points		
VI	Compulsory	1.	Metal Forming Systems	3 + 2	5		
		2.	Metal Cutting Systems	2 + 2	5		
		3.	Computer-Integrated Production (CAD, CAPP, BP, CIM)	2 + 2	5		
		4.	Welding and Heat Treatment	2 + 2	5		
	Elective (2)	5.		Control Systems Design	2 + 2	5	
				Metal Forming Tools	2 + 2	5	
				Mechatronics	2 + 2	5	
				Design of Technological Processes	2 + 2	5	
			6.		Tools and Accessories I	2 + 2	5
					Machine Dynamics	2 + 2	5
					Wood Processing Machines ¹	2 + 2	5
					Hydro-Thermal Wood Processing ¹	2 + 2	5
		Wood Product Design ¹	2 + 2	5			
	Optional		Technical English Language II	0 + 2			
					13 + 12	30	
<i>B.Sc. paper for Bachelor degree in Mechanical Engineering (Study program – Production Engineering) or further education for M.Sc.</i>				2 months	5		

¹ For Mechanical Wood Processing study program

3.2. ENERGY AND TRANSPORTATION ENGINEERING

There are three study groups at this department:

- **Thermal Engineering (TT)**
- **Thermal Energetics (TE)**
- **Transportation Engineering (SM).**

Students who earn the Bachelor Degree in Energy and Transportation Engineering have wide-ranging opportunities for employment.

They can deal with design in the field of thermal engineering and thermal energetics, such as design of heating and air-conditioning systems (housing, business and industrial facilities), refrigeration systems, thermal energy installations, pump and compression installations, etc. A particular engineering challenge for this study group is reflected in possibility to deal with alternative energy sources such as geothermal energy, biomass energy, solar energy, etc. Energy efficiency is another potential field of work, primarily due to the low energy efficiency of our industry. Managing construction, inspection and maintenance of the said systems is carried out by engineers of this department.

Transportation Engineering is an especially interesting study group. Depending on their interests, students can deal with design, construction and maintenance of engines and vehicles, design of information systems central to vehicle maintenance as well as vehicle maintenance systems. Besides, they can also deal with transportation and traffic issues in which vehicles play crucial role. This study group focuses on vehicle safety systems, both passive and active, and their influence on traffic safety, vehicle certification, traffic accident analyses, etc. As vehicles are nowadays a major cause of environment pollution in urban areas throughout the world, special attention is devoted to study of these problems and the ways to reduce emissions of harmful combustion products generated by engines and other plants.

After they complete the undergraduate studies, students gain the professional title as follows:

Bachelor of Science – Mechanical Engineering, Energy and Transportation Engineering

The second year curriculum - IV semester

Sem.	No.	COURSE	Hours L + E	ECTS points
IV	1.	Programming	2 + 2	5
	2.	Thermodynamics I	3 + 2	6
	3.	Fluid Mechanics	3 + 2	6
	4.	Metrology	3 + 2	6
	5.	Fuels, Industrial Water and Lubricants	3 + 2	5
	6.	Industrial Practice	4 weeks	2
	Optional	English Language IV	0 + 2	
Total			14 + 12	30

The third year curriculum - V semester

Sem.		No.	COURSE	Hours L + E	ECTS points
V	Compul sory	1.	Thermodynamics II	3 + 2	6
		2.	Introduction to IC Engines	3 + 2	6
		3.	Boilers	3 + 2	6
	Elective (2)	1.	Pipe Transportation (TT, TE)	3 + 2	6
		2.	Heating (TT)	3 + 2	6
		3.	Heat Turbo Machines (TE)	3 + 2	6
		4.	Motor Vehicles- Theory of Motion (SM)	3 + 2	6
		5.	Rail Vehicles (SM)	3 + 2	6
		6.	Traffic Safety (SM)	3 + 2	6
		7.	Hydraulics and Pneumatics of Mobile Machines (SM)	3 + 2	6
Optional	Technical English Language I	0 + 2			
Total			15 + 10	30	

The third year curriculum - VI semester

Sem.		No.	COURSE	Hours L + E	ECTS points	
VI	Compulsory	1.	Control Systems Design	3 + 2	6	
		2.	Introduction to Maintenance Theory	3 + 2	6	
	Elective (3)	1.	Pumps, Compressors and Blowers (TT, TE)	3 + 2	6	
		2.	Air-conditioning (TT)	3 + 2	6	
		3.	Refrigeration Systems (TT)	3 + 2	6	
		4.	Thermal Power Plants (TE)	3 + 2	6	
		5.	Heating Devices (TE)	3 + 2	6	
		6.	Technology of Engine and Vehicle Maintenance (TE)	3 + 2	6	
		7.	Introduction to Vehicle Systems (SM)	3 + 2	6	
		8.	Engine Equipment (SM)	3 + 2	6	
	9.	Technical Regulations for Vehicles and Certification (SM)	3 + 2	6		
	Optional	Technical English Language II		0 + 2		
	Total				15 + 10	30
	<i>B.Sc. paper for Bachelor degree in Mechanical Engineering (Study Program – Energy or Transportation Engineering) or further education for M.Sc.</i>				2 months	5

TT – Thermal Engineering study group

TE – Thermal Energetics study group

SM – Transportation Engineering study group

3.3. MECHATRONICS

Mechatronics is an engineering discipline of the 21st century that enables creation and utilization of intelligent machines which are based on hybrid technologies.

The main objective of “Mechatronics” study program within the first cycle of higher education at the Faculty of Mechanical Engineering is that students acquire integral and systematic knowledge of mechatronics (complex technical systems – mechanical engineering, electronics and information technology) in order to meet ever-changing requirements of engineering activities at various levels.

The outcome of learning process at the Mechatronics study program is engineer’s competence to design a completely integrated technical system successfully and in a professional manner, both in terms of space and function, starting from the concept stage, through realization to exploitation and maintenance.

The professional title obtained after the completion of the first cycle is Bachelor of Mechanical Engineering, Mechatronics study program.

The second year curriculum - IV semester

Sem.	No.	COURSE	Hours L + E	ECTS points
IV	1.	Programming	2 + 2	5
	2.	Thermodynamics	3 + 2	6
	3.	Fluid Mechanics	3 + 2	6
	4.	Introduction to Mechatronics	3 + 2	6
	5.	Machine Design	3 + 2	5
	6.	Industrial Practice	4 weeks	2
	Optional	English Language IV	0 + 2	
Total			14 + 10	30

The third year curriculum - V semester

Sem.		No.	COURSE	Hours L + E	ECTS points
V	Compulsory	1.	Electronics	3 + 1	7
		2.	Control Systems Design	3 + 1	6
		3.	Hydraulics and Pneumatics	3 + 2	7
	Elective (1 out of 2)	4.	Machine Building Technology	3 + 2	5
			Machining Systems		
	Elective (1 out of 2)	5.	Power Plants	3 + 1	5
			IC Engines		
	Optional		Technical English Language I	0 + 2	
Total				15 + 7	30

The third year curriculum - VI semester

Sem.		No.	COURSE	Hours L + E	ECTS points	
VI	Compulsory	1.	Metrology	3 + 2	6	
		2.	Process Automation and Visualization	3 + 1	6	
		3.	Introduction to Robotics	3 + 2	6	
	Elective (1 out of 2)	4.	3D-CAD Machine Design	3 + 2	6	
			NC Programming and Flexible Automation			
	Elective (1 out of 2)	5.	Introduction to Transport Technology	3 + 2	6	
			Storage Technology and Logistics			
	Optional		Technical English Language II	0 + 2		
	Total				15 + 10	30
	<i>B.Sc. paper for BACHELOR degree in Mechanical Engineering (Mechatronics Study Program) or further education for M.Sc.</i>				2 months	5

3.4. INDUSTRIAL ENGINEERING AND MANAGEMENT

The *Industrial Engineering and Management* within mechanical engineering studies provides education for engineers who are to deal with a series of problems referring to the following fields: design, organization and monitoring of production processes, maintenance of technical systems and production equipment, quality management, human resources management, providing computer aided support in production, design and maintenance, design of information systems, analysis of economics, productivity and cost-effectiveness indicators, analysis and enhancement of all business, production and other systems, development and design of products, design of work space and work conditions, etc.

The necessity of such a study in mechanical engineering has resulted from the fact that all activities following design and construction are very complex and have great impact on the success of production and business systems. This type of study appeared in the USA in 1901 whereas nowadays it is being applied in more than 70 countries worldwide. Some surveys in our surroundings indicate that around 70% of the employed engineers deal with this field of work and that realistically the economy's requirements for such knowledge and experts will be increased even more.

During the study at this department, students gain knowledge about state-of-the-art methods and techniques in this field which are applied in today's European and world market-oriented companies and economies. Study programs at this department at the Faculty of Mechanical Engineering enable candidates to take companies further towards business excellence in line with European and world standards.

After they complete the undergraduate studies, students gain the professional title as follows:

Bachelor of Science – Mechanical Engineering, Industrial Engineering and Management

The second year curriculum - IV semester

Sem.	No.	COURSE	Hours L + E	ECTS points
IV	1.	Programming	2 + 2	5
	2.	Thermodynamics	3 + 2	6
	3.	Fluid Mechanics	3 + 2	6
	4.	Metrology	3 + 2	6
	5.	Engineering Statistics	2+ 2	5
	Option.	English Language IV	0 + 2	
		Industrial Practice	4 weeks	2
Total			15 + 10	30

The third year curriculum - V semester

Sem.		No.	COURSE	Hours L + E	ECTS points
V	Compulsory	1.	Technology of Organization of Industrial Systems	3 + 2	7
		2.	Automatic Control Systems	3 + 2	7
		3.	Company Economics	3 + 2	7
	Elective	4.	Machine Building Technology	2 + 2	5
			Energy Systems	2 + 2	5
		5.	Design of Technological Processes	2 + 2	4
			Environmental Protection and Sustainable Development	2 + 2	4
	Optional		Technical English Language I	0 + 2	
	Total				15 + 10

The third year curriculum - VI semester

Sem.		No.	COURSE	Hours L + E	ECTS points	
VI	Compulsory	1.	Quality Management	3 + 2	7	
		2.	Maintenance	3 + 2	7	
		3.	Production Systems Management	3 + 2	6	
	Elective	4.	Storage Technology and Logistics	2 + 2	5	
			Human Resources Management	2 + 2	5	
		5.	Commercial Business	2 + 2	5	
			Business-Production Information Systems	2 + 2	5	
	Optional		Technical English Language II	0 + 2		
	Total				13 + 12	30
	<i>B.Sc. paper for Bachelor degree in Mechanical Engineering (Study Program – Industrial Engineering and Management) and/or further education</i>				2 months	5

3.5. SAFETY AT WORK

A mechanical engineer's job that includes safety at work is humane but at the same time very demanding. The following activities are performed by a professional who has completed safety at work studies:

- Survey and analysis of production systems made in the country and abroad in terms of meeting defined norms of safety at work, inspection of investment-technical documentation in reference to safety at work issues,
- Product development in terms of safety and security issues of its use according to recommendations of European and world standards,
- Monitoring of protection systems and analysis of workplace conditions,
- Planning and development of safety systems,
- Expert analysis of accidents, injuries, casualties,
- Organization and safety system management.

The objective of the first cycle study program is to enable students to apply scientific and professional accomplishments in safety at work engineering and safety problem-solving in production and other workplace units.

Special objectives of the program are acquisition of knowledge and skills to deal with the following:

- Monitoring of the safety system,
- Inspection and analysis of workplace equipment in terms of safety issues,
- Analysis of workplace conditions,
- Design and quality management of work environment,
- Development and application of methodologies, tools and procedures in safety system management
- Occupational risk analysis,
- Problem-solving in safety systems and workers' health protection,
- Planning and developing of a protection system,
- Innovative activities and team work,
- Monitoring in the safety system,
- Enrolment in doctoral studies referring to the same or similar fields of studies.

Professional title earned after the completion of the first cycle:

Bachelor of Science (**B.Sc.**) - Mechanical Engineering, Safety at Work

The second year curriculum - IV semester

Sem.		No.	COURSE	Hours L + E	ECTS points
IV	Compulsory	1.	Programming	2 + 2	5
		2.	Thermodynamics	3 + 2	6
		3.	Fluid Mechanics	3 + 2	6
		4.	Safety at Work	2 + 2	6
		5.	Control Technology	3 + 2	5
		6.	Industrial Practice	4 weeks	2
	Optional	English Language IV	0 + 2		
Total				13 + 12	30

The third year curriculum - V semester

Sem.		No.	COURSE	Hours L + E	ECTS points
V	Compulsory	1.	Protection against Harmful Effects of Electricity	3 + 2	5
		2.	Protection Systems and Devices	2 + 2	5
		3.	Protection against Fire and Explosion	2 + 2	5
	Elective (3 out of 4)	4.	Microclimate and Workplace Environment	2 + 2	5
		5.	Industrial Facilities and Urbanization	2 + 2	5
		6.	Waste Management	2 + 2	5
		7.	Information Technology	2 + 2	5
	Optional	Technical English Language I	0 + 2		
Total				13 + 14	30

The third year curriculum - VI semester

Sem.		No.	COURSE	Hours L + E	ECTS points	
VI	Compulsory	1.	Noise and Vibrations	2 + 2	5	
		2.	Occupational Medicine	2 + 2	5	
		3.	Design of Protection Systems and Devices	2 + 2	5	
	Elective (3 out of 4)	4.	Metrology	2 + 2	5	
		5.	Risk Assessment and Simulation	2 + 2	5	
		6.	Safety at Work Economics	2 + 2	5	
		7.	Safety Systems	2 + 2	5	
	Optional		Technical English Language II	1 + 1		
	Total				13 + 13	30
	<i>B.Sc. paper for Bachelor degree in Mechanical Engineering (Study Program – Safety at Work) or further education for M.Sc.</i>				2 months	5

GRADUATE STUDIES
CURRICULA
(Master of Science)

2. STUDY PROGRAMS AND CURRICULA in VII, VIII, IX and X semesters

2.1. PRODUCTION ENGINEERING

The second cycle of the academic study program (Master) in Production Engineering is a continuation of the undergraduate academic studies (Bachelor) and aims at providing broader knowledge to students who successfully completed the first cycle and enables them for independent scientific-research work. Production Engineering is an engineering field which by using imagination, intellect, experience and intuition applies contemporary scientific knowledge in successful design and production of machines, devices, tools and wide array of various products necessary for economy to function. This field encompasses design of technological processes and their management, quality management and control, as well as management of factories dealing with metal processing industry and other similar industries. Production Engineering has a crucial role in maintenance and successful functioning of a great deal of economy branches such as: transportation, agriculture, power utility, oil industry, research-development centers along with development and application of new specific technologies and much more. Therefore, Production Engineering should be regarded as a study program that was created as a response to a number of needs required in practice. Namely, this program should enable students to specialize and advance their knowledge based on understanding of basic physical principles from various engineering fields, acquire additional professional knowledge central to development of cutting-edge engineering systems, enable them to integrate case-specific knowledge and get introduced to research work during realization of this study program. Students acquire knowledge and skills in a two-year (four-semester) study program in the course of a modern educational process that makes use of: multimedia, audio-visual, interactive theoretical and practical classes along with laboratory and calculus exercise, and professional practice in companies. Production Engineering study program enables students to deal with computer aided design of products, technologies, technological systems and plants as well as management of all kind of processes in production systems. Upon completion of this study program, students will be able to identify problems in any particular case in the industry and science and by applying scientific methods and acquired skills to offer improvements or completely new solutions for specific problems.

THE FOURTH YEAR CURRICULUM – VII and VIII semesters

SEM.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
VII	Comp	1.	Numerics	3 + 2	6
		2.	Non-conventional Technologies	3 + 2	6
		3.	Design of Technological Processes	2 + 2	5
	Elective (2)	1.	Information Systems	2 + 2	5
		2.	Standardization and Industrial Legislation	2 + 2	5
		3.	Exploitation and Maintenance	2 + 2	5
		4.	Advanced Elasto-Mechanics	2 + 2	5
		5.	Contemporary Materials	2 + 2	5
		6.	Assembling Technologies	2 + 2	5
		7.	Wood Splicing ¹	2 + 2	5
		8.	Wood Industry Energetics ¹	2 + 2	5
	Laboratory Work	4 weeks	3		
Total				12 + 10	30
VIII	Comp	1.	Flexible Technological Systems	3 + 2	6
		2.	Industrial Robotics	3 + 2	6
	Elective (3)	1.	Modeling and Simulation	2 + 2	5
		2.	Safety Systems	2 + 2	5
		3.	Design of Welding and Heat Treatment Technology	2 + 2	5
		4.	Design of Production Systems	2 + 2	5
		5.	Technology of Plastics Treatment	2 + 2	5
		6.	Tools and Accessories	2 + 2	5
		7.	Final Wood Processing ¹	2 + 2	5
		8.	Wood Chipboards ¹	2 + 2	5
		9.	MPD Production Systems ¹	2 + 2	5
	Laboratory Work	4 weeks	3		
Total				12 + 10	30

THE FIFTH YEAR CURRICULUM – IX and X semesters

SEM.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
IX	Compulsory	1.	Automation of Production Processes	3 + 2	5
		2.	Organization of Production	2 + 2	5
		3.	Nanotechnologies	2 + 2	5
	Elective (2)	1.	Quality Management	2 + 2	5
		2.	Technical Expertise	2 + 2	5
		3.	Numerical Machines Programming	2 + 2	5
		4.	Protection Systems and Devices	2 + 2	5
		5.	Special Machines and Mechanisms	2 + 2	5
		6.	Effective Production Systems	2 + 2	5
			Laboratory Work	4 week	5
Total				13 + 12	30
X	Compulsory	M.Sc. thesis		Up to 6 months	30

¹ Mechanical Wood Processing study program

2.2. ENERGY AND TRANSPORTATION ENGINEERING

The Master program for **Thermal Engineering** study group is an extension and advanced program of undergraduate studies aiming to enable more ambitious students to expand their knowledge as well as to enable them for independent scientific research work and possibly direct them towards the adequate doctoral studies. This program aims to provide relatively broad knowledge but it primarily focuses on solving complex problems in thermal engineering. This program also focuses on fundamental disciplines which include selected aspects of thermodynamics, fluid mechanics, combustion, control and regulation, etc. It provides specialist knowledge necessary for understanding complex thermal engineering systems, their design and analysis. After they complete master studies, students are enabled to develop equipment and design complex heating, air conditioning and refrigeration systems as well as to carry out complex thermodynamic and technical-economic analyses. The program has been designed in line with sustainable development concepts in energy engineering thus special attention is devoted to enhancement of energy efficiency and use of renewable energy sources as one of the elementary prerequisites to reduce green house gases, and influence of thermal engineering systems on the environment in general.

Students enrolled to the **Thermal Energetics** study group are enabled to deal with both professional and scientific research jobs. Special attention is given to improvement of the existing and development of new technologies for production of electrical power, heat and technological steam, utilization of renewable sources of energy as well as rationalization and savings concerned with the use of all these forms of energy. Students have access to various techniques of modeling complex technological processes as well as opportunity for active participation in improvement of thermal power plants performance in particular phases of their use. Reconstruction and modernization are part of their life cycle, that is, a process of extending time of their use. At the same time, the planning process, extension of their life-cycle and exploitation of plants are achieved with the aim to attain a high degree of plant reliability while using economic criteria.

Students enrolled to **Engines and Vehicles** as well as **Transportation Engineering** study groups are enabled to deal with both professional and scientific research jobs. By choosing subjects a student specializes according to his/her affinities to deal with engines and vehicles, their exploitation and maintenance or transportation engineering which encompasses multidisciplinary approach regarding transportation and traffic issues. It integrates transportation and mechanical engineering which nowadays is necessary in solving many contemporary transportation issues. Today, there is a great need for quality expertise or transportation engineering expertise, traffic safety, transportation management, environment protection, and transportation energy efficiency.

THE FOURTH YEAR CURRICULUM – VII semester

SEM.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
VII	Compulsory	1.	Numerics	2 + 2	6
		2.	Heat and Mass Transfer	3 + 2	6
	Elective (3)	1.	Combustion (TE, TT)	2 + 2	6
		2.	Heating Systems (TT)	2 + 2	6
		3.	Heat Transformers (TT)	2 + 2	6
		4.	Steam Generators I (TE)	3 + 2	
		5.	Energy Steam Boilers (TE)	3 + 2	6
		6.	Design of Steam and Gas Turbines (TE)	3 + 2	6
		7.	Power Transfer and Vehicle Control System (SM)	3 + 2	6
		8.	Vehicle Crash Dynamics (SM)	3 + 2	6
		9.	Internal Combustion Engines II (SM)	3 + 2	6
		10.	Rail Vehicles Maintenance (SM)	3 + 2	6
	11.	Ecology and Vehicles (SM)	3 + 2	6	
Total				14 + 10	30

THE FOURTH YEAR CURRICULUM – VIII semester

SEM.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
VIII	Compulsory	1.	Fluid Mechanics II	3 + 2	6
		2.	Energy Economy (TT; TE, SM)	3 + 2	6
	Elective (3)	1.	Thermodynamic Methods of Evaluation (TT, TE)	3 + 2	6
		2.	Transport Technology	3 + 2	6
		3.	Air-conditioning Systems (TT)	3 + 2	6
		4.	Thermal Power Plants II	3 + 2	6
		5.	Steam Generators II	3 + 2	6
		6.	Fuel Supply Systems (SM)	3 + 2	6

	7.	Vehicle Traction and Braking Systems (SM)	3 + 2	6
	8.	Modeling of Engine Processes (SM)	3 + 2	6
	9.	Supercharged Engines (SM)	3 + 2	6
	10.	Vehicle Dynamics (SM)	3 + 2	6
		Laboratory Work	4 weeks	4
Total			15 + 10	30

THE FIFTH YEAR CURRICULUM – IX and X semester

SEM.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
IX	Compulsory	1.	Computer Aided Design	2 + 2	6
		2.	Control Design Systems	3 + 2	6
	Elective (3)	1.	Simulation of Flow-Thermal Processes	2 + 2	6
		2.	Energy Efficiency (TT, TE)	3 + 2	6
		3.	Two-phase Flow (TT, TE)	3 + 2	6
		4.	Renewable Sources of Energy (TE, TT)	3 + 2	6
		5.	Design and Construction of Thermal Power Plants (TE)	3 + 2	6
		6.	Tribology of Motor Vehicles (SM)	3 + 2	6
		7.	Special Purpose Vehicles (SM)	3 + 2	6
		8.	Engine and Vehicle Mechatronics (SM)	3 + 2	6
		9.	Alternative Drive Systems (SM)	3 + 2	6
		10.	Transportation Engineering Management and Mechanization (SM)	3 + 2	6
Total				15 + 10	30
X	Compulsory	M.Sc. thesis			30

TT – Thermal Engineering

TE – Thermal Energetics

SM – Transportation Engineering

2.3. MECHATRONICS

The main goal of the second cycle study program, that is, “Master in Mechatronics” is to enable students for team and independent work in regards with the analysis, synthesis and design of complex mechatronic components and systems. By choosing elective subjects and courses within the study program, students can specialize for particular professional profiles.

State-of-the-art intelligent devices, machines and plants reflect current engineering in the world with the tendency of more intensified development in the decades to come. Hybrid mechatronic (mechanical-electronic-computer) systems require integral instead of individual engineering approach in the course of development of such products. Mechatronics studies provide synergy of engineering know-how that can effectively respond to those requirements.

Upon completion of four semester undergraduate studies where students acquire basic knowledge referring to physics laws and introduction to mechanical – machine systems, during the V and VI semester at the Mechatronics – Bachelor study program students acquire corresponding knowledge in electronics, automation, hydraulics, robotics and programming enabling them for a wide range of mechatronic tasks in the modern industry and other fields.

During the second cycle (Master, VII-IX semester), students have the opportunity for affirmation of their own affinities and for shaping their professional orientation more specifically through a system of elective courses.

Digital and programming technologies are grouped in such a way as to allow students to opt for either mechatronic systems in industry or mobile and micro technical systems.

High level of technological knowledge and methods with the aim to develop products provide mechatronics engineers (Master level) with innovative approach and competence to deal with both professional and scientific-research activities.

THE FOURTH YEAR CURRICULUM – VII and VIII semesters

Sem.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
VII	Compulsory	1.	Numerics	3 + 2	6
		2.	Proportional and Servo Technology	3 + 2	6
		3.	Actuators and Sensors	3 + 2	6
	Elective (1 out of 2)	4.	Control and Communication Technology (Fieldbus Technology)	3 + 2	5
			Systems Theory		
	Elective (1 out of 2)	5.	Machine Dynamics and Numerical Methods	3 + 2	5
			Higher Theory of Strength and FEM		
	Optional	6.	Laboratory Work	2 weeks	2
Total				15 + 10	30
VIII	Compulsory	1.	Modeling and Simulation	3 + 2	5
		2.	Digital Control Systems	3 + 2	6
		3.	Electric Drive and Drive Systems	3 + 1	5
	Elective (1 out of 2)	4.	Programming Techniques in Mechatronics	3 + 3	5
			Object Programming & C++		
	Elective (1 out of 2)	5.	Safety Systems	3 + 3	6
			Engine and Vehicle Mechatronics		
	Optional	6.	Laboratory Work	4 weeks	3
Total				15 + 11	30

THE FIFTH YEAR CURRICULUM – IX and X semesters

Sem.	Type of Lecture	No.	COURSES	Hours L + E	ECTS points
IX	Compulsory	1.	Microprocessor Programming	3 + 2	6
		2.	Industrial and Mobile Robots	3 + 1	5
		3.	Programming and Application of PLC	3 + 3	6
	Elective (1 out of 3)	4.	Technical Acoustics	3 + 1	5
			Signal and Image Processing		
			Intelligent Systems		
	Elective (1 out of 3)	5.	Introduction to Micro Engineering	3 + 1	4
			Mechanisms		
			Analogue and Impulse Technology		
	Compulsory	6.	Design Project in Mechatronics	0 + 3	4
Total				15 + 11	30
X	Comp	MASTER THESIS M.Sc.		30	

2.4. INDUSTRIAL ENGINEERING AND MANAGEMENT

Four-year **Master** studies continue with a number of compulsory and elective subjects within this study program which enable students to embrace a wide range of fields of work such as design, production and companies' business management. Studies are finalized by a *master* thesis.

Knowledge and competences that they acquire during the first and second cycle at this department are as follows:

- Introduction to engineering and technology in production, energy and process engineering,
- Basic economic and legal disciplines necessary for companies' business management,
- Full grasp of informational and computational technologies necessary for modern business and management,
- Active knowledge of English language,
- Considering universal enough knowledge and skills, opportunities for employment range from starting their own business to work in various sectors of big companies,
- Job positions in companies may range from a general manager, head of production unit, development and management of the quality system and protection of environment (in line with ISO 9000 and 14000), head of commercial unit, IT engineer, etc.

Master level studies offer specialist knowledge in the said areas and ensure scientific approach in solving the most complex work tasks.

THE FOURTH YEAR CURRICULUM – VII and VIII semesters

VII	Compulsory	1.	Production Systems	3 + 2	6
		2.	Marketing	2 + 2	5
		3.	System Engineering	3 + 2	6
	Elective (2)	4.	Object Oriented Information Technologies	2 + 2	5
			Standardization and Industrial Legislation	2 + 2	5
		5.	Simulation of Work Processes	2 + 2	5
			Industrial Waste Management	2 + 2	5
	6.	Laboratory Work	4 weeks	3	
	Total				13 + 10
VIII	Compulsory	1.	Operational Research	3 + 2	6
		2.	Product and Process Development	3 + 2	6
		3.	Information System Design	2 + 3	5
	Elective (2)	4.	Theory of Decision Making	2 + 2	5
			Technology Transfer Processes	2 + 2	5
		5.	Safety at Work	2 + 2	5
			Investment Management	2 + 2	5
	6.	Laboratory Work	4 weeks	3	
	Total				12 + 11

THE FIFTH YEAR CURRICULUM – IX and X semesters

Sem.	Type of Lecture	No.	COURSE	Hours L + E	ECTS points
IX	Compulsory	1.	Project Management	2 + 3	6
		2.	Integrated Management Systems and Business Excellence	3 + 2	6
		3.	Knowledge Management	3 + 2	5
	Elective	4.	Computer Integrated Production	2 + 2	5
			Entrepreneurial Management	2 + 2	5
		5.	Introduction to Communicology	2 + 2	5
			Modern Communication Systems	2 + 2	5
			Laboratory Work	4 weeks	3
	Total				12 + 11
X	Comp.		MASTER THESIS M.Sc.		30

2.5. SAFETY AT WORK

The second cycle studies aim at the following professional competences:

- Professional risk assessment,
- Drafting reports on safety at work and health protection,
- Drafting plans and technical documentation regarding safety at work,
- Drafting normative acts and regulation regarding safety at work,
- Safety and health protection monitoring,
- Analyses of accidents, injuries, casualties and expertise,
- Education and knowledge management regarding safety at work,
- Training, professional selection and development of skills for safe work,
- Management of available resources in the safety and health protection system,
- Development of methodology, methods and procedures for safety system management,
- Organization and safety system management,
- Application of information technologies in safety at work engineering,
- Enrolment to doctoral studies in the same or similar fields of study.

Professional title earned upon completion of the second cycle studies is: Master of Science in Mechanical Engineering (Study program – Safety at Work).

THE FOURTH YEAR CURRICULUM – VII and VIII semesters

SEMESTER	Type of Lecture	No.	COURSE	HOURS L+E	ECTS points	
VII	Compulsory	1.	Ergonomic Design	2 + 2	5	
		2.	Chemistry in Industrial Systems	2 + 2	5	
		3.	Transport and Storage of Hazardous Materials	2 + 2	5	
	Elective (three subjects)	4.	Electromagnetic Radiation	2 + 2	5	
		5.	Work Environment Comfort	2 + 2	5	
		6.	Uncontrolled Combustion Processes	2 + 2	5	
		7.	Plants and Installations under Pressure	2 + 2	5	
	Laboratory Work				2 weeks	2
	Total				13+12	30
VIII	Compulsory	1.	Safety in Technological Systems	2 + 2	5	
		2.	Safety in Construction Works	2 + 2	5	
		3.	Internal Transportation Protection	2 + 2	5	
	Elective (three)	4.	Maintenance of Technical Devices	2 + 2	5	
		5.	Microbiology	2 + 2	5	
		6.	Psychophysiology of Work	2 + 2	5	
		7.	Fire Extinguishing Systems	2 + 2	5	
	Laboratory Work				4 weeks	2
	Total				13+12	30

THE FIFTH YEAR CURRICULUM – IX and X semesters

SEM	Type of Lecture	No.	COURSE	HOURS L+E	ECTS points	
IX	Compulsory	1.	Technical Expertise	2 + 2	5	
		2.	Toxicology	2 + 2	5	
		3.	Equipment and Product Safety	2 + 2	5	
	Elective (three subjects)	4.	Biomechanics	2 + 2	5	
		5.	Intervention and Rescue Equipment	2 + 2	5	
		6.	Design of Fire and Explosion Protection Systems	2 + 2	5	
		7.	Methodology of Scientific-Research Work	2 + 2	5	
				Laboratory Work	2 weeks	
				Total	13+12	30
	X	Comp.		MASTER THESIS M.Sc.	30	

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