UNIVERSITY OF BANJA LUKA
FACULTY OF MECHANICAL ENGINEERING

CURRICULUM

Undergraduate and graduate study

Banja Luka, 2017

1. GENERAL INFORMATION

Since 1 October 2016 the Faculty of Mechanical Engineering in Banja Luka has been organizing academic study according to the principles of the Bologna Declaration based on the 4+1+3 model.

		ECTS*
Doctor of Philosophy in Mechanical Engineering (PhD)	Third-cycle study (postgraduate)	480 450 420 390 360 330
Master of Science (MSc)	Second-cycle study (graduate)	300 270
Bachelor of Science in Mechanical Engineering (BSc)	First-cycle study (undergraduate)	240 210 180 150 120 90 60 30

*ECTS (*European Credit Transfer System*)

Curricula at the Faculty of Mechanical Engineering specify study subjects, their duration and distribution across years and semesters, as well as the weekly number of classes for various forms of teaching.

Generally, the academic year starts on 1 October of the current year and lasts for 12 months, being comprised of teaching, examination and breaks, accordingly defined by an academic calendar of the University of Banja Luka for each academic year. Classes are organized in two semesters, each lasting 15 weeks.

The Faculty of Mechanical Engineering offers the following study programmes:

1. Production Engineering (PE) – (I and II cycle)
2. Energy and Transportation Engineering (ETE) – (I and II cycle),
3. Mechatronics (M) – (I and II cycle),
4. Industrial Engineering (IE) – (I and II cycle),
5. Occupational Safety (OS) – (I and II Cycle) and
6. Mechanical Design (DE) – (II cycle).

After the completion of undergraduate academic study that lasts four years (eight semesters) the academic title of **BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSc) – 240 ECTS** is awarded. In addition, diploma supplement provides a list of subjects and courses completed throughout the period of study and the name of a specific study programme.

After the completion of graduate academic study that lasts one year (two semesters) and that is awarded 60 ECTS, in such a way that the sum of credits at undergraduate and graduate study amounts to 300 ECTS, students acquire the academic title of **MASTER OF SCIENCE (MSc) for a specific study programme – 300 ECTS**. Diploma supplement provides a list of subjects and courses completed throughout the period of study. Specialization within the specific study programme is added to the academic title.

After the completion of postgraduate study that lasts three years (six semesters and 180 ECTS), in such a way that the sum of credits at undergraduate, graduate and postgraduate study amounts to 480 ECTS, the academic title of **DOCTOR OF PHILOSOPHY IN MECHANICAL ENGINEERING – 480 ECTS** is awarded. Diploma supplement provides a list of subjects and courses completed throughout the study. A specific study programme is added to the scientific title.

The tables below present I and II year curriculum for all undergraduate study programmes (common part).

Undergraduate Study Curriculum

--- All study programmes ---

1. Production Engineering (PE),
2. Energy and Transportation Engineering (ETE),
3. Mechatronics (M),
4. Industrial Engineering (IE) and
5. Occupational Safety (OS).

2. CURRICULUM FOR ALL STUDY PROGRAMMES (I, II, III and IV semester)

The first four semesters are the same for all study programmes.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)*	ECTS
I	Compulsory	1.	Mathematics I	3 + 3	8
		2.	Mechanics I	2 + 2	5
		3.	Engineering Graphics	3 + 3	7
		4.	Materials I	2 + 2	5
		5.	Technical Physics	2 + 2	5
	Optional		Sport I	0 + 2	
Total:				**24**	**30**

*L – lecture; E – exercise.

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)*	ECTS
II	Compulsory	1.	Mathematics II	3 + 3	7
		2.	Mechanics II	2 + 2	5
		3.	Strength of Materials	3 + 3	8
		4.	Materials II	2 + 2	5
		5.	Manufacturing Technologies	2 + 2	5
	Optional		Sport II	0 + 2	
Total:				**24**	**30**

Second year – III semester

Sem.	Status	No.	Subject	Classes (L + E)*	ECTS
III	Compulsory	1.	Mathematics III	3 + 3	7
		2.	Mechanics III	3 + 3	7
		3.	Machine Elements I	3 + 2	6
		4.	Computer Programming	2 + 2	5
		5.	Electrical Engineering	2 + 2	5
	Optional		English Language I	0 + 2	
Total:				**25**	**30**

Second year – IV semester

Sem.	Status	No.	Subject	Classes (L + E)*	ECTS
IV	Compulsory	1.	Machine Elements II	3 + 2	6
		2.	Thermodynimics I	3 + 2	6
		3.	Fluid Mechanics I	3 + 2	7
		4.	Computer-Aided Design	3 + 2	6
		5.	Theory of Measurement (PE, IE, OS)	2 + 2	5
			Fundamentals of Mechatronics (M)		
			Fuels, lubricants and industrial water (ETE)		
	Optional		English Language II	0 + 2	
Total:				**24**	**30**

3. CURRICULA FOR EACH STUDY PROGRAMME (V, VI, VII, and VIII semester)

3.1. PRODUCTION ENGINEERING – Undergraduate study (*Bachelor's degree*)

The Production Engineering study programme has been administered at the Faculty of Mechanical Engineering since 1971 with the aim to provide education for engineers dealing with production engineering and instill skills needed in the production industry.

The goal of the new Production Engineering study programme is to educate professionals capable of undertaking production tasks in national and European companies, thus transferring knowledge from developed foreign companies to companies in the country. By introducing high technologies, such professionals will initiate growth and development of the companies in the country, their integration into global market flows and chains of supply of trans-national companies. The undergraduate level deals with production design, planning and management of the available production resources as well as handling and maintenance of production equipment.

After the completion of the study, engineers holding a bachelor's degree in production engineering will be able to apply conventional and non-conventional machining, have a grasp of design, engineering and manufacturing by applying CAD/ CAM/ CAE and other specialized computer tools and programs, select optimal materials, define production technologies for complex parts and products, their optimization and efficient production.

The undergraduate academic study lasts for four years (eight semesters) and after completion the title of **Bachelor of Science in Mechanical Engineering – Production Engineering (240 ECTS)** is awarded.

After acquiring multidisciplinary knowledge and skills, a Bachelor of Science in Mechanical Engineering – Production Engineering can be employed by a variety of production companies in metal industry; all other types of industry with a high level of automation; in research-development centres, institutes, design agencies and companies; in companies dealing with the production of tools, machines and equipment in metal industry; at posts dealing with machine system maintenance in virtually all companies and institutions.

Third year – V semester

Sem.	Status	No.	Subject	Classes (L + E)*	ECTS
V	Compulsory	1.	Metal Cutting	3 + 2	6
		2.	Metal Forming Technology	3 + 2	6
		3.	Computer-Aided Design II	3 + 2	6
		4.	English for Engineering I	0 + 2	1
	Elective	5.	Fundamentals of Design	2 + 2	6
			Contemporary Materials		
		6.	Tribology	2 + 2	5
			Non-Conventional Machining Processes		
Total:				**25**	**30**

Third year – VI semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VI	Compulsory	1.	Machine Tools	3 + 2	6
		2.	Welding and Heat Treating	3 + 2	6
		3.	Metal Forming Machines	3 + 2	6
		4.	English for Engineering II	0 + 2	1
	Elective	5.	Cutting Tools and Fixtures	2 + 2	6
			Metal Forming Tools		
		6.	Measurements in Production Engineering	2 + 2	5
			Production Automation		
Total:				**25**	**30**

Fourth year – VII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VII	Compulsory	1.	Process Planning Design	3 + 2	6
		2.	Computer-Aided Manufacturing	3 + 2	6
		3.	Elements of Control Systems	3 + 2	6
	Elective	4.	Advanced Machining Processes	2 + 2	5
			Micro Machining		
		5.	Hydraulics and Pneumatics	2 + 2	5
			Diagnostics and Maintenance		
			Industrial Practice	0 + 2	2
Total:				**25**	**30**

Fourth year – VIII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VIII	Compulsory	1.	Flexible Technological Systems	3 + 2	5
		2.	Modelling and Simulation	3 + 2	5
	Elective	3.	Production Systems Design	2 + 2	5
			Assembly Technologies		
		4.	PLM Systems	2 + 2	5
			Information and Communication Technologies		
		5.	Organization of Production	2 + 2	5
			Quality Management		
			Final Paper – Bachelor's Degree		5
Total:				**22**	**30**

3.2. ENERGY AND TRANSPORTATION ENGINEERING – Undergraduate study (*Bachelor's degree*)

The Energy and Transportation Engineering study programme is devised to provide knowledge students need for three specializations: thermal engineering (TE); hydro and thermal energetics (THE); engines, motor vehicles and transportation engineering (TrE). Its objective is to enable students to design, construct, maintain, formulate and solve problems in the said fields.

After undergraduate study students acquire basic knowledge in physical laws, mechanical and machine systems, as well as in power systems, engines, motor vehicles, legal regulation for road transportation and maintenance of technical systems. They will be enabled to do the following: deal with design relating to thermal engineering and energetics (heating systems, air-conditioning, refrigeration systems, thermal energy installations, pumps and compression installations, etc.), design and development of equipment, such as various combustion systems, boilers, thermal turbomachines, driers, etc.; deal with alternative sources of energy (geothermal energy, biomass energy, solar energy, etc.), design, building and maintenance of motor vehicles, design of maintenance facilities for motor vehicles, running and managing transportation companies.

The undergraduate academic study lasts for four years (eight semesters) and after completion the title of **Bachelor of Science in Mechanical Engineering – Energy and Transportation Engineering (240 ECTS)** is awarded.

After acquiring multidisciplinary knowledge and skills, engineers with a bachelor's degree can seek employment in a number of companies dealing with production and distribution of devices and equipment in the field of thermal engineering and hydro and thermal energetics or engines and motor vehicles; district heating and utility companies; thermal power plants; all branches of industry that use huge amounts of thermal or electrical energy and have technical and energy units and systems; transportation companies; car services; virtually all companies and firms dealing with transportation; research and development centres and institutes, design offices and companies dealing with research and development of new technologies and products.

Third year – V semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
V	Compulsory	1.	Thermodynamics II	3 + 2	6
		2.	IC Engines	3 + 2	6
		3.	English for Engineering I	0 + 2	1
	Elective	4.	Fundamentals of Boilers (HTE, TE)	3 + 2	6
			Motor Vehicles I (TrE)		
		5.	Hydraulics and Pneumatics (HTE, TE)	2 + 2	6
			Transportation Safety (TrE)		
		6.	Fundamentals of Maintenance Theory (HTE, TE)	2 + 2	5
			Hydraulics and Pneumatics of Mobile Machines (TrE)		
			Technical Regulations for Motor Vehicles (TrE)		
Total:				**25**	**30**

Third year – VI semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VI	Compulsory	1.	Fundamentals of Turbomachines Theory	3 + 2	6
		2.	Measurements in Energetics	3 + 2	6
		3.	English for Engineering II	0 + 2	1
	Elective	4.	Heat Exchangers in Thermal Power Plants (HTE, TE)	3 + 2	6
			Hydro-Mechanical Equipment (HTE)		
			Engine and Motor Vehicle Maintenance Technology (TrE)		
			Refrigeration Systems (TE)		
		5.	Thermal Power Plants (HTE)	2 + 2	6
			Hydro Power Plants (HTE)		
			Engine Design (TrE)		
			Heating (TE)		
		6.	Fundamentals of Organization and Economics (HTE, TrE)	2 + 2	5
			Motor Vehicles II (TrE)		
			Fundamentals of Transport Technology (TrE)		
			Pipeline Transportation (TE)		
Total:				**25**	**30**

Fourth year – VII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VII	Compulsory	1.	Pumps, Compressors and Fans	3 + 2	6
		2.	Elements of Control Systems	3 + 2	6
		3.	Experts in Teamwork	2 + 0	3
	Elective	4.	Steam and Gas Turbines (HTE)	3 + 2	5
			Hydraulic Turbines (HTE)		
			Fundamentals of Energy Supply (HTE)		
			Mechatronics in Engine and Motor Vehicle Systems (TrE)		
			Air-Conditioning (TE)		
		5.	Design of Thermal Power Plants (HTE)	3 + 2	5
			Design of Hydro Power Plants (HTE)		
			IC Engines II (TrE)		
			Ecology and Motor Vehicles (TrE)		
			Heating Systems (TE)		
			Industrial Practice	0 + 3	5
Total:				**25**	**30**

Fourth year – VIII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VIII	Compulsory	1.	Power Steam Boilers (HTE, TE)	3 + 2	5
			Heat and Mass Transfer (TrE, TE)		
		2.	Energy Economics (HTE, TE)	3 + 2	5
			Computer-Aided Design II (TrE)		
	Elective	3.	Renewable Energy Sources (HTE, TE)	3 + 2	5
			Project Management in Energetics (HTE)		
			Motor Vehicle Dynamics (TrE)		
		4.	Plants for Combined Generation of Electrical and Thermal Energy (HTE)	3 + 2	5
			Hybrid Energy Systems (HTE)		
			Dynamics of Vehicle Collision (TrE)		
			Air-Conditioning Systems (TE)		
		5.	Thermal Power Plants II – Nuclear Power Plants (HTE)	3 + 2	5
			Fuel Supply Systems (TrE)		
			Transportation and Storage of Hazardous Materials (TrE)		
			Cogeneration and Trigeneration Systems (HTE, TE)		
			Final Paper – Bachelor's Degree		5
Total:				**25**	**30**

3.3. MECHATRONICS – Undergraduate study (*Bachelor's degree*)

The study programme aims to educate mechatronics engineers and enable them to design, maintain and construct mechatronic products and processes.

Mechatronics originated in the 1980s as a result of intensive development of engineering sciences, particularly mechanical engineering, electronics, automation, and information technology, on the one hand, and the increasing living standard and consumption, on the other. This led to higher quality requirements and performance of industrial and commercial products. Thus, this resulted in products becoming "intelligent", which is achieved by "integrating" electronics and software in their design. Furthermore, all of this requires a new approach to the product and process design which includes parallel integration of the said technical disciplines, thereby accomplishing synergy effect which leads to novel and better quality of an end product. That is why, besides mathematics, mechanics, fluid mechanics, thermodynamics and mechanical engineering, engineers need to gain knew knowledge in electrical engineering (electronics), automation and information technology.

The undergraduate academic study lasts for four years (eight semesters) and after its completion the title of **Bachelor of Science in Mechanical Engineering – Mechatronics (240 ECTS)** is awarded.

When students become mechatronics engineers, they can be part of a team that designs and develops mechatronic products and processes. Also, mechatronic engineers have the skills to maintain and service the existing complex automation systems that include mechanical, electronic and software devices, such as: automated production lines (machine industry, wood industry, construction materials industry, etc.), flexible production robot cells (machine industry, wood industry, etc.), processing industry plants (food and chemical) and power plants. They are enabled to integrate and apply acquired skills, theoretical and practical knowledge to solve engineering problems relating to production, maintenance and development. In addition, they have grasped fundamental engineering techniques in the product design with an emphasis on multidisciplinary approach.

Third year – V semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
V	Compulsory	1.	Measurements in Mechatronics	3 + 2	6
		2.	Electronics I	3 + 2	6
		3.	Modelling and Simulation	3 + 2	6
		4.	English for Engineering I	0 + 2	1
	Elective	5.	Transportation Systems in Industry	2 + 2	6
			Computer-Aided Design II		
		6.	Fundamentals of Engines and Vehicles	2 + 2	5
			Power Plant Engineering		
Total:				**25**	**30**

Third year – VI semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VI	Compulsory	1.	Actuators and Sensors	3 + 2	6
		2.	Control Systems I	3 + 2	6
		3.	Hydraulics and Pneumatics	3 + 2	6
		4.	Object-Oriented Programming	2 + 2	6
		5.	English for Engineering II	0 + 2	1
	Elective	6.	Control and Communication Technique	2 + 2	5
			Warehouse Systems and Logistics		
			Electronics II		
Total:				**25**	**30**

Fourth year – VII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VII	Compulsory	1.	Programmable Logic Controllers	3 + 2	6
		2.	Robotics	3 + 2	6
		3.	Control Systems II	3 + 2	6
		4.	Expert Team Work	2 + 0	2
	Elective	5.	Process Automation and Visualisation	2 + 2	4
			NC – Programming and Flexible Automation		
		6.	Machine Tools	2 + 2	4
			Proportional and Servo Technique		
			Industrial Practice		2
Total:				**25**	**30**

Fourth year – VIII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VIII	Compulsory	1.	Microcontroller Programming	3 + 2	6
		2.	Power Drives in Mechatronic Systems	3 + 2	6
		3.	Company Organization and Economics	2 + 2	5
	Elective	4.	Safety of Mechatronic Systems	2 + 2	5
			Engine and Vehicle Mechatronics		
		5.	Law for Engineers	2 + 0	3
			Philosophy of Science		
			Final Paper – Bachelor's Degree		5
Total:				**20**	**30**

3.4. INDUSTRIAL ENGINEERING – Undergraduate study (*Bachelor's degree*)

The aim of the study programme is to educate engineers to deal with industrial engineering and enable them to perform tasks in industrial production.

The necessity of such a study, i.e. such a profile of mechanical engineer, is reflected in the fact that operational and other activities that accompany the organization of production after products have been designed are very complex and have significant impact on the overall success of production and enterprise systems. Industrial engineering study first started in the USA at the beginning of the 20th century. It is currently being administered in over 70 countries. Research in our region has shown that around 70% of employed mechanical engineers deal with work related to this field. Thus, it is realistic to expect that the industry's needs for this type of knowledge and this expert profile are likely to increase significantly.

After they complete undergraduate study, industrial engineers will be able to develop a product in line with initial requirements and prepare corresponding design and technological documentation by applying adequate software tools; analyse existing business processes while using standard methods and techniques and recommend their optimisation; assess the complexity of a problem relating to industrial engineering and choose relevant tools and techniques to solve them, analyse and estimate the costs of products and processes and the indicators of business success; carry out the research of market needs for particular products, collect and analyse relevant data and suggest optimal solutions and organise and develop good team work.

The undergraduate academic study lasts for four years (eight semesters) and after its completion the title of **Bachelor of Science in Mechanical Engineering –Industrial Engineering (240 ECTS)** is awarded.

After acquiring multidisciplinary knowledge and skills and a bachelor's degree in industrial engineering, such a mechanical engineer can seek employment in various companies dealing with research, design, technological preparation, organization and optimisation of operation, quality management and development of logistic support.

Third year – V semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
V	Compulsory	1.	Engineering Statistics	2 + 2	6
		2.	Industrial Management	2 + 2	5
		3.	Product Processing Technologies	3 + 3	7
		4.	English for Engineering I	0 + 2	1
	Elective	5.	Process Organization	2 + 2	5
			Technology of Industrial Systems Organization		
		6.	Computer-Aided Design II	2 + 3	6
			Renewable Sources of Energy		
Total:				**25**	**30**

Third year – VI semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VI	Compulsory	1.	Quality Management	3 + 2	6
		2.	Marketing	2 + 2	5
		3.	Operational Research	2 + 2	6
		4.	English for Engineering II	0 + 2	1
	Elective	5.	Warehouse Systems and Logistics	3 + 2	6
			Elements of Control Systems		
		6.	Welding and Heat Treating	3 + 2	6
			Energy Management and Energy Efficiency		
Total:				**25**	**30**

Fourth year – VII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VII	Compulsory	1.	Measurements in Industry	3 + 2	6
		2.	Engineering Economics	2 + 2	5
		3.	Project Management	2 + 2	5
		4.	Expert Team Work	2 + 0	3
	Elective	5.	Process Planning Design	2 + 2	5
			Business Excellence Models		
		6.	Occupational Safety and Health	2 + 2	4
			Waste Management		
		7.	Industrial Practice	0 + 2	2
Total:				**25**	**30**

Fourth year – VIII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VIII	Compulsory	1.	Production Management	3 + 2	7
		2.	Maintenance	2 + 2	6
		3.	Human Resource Management	2 + 2	6
	Elective	4.	Production Systems Design	2 + 3	6
			Computer-Integrated Manufacturing		
			Final Paper – Bachelor's Degree		5
Total:				**18**	**30**

3.5. OCCUPATIONAL SAFETY – Undergraduate study (*Bachelor's degree*)

The undergraduate Occupational Safety study programme aims at enabling students to apply scientific and professional know-how in occupational safety engineering and at solving problems relating to safety in production and other companies. It is a well-known fact that modern work and all other environments are characterized by accidents that often lead to human casualties or material losses, mainly caused by a human factor. The study programme provides education which enables professionals to define preventive measures for accidents in the work and any other environment. Its particular goal is to provide knowledge and skills for monitoring in the occupational safety system in order to eliminate potential dangerous and hazardous events in occupational settings that may lead to accidents which, in turn, result in minor and major consequences and injuries. Occupational safety engineers solve problems relating to health and safety systems, as well as plan and develop protection systems. It is in their scope of work to disable further operation of systems and devices that are not safe for the work environment. They make sure that every worker is trained and acquainted with safe equipment operation at the workplace. The goal of the education in this field is to enable every individual to develop his/ her own logic to predict possible work-related accidents and undertake adequate actions to avoid them.

The undergraduate academic study lasts for four years (eight semesters) and after its completion the title of **Bachelor of Science in Mechanical Engineering – Occupational Safety (240 ECTS)** is awarded.

Mechanical engineers with a bachelor's degree in occupational safety can seek employment in production and non-production companies and other organizations. Experts in this field have multidisciplinary knowledge and skills needed in the modern work and living environment. This is due to the fact that other professionals in engineering sciences gain education in specific scientific disciplines.

Third year – V semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
V	Compulsory	1.	Protection against Dangerous Effects of Electricity	2 + 2	6
		2.	Protection Systems and Devices	3 + 2	6
		3.	Fire and Explosion Protection	2 + 2	5
		4.	English for Engineering I	0 + 2	1
	Elective	5.	Microclimate and Work Environment	2 + 2	4
		6.	Industrial Facilities and Urbanization	2 + 1	4
		7.	Waste Management	2 + 1	4
		8.	Information Technologies	2 + 2	4
Total:				**25**	**30**

Third year – VI semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VI	Compulsory	1.	Noise and Vibration	2 + 2	6
		2.	Occupational Medicine	2 + 2	6
		3.	Design of Protection Systems and Devices	2 + 2	5
		4.	English for Engineering II	0 + 2	1
	Elective	5.	Measurement Technique	2 + 2	4
		6.	Risk Assessment and Simulation	2 + 2	4
		7.	Economics and Occupational Safety	2 + 1	4
		8.	Safety Technique	2 + 1	4
Total:				**25**	**30**

Fourth year – VII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VII	Compulsory	1.	Ergonomic Design	2 + 2	5
		2.	Chemistry in Industrial Plants	3 + 2	5
		3.	Transport and Storage of Hazardous Materials	2 + 2	5
	Elective	4.	Electromagnetic Radiation	2 + 2	5
		5.	Work Environment Comfort	2 + 2	5
		6.	Pressure Plants and Installations	2 + 2	5
		7.	Uncontrolled Combustion Processes	2 + 2	5
Total:				**25**	**30**

Fourth year –VIII semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
VIII	Compulsory	1.	Safety in Technological Systems	2 + 2	5
		2.	Safety in Construction Works	2 + 2	4
		3.	Psychophysiology of Work	2 + 2	5
	Elective	4.	Internal Transport Protection	2 + 2	3
		5.	Maintenance of Technical Systems	2 + 2	3
		6.	Microbiology	2 + 2	3
		7.	Engineering Entrepreneurship	2 + 2	3
			Industrial Practice		2
			Final Paper – Bachelor's Degree		5
Total:				**24**	**30**

Graduate study

Curricula

--- All study programmes ---

1. Production Engineering (PE),
2. Energy and Transportation Engineering (ETE),
3. Mechatronics (M),
4. Industrial Engineering (IE) and
5. Occupational Safety (OS)
6. Mechanical Design (MD)

4. CURRICULA FOR EACH STUDY PROGRAMME (I and II semester)

1.1. PRODUCTION ENGINEERING – Graduate study (*Master's degree*)

The graduate academic study programme dealing with Production Engineering is a continuation of the undergraduate study.

The objectives of the study are divided into two groups, namely acquisition of advanced knowledge and skills and introduction to the scientific-research work.

The knowledge and skills include modern production technologies, their application and integration, as well as new engineering principles and problem-solving methods to deal with tasks in the industrial production. Besides, the emphasis is on a systemic approach to engineering problems, which requires identification of necessary knowledge and its integrated application in solving specific problems. The other part of the teaching contents introduces students to the fundamentals of methodology of scientific research and organization of scientific – research work. The main task and objective is to educate highly-trained engineering staff skilled to design complex technological processes and production systems comprising machines, robot and transportation systems that include a single production cell at least.

After students complete their master's study in Production Engineering, they will be able to use their knowledge of the latest generations of machines, intelligent robots, transportation systems, sensors and communication equipment to connect them; apply integrated, collaborative and distributing approach to the development of products and processes and the control of overall life cycle of a product; understand basic principles and properties of flexible production and modern production concepts based on it; be acquainted with the development trends of new technologies and create his/ her own vision of production technologies in the future; model manufacturing processes, machining systems, and control systems.

The graduate academic study lasts for one year (two semesters) and follows the undergraduate academic study (bringing additional 60 ECTS). After completion the title of **Master of Science in Production Engineering** (300 ECTS) is awarded.

Having gained multidisciplinary knowledge and skills, engineers holding a Master of Science degree in production engineering can seek employment in companies dealing with a number of business activities and various research jobs, including the application of new technologies and production processes.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
I	Compulsory	1.	Numerical Mathematics	3 + 2	6
		2.	Nanotechnologies	3 + 2	6
	Elective	3.	Computer-Aided Process Planning – CAPP Systems	3 + 2	6
			Standardization and Industrial Legislative		
		4.	Machining Process Databases	3 + 2	6
			Designing Welding and Heat Treating Technologies		
		5.	Product Development	3 + 2	6
			Design Optimization		
Total:				**25**	**30**

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
II	Compulsory	1.	Design of Experiments	3 + 2	5
		2.	Research Based on the Theoretical Background of Master Thesis	3 + 2	5
	Elective	3.	New Technologies in Production Engineering	3 + 2	5
			Engineering Analysis Methods		
			Master's Thesis		15
Total:				**15**	**30**

4.2. ENERGY AND TRANSPORTATION ENGINEERING – Graduate study (*Master's degree*)

The graduate academic study at Energy and Transportation Engineering is a continuation of the undergraduate study.

The objectives of this study programme are the acquisition of advanced knowledge and skills and the introduction to scientific-research work. The new knowledge and skills imply a systemic approach to solving of engineering problems that require the identification of knowledge needed for integrated application.

After the completion of master's study the energy and transportation engineer will be able to use his/her advanced knowledge in specific fields (thermal engineering, hydro and thermal energy technologies, and engines, vehicles and transportation) to solve problems in academic and industrial environments; independently develop and improve the principles and details of organization and functioning of system components, very often in a research context; organize and carry out scientific-research projects or industrial projects; work in a multidisciplinary environment and make adequate decisions in order to enhance energy efficiency; apply advanced experimental, mathematical and computational methods to solve engineering problems; understand complex impact of transportation and motor vehicles on the environment; acquire knowledge about the structure and design of vehicles, requirements needed to be met relating to vehicle design throughout its life cycle and the application of modern software in this field.

The graduate academic study lasts for one year (two semesters) and follows the undergraduate academic study (bringing additional 60 ECTS). After completion the title of **Master of Science in Energy and Transportation Engineering** (300 ECTS) is awarded.

Having gained multidisciplinary knowledge and skills, engineers holding a Master of Science degree in Energy and Transportation Engineering can seek employment in companies dealing with a number of business activities and various jobs including research, design, organization, optimization and the application of new technologies and processes.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
I	Compulsory	1.	Numerical Mathematics	3 + 2	5
		2.	Fluid Mechanics II	2 + 2	5
		3.	Organization of Scientific Research Work (TE)	2 + 2	5
			Assembly and Repair Technologies in Energetics (HTE)		
			Intelligent Buildings (TE, TrE, HTE)		
	Elective	4.	Exploitation of Power Plants (HTE)	2 + 2	5
			Combustion (EE, HTE)		
			Supercharged Engines (TrE)		
		5.	Designing Steam and Gas Turbines (HTE)	2 + 2	5
			Designing Hydraulic Turbines (HTE)		
			Technical Diagnosis in Energetics (HTE)		
			Motor Vehicle Tribology (TrE)		
			Two-Phase Flow (TrE)		
		6.	Steam Generators (HTE)	2 + 2	5
			Elements of Hydro-Electrical Plants (HTE)		
			Thermodynamic Methods of Evaluation (HTE, TE)		
			Modelling of Engine Processes (TrE)		
			Alternative Propulsion Systems (TrE)		
Total:				**25**	**30**

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
II	Elective	1.	Selected Chapters in Thermal and Hydro-Energetics (HTE)	3 + 2	5
			Vehicle Propulsion and Suspension Systems (TrE)		
			Economic and Environmental Aspects of Energy Efficiency and Renewable Energy Sources – Cost-Effectiveness and CO_2 Emission (TE)		
		2.	New Energy Technologies (HTE)	3 + 2	5
			Operation Regimes and Exploitation of Steam and Gas Turbines (HTE)		
			Simulation of Energy Systems and Computer-Aided Design (HTE)		
			Selected Chapters in Engines and Vehicles (TE)		
			Heat Exchangers (TE)		
		3.	Planning and Construction of Power Facilities (HTE)	3 + 2	5
			Energy Management and Energy Efficiency (HTE, TE)		
			Selected Chapters in Transportation Engineering (TrE)		
			Master's Thesis	3 + 2	15
Total:				**25**	**30**

4.3. MECHATRONICS – Graduate study (*Master's degree*)

The graduate Mechatronics study programme is a continuation of the study programme started at the undergraduate level.

The objective of this study programme is the acquisition of more advanced theoretical knowledge in particular scientific disciplines that will introduce students to scientific-research work to come. Primarily, this refers to fundamental sciences and applied engineering sciences, such as mathematics, robotics, biomechanics and automatic control. Besides, students become familiar with new technologies such as micro and nano technology, design and application of embedded systems, machine vision and intelligent systems. Alongside theoretical knowledge, students engage in practical work which includes the design and realization of mechatronic systems. Thus, theoretical knowledge acquired is directly applied to solve practical problems. When doing so, apart from applying fundamental knowledge, students use applied knowledge and gain relevant insight into and comprehension of mechatronics. They are able to understand that the accurate operation of a device requires adjusted development and realization of all of its modules. Further, a modular approach enables systematic work and abiding by the timeframes previously set. In addition, students are capable of using modern software packages and tools in their work.

The graduate academic study lasts for one year (two semesters) and follows the undergraduate academic study (bringing additional 60 ECTS). After completion the title of **Master of Science in Mechatronics** (300 ECTS) is awarded.

After they complete their master's study in mechatronics, students can recognize, define and analyse mechatronic problems they have not encountered before. Throughout the process they turn to critical thinking, analysis and synthesis, and are capable of predicting the behaviour of a selected solution, as well as its advantages and disadvantages. They are trained to notice, define and solve practical technical and technological problems in a number of fields, being aware of potential impact of their professional activities on overall safety and the environment. Owing to the multidisciplinary approach when solving mechatronic problems, after the completion of the master's study students can lead project teams with a number of engineers of various technical specializations.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
I	Compulsory	1.	Numerical Mathematics	3 + 2	6
		2.	Industrial and Mobile Robots	2 + 2	5
		3.	System Identification	2 + 2	5
		4.	Intelligent Systems	2 + 2	5
	Elective	5.	Machine Vision	2 + 2	5
			Microengineering		
			Industrial Transportation Systems		
		6.	Embedded Computer Systems	2 + 2	4
			Computer-Aided Design II		
			Fundamentals of Engines and Vehicles		
			Proportional and Servo Technique		
Total:				**25**	**30**

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
II	Compulsory	1.	Power Drive Control	2 + 2	5
		2.	Mechatronic Design Project	4 + 0	5
	Elective *	3.	Safety of Mechatronic Systems	2 + 2	5
			Engine and Vehicle Mechatronics		
			Warehouse Systems and Logistics		
			Biomechanics		
			Electronics II		
			Master's Thesis	12	15
Total:				**24**	**30**

*One subject is selected, not attended earlier.

4.4. INDUSTRIAL ENGINEERING – Graduate study (*Master's*)

The graduate study programme in Industrial Engineering is a sequence to the undergraduate study programme.

The programme aims to provide advanced new knowledge and skills in Industrial Engineering. These include the systems of effective and efficient management in industrial production systems. The focus is on a systemic approach to the solving of engineering problems which requires the identification of necessary knowledge and integrated application. The study programme enables students to guide companies towards business excellence in accordance with the European and global standards.

After they complete the master's study in Industrial Engineering, students can use a systemic approach to solve actual industrial problems; analyse existing business processes by applying adequate methods and techniques and recommend their optimisation; apply modern engineering tools for modelling, simulation, calculation and design; research and evaluate economic, social and legal conditions in order to solve engineering problems; manage the life cycle of a product from the idea, market research, design and reproduction, its use and, finally, recycling and its disposal; design, implement and maintain an integrated management system in compliance with international standards central to the organization; define tasks and goals for measurement and testing laboratories as well as choose measurement devices and other resources necessary to solve problems.

The graduate academic study lasts for one year (two semesters) and follows the undergraduate academic study (with the additional 60 ECTS). After completion the title of **Master of Science in Industrial Engineering** (300 ECTS) is awarded.

Engineers holding a master's degree in Industrial Engineering, with their multidisciplinary knowledge and skills, can seek employment in a variety of companies dealing with research, design, technological preparation, organization and optimisation of work processes, design and implementation of management systems and development of logistic support.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
I	Compulsory	1.	Systems Engineering	3 + 2	7
		2.	Integrated Management Systems	3 + 2	6
		3.	Design of Measurement and Testing Laboratory	3 + 2	7
	Elective	4.	Simulation of Work Process	2 + 2	5
			Product Life Cycle Management (PLM&LCA)		
		5.	Engineering Entrepreneurship	2 + 2	5
			Finance Management		
Total:				**23**	**30**

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
II	Compulsory	1.	Lean Production	3 + 2	6
		2.	Knowledge Management	2 + 2	5
	Elective	3.	Documentation Management Systems	2 + 2	4
			Standardisation and Industrial Legislation		
			Master's Thesis		15
Total:				**14**	**30**

4.5. OCCUPATIONAL SAFETY – Graduate study (*Master's degree*)

The graduate study programme in Occupational Safety is a sequence to the undergraduate programme.

It aims at expanding the knowledge acquired during the undergraduate study and at introducing students to scientific research work; gaining more knowledge about research approach methodologies and their applications in real conditions; developing and applying existing research methods in this field, i.e. procedures that aim at reducing accidents to great extent in the work and other environments. Teaching units provide background and introduction to scientific research methodology and organization of scientific-research work. Students get tasks and problems that they should solve during the study with the support of their mentors. After that, they have the know-how to approach real problems with the use of modern scientific principles and achievements.

After the completion of study students have multidisciplinary knowledge necessary to maintain safety and health at work. They will also know how to do scientific assessments that lead to reduction of accidents in the work and living environments. They will be able to do scientific research that should help prevent accidents.

The graduate academic study lasts for one year (two semesters) and follows the undergraduate academic study (with the additional 60 ECTS). After completion the title of **Master of Science in Occupational Safety (300 ECTS)** is awarded.

Engineers holding a master's degree in Occupational Safety can work in production and non-production companies, research institutes and organizations. A professional in this field has multidisciplinary knowledge and skills that the modern society requires in order to provide safety and health.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
I	Compulsory	1.	Technical Expertise	3 + 2	5
		2.	Toxicology	2 + 2	5
		3.	Equipment and Product Safety	2 + 2	5
	Elective	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.	Fire Extinguishing Systems and Devices	2 + 2	5
Total:				**25**	**30**

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
II	Compulsory	1.	Methodology of Scientific Research	2 + 0	5
		2.	Laboratory Research	1 + 3	5
		3.	Experimental Research	1 + 3	5
			Master's Thesis	15	15
Total:				**25**	**30**

4.6. MECHANICAL DESIGN – Graduate study (*Master's degree*)

The graduate study programme entitled Mechanical Design is a continuation of the undergraduate academic study. Design is a universal process applied in all fields of mechanical engineering. This study programme (graduate) is compatible with all 5 study programmes of the undergraduate level at the Faculty of Mechanical Engineering in Banja Luka (Energy and Transportation Engineering, Production Engineering, Mechatronics, Industrial Engineering and Occupational Safety), as well as with the undergraduate study at other faculties of mechanical engineering in the region (with 240 ECTS). All undergraduate study programmes at the Faculty of Mechanical Engineering in Banja Luka have common curriculum during the first two years and provide adequate theoretical background for disciplines studied at the Mechanical Design study programme. During the other two years (second and third) students study specific subjects which provide the foundation for design and development of machine systems (production, manufacturing, energy, safety and industrial systems). Therefore, during the undergraduate study students become familiar with theoretical aspects of general subjects and specifics of particular machine systems, whereas at the Mechanical Design they learn how to design and develop those systems (devise, create, optimise, improve and make them more efficient).

The course units at the Mechanical Design enable students to acquire knowledge in machine design, modern product design (development) methods, as well as computation and optimisation methods. The product development and design comprise the highest level of practical application of knowledge.

After completion the title of **Master of Science in Mechanical Design** (300 ECTS) is awarded.

Having acquired multidisciplinary knowledge and skills, engineers holding a master's degree in Mechanical Design can work in a number of companies dealing with research, development, design, optimisation, production and management of project teams comprising engineers of various specialisations. He/ she is capable of creative thinking, analysis, while developing and improving products and processes.

First year – I semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
I	Compulsory	1.	Numerical Mathematics	3 + 2	6
		2.	Vibration and Noise	3 + 2	6
		3.	Theory of Elasticity	3 + 2	6
	Elective	4.	Product Development	3 + 2	6
			Innovations and Patents		
		5.	Fundamentals of Strength of Composite Structures	3 + 2	6
			Light Structures		
Total:				**25**	**30**

First year – II semester

Sem.	Status	No.	Subject	Classes (L + E)	ECTS
II	Compulsory	1.	Ecological Design	3 + 2	5
		2.	Design of Hydro-Pneumatic Systems	3 + 2	5
		3.	Structural Optimisation	3 + 2	5
			Master's Thesis	5 + 4	15
Total:				**24**	**30**