

Goals and Learning Outcomes for Master Studies For Each of 20 Modules

Aerospace engineering

semester	ID		title	goal	learning outcome
1	MSc-0275	obligatory	Applied Aerodynamics	The objective for course is to develop an understanding of low-speed aerodynamics and an introduction to compressible flows. The course covers concepts in incompressible airfoil theory, including symmetric and cambered airfoils using analytical and numerical approaches. The course also covers incompressible wing theory, including down wash, lifting-line theory, elliptic wings, general twisted wings, application of fundamentals to the design of a wing to meet given performance criteria.	After passing the subject the students are expected to understand and explain various aspects of the link between the body shape and its aerodynamic characteristics. In addition, it is expected that students recognize the use of opportunities acquired knowledge in aerodynamics, to other areas of techniques.
1	MSc-0629	obligatory	Structural Analysis	1. introduction to problems and modern calculation methods in stress analysis of aircraft structures, as well as their application to solving real problems 2. introduction to experimental stress analysis of aircraft structures 3.introduction to thin walled structures and composite materials 4. introduction to modern computational methods for stress analysis related to airframe structures	1. mastering basic structural analysis theories. 2. Application of them to solve practical problems. 3. Understanding basis of aircraft design process. 4. Understanding modern methods in structural analysis for stress analysis of aircraft structures.
2	MSc-0186	obligatory	Flight Dynamics	Introduce students to the dynamics of flight, ie. movement of aircraft in atmospheric flight. In this course students will studying the stability and maneuverability of aircraft, ie.	Completed the planned curriculum students obtain a sufficient theoretical knowledge that is able to be creatively independent state to define static and dynamic stability and maneuverability

movement of aircraft around the center of gravity. Under the terms of reference that encompasses and integrates the entire field contents taught, students will be capable of using modern software packages, such as: Matlab, Mathcad, etc.. fully master the calculation of stability and controllability of aircraft in the airspace.

of modern aircraft and all restrictions of flight options that resulting from it. In this course students will receive full sublimation and verification of previously acquired knowledge and skills that they get into the aviation module from aerodynamic case.

2	MSc-0639	obligatory	Composite Structures	<p>1. introduction to modern approach in stress analysis of composite material structures on aircraft, it's application to practical problems solutions as well as experimental methods applied to structural verification of composite structures. 2.Introduction to specifics of thin walled structures and application of composite materials for these structures. 3.Introduction to computer simualtion and stress analysis of composite structures on aircrafts.</p>	<p>1. mastering basic theoretical knowledge of structural analysis. 2. Application of theoretical principles to solution of practical problems 3. Understanding basic aircraft design principles 4. Understanding modern approach and methodology in design and stress-strain analysis of aircraft structures</p>
2	MSc-0577	obligatory	Computational Aerodynamics	<p>The goal of the course is to train students in modeling of flow problems. After attending the course, finishing all exercises and giving the final presentation, students should be able to recognize the type of the problem, formulate necessary boundary and initial conditions, choose an appropriate discretization scheme and write a program for calculating flow inside or around simpler geometric shapes, such as a nozzle or an airfoil.</p>	<p>By successfully adopting the program of the course, a student: -acquires theoretical knowledge sufficient to recognize the type of the problem as well as the type and number of additional conditions necessary to completely and uniquely define the problem that is being simulated; -recognizes basic approximation schemes of the typical problems; -masters the principles and foundations of programming related to simulations of continuum; -observes the structure of the simulation software that consists of pre-processing, simulation and visualization.</p>
3	MSc-0120	obligatory	Aircraft propulsion	<p>Course objective is to introduce students to the types and principles of functioning of basic aircraft power elements, as well as their characteristics and domains of use. Furthermore, the relation between the type of</p>	<p>By mastering this course, a student acquires abilities to perform analysis and synthesis of the whole system that consists of the aircraft and its power elements. A student gains knowledge on structures of the various types of aircraft</p>

the aircraft and propulsion system is pointed out, so that each mission can be realized in an optimal way according to the desired goals and constraints.

engines and components they are made of. Based on the acquired knowledge on the engine performances, a student is able to form an opinion on the quality of usually used engines and will acquire knowledge necessary for further self-improvement.

3	MSc-0136	obligatory	Aircraft Design	Purpose of the subject is to introduce students to submit concept of the aircraft. Process include analysis of existing similar airplanes and assessment of their good and weak points. To select optimum concept. To define basic geometric parameters of an aircraft. To select configuration, propulsion system, specific load and specific thrust/power. To calculate loads, performances and stability of the airplane.	After attending all lectures and recitations and after completion of projects students will be able to analyze, to specify and to develop aircraft concept according to required purpose and performances. Completion of project assumes passage through whole process of conceptual aircraft design. For selected segment of aircraft student should complete preliminary design, and for certain parts detail design of these parts should be included in the student project.
3	MSc-0109	obligatory	Aircraft control and systems	Subject task is to introduce students with integrated flight control computer systems, their functions, structures and principles. This have to enable students to enter into more detailed integration of aircraft systems and its components in aircraft control.	By the subject student gets knowledges and understandings about existing aircraft integrated control computer systems. These knowledges enables understanding of aircraft control systems if they are oriented to other aeronautical fields, or to further specialization in this aeria.
4	MSc-0612	obligatory	Skill Praxis M - VAZ	Practical experience and stay in environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of an mechanical engineer in such a business system.	Student gets practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, within the context of his future professional competence. Establish the personal contacts that will be able to use in further education, or entering into future employment.

1	MSc-0311	elective	Avionics	Objectives of the course are to introduce students to aviation electronic equipment and systems, their functions, structures and basic principles. The subject should provide students a detailed a detailed view of the latest trends in avionics technology and development.	Successful completion of course students acquire the ability to understand the existing solutions aviation electronic equipment and systems. The student acquires knowledge about the structures of various types of avionics equipment and systems. The knowledge that allow students to opt for other aviation issues to understand the electronic aviation equipment and systems, and for those who want to specialize in these issues are fundamental to the acquired knowledge for further work.
1	MSc-0348	elective	Aircraft Performance	Introduce students to the complex movement of aircraft in atmospheric flight. Students will learning the performance of aircraft, ie the movement of aircraft center of gravity in space under the action of forces. Under the terms of reference that encompasses and integrates the entire field contents taught, students will be able to work independently and with the use of modern software packages, such as: Matlab, Mathcad, Excel, etc.. fully master the budget performance aircraft in the airspace.	Completed the planned curriculum students obtain sufficient theoretical knowledge that is able to be creatively self-performance capabilities to define the modern aircraft and all restrictions of flight options that resulting from it. In this course students will receive full sublimation and verification of previously acquired knowledge and skills that they get into the aviation module from aerodynamic case.
2	MSc-0309	elective	High Speed Aerodynamics	The aim of this course is to introduce students to basic concepts in the field of high speed aerodynamics. Emphasis is given to transonic and supersonic flow problems. External flows (supersonic airfoils, wings and aircraft in general) and internal flows (supersonic inlets, nozzles and diffusers).	Upon completion and passing the course the student expected to understand the basic concepts and problems addressed in the field of aerodynamics at transonic and supersonic speeds. It is expected that the student knows how to apply the acquired knowledge in this field to solve practical engineering problems.
2	MSc-0545	elective	Windturbines 2	In the course of Wind turbines 2, the student will be acquainted with analysis and design principles of wind turbines and its parts. Beside the detailed study of different wind turbine designs, issues regarding regulation and dynamic balancing, the student will be in opportunity to gain knowledge about	The student will gain following subject-specific skills by mastering the curriculum: - thorough knowledge and understanding of different wind turbine concepts and design methods; - skills needed for wind turbine and its parts selection according to given operating conditions using scientific methods and procedures; - integration

				numerical simulations and flow, structural and modal analysis of wind turbine components, as well as basic principles of optimization of rotors for various operating conditions.	of fundamental knowledge in mathematics, programming, mechanics and fluid mechanics and application to design and calculations of wind turbines;
2	MSc-0326	elective	Helicopters	1. Introduction to rotary lifting surface vehicles. 2. Introduction to rotor aerodynamic theory. 3. Design of helicopters. 4. Performance of helicopters.	1. Understanding of aerodynamic VTOL schemes. 2. Aerodynamic scheme of helicopters. 3. Mastering theoretical foundations of rotary wing aerodynamics. 4. Ability to estimate of aerodynamic and performance characteristics.
3	MSc-0645	elective	Aeroelasticity	1. introduction to modern aeroelasticity problems and their analysis and practical methods to solving aeroelasticity problems in real aircraft structures 2. introduction to experimental dynamic analysis of aircraft structures 3. introduction to dynamics of thin walled structures	1. mastering basic theoretical knowledge related to aeroleasticity 2. application of theoretical knowledge to solve aeroelasticity problems on real aircraft structures
3	MSc-0344	elective	Aircraft armement systems	The study of this course is to ensure adoption of procedures and methods for problem solving related to aircraft armament calculations. Students will be capable of independently study aircraft rocket, bomber and firearms armament elements in order to obtain maximum effectiveness for the given conditions of application for each of these types of aircraft weapons. Particular attention will be faced towards development trends of modern aircraft armament.	By mastering of the course curriculum student obtains following subject-specific skills: - thorough knowledge and understanding of different types of aircraft weapons and their application - calculation of air weapons characteristics and possibility of their integration into the aircraft with the use of scientific methods and procedures - linking basic knowledge in mathematics, programming, mechanics and fluid mechanics and their application in design and calculation of aviation weapons and its integration;
3	MSc-0154	elective	Aircraft Maintenance	In the course of aircraft maintenance students will get basic knowledge of contemporary theory and practice of maintenance and overhaul of civil and military aircraft. Also, one part of the course will be devoted to the study of maintainability, reliability, combat	Completed the planned curriculum introduces students to the procedures of creative thinking and decision making in the field of maintenance of aircraft and acquire sufficient theoretical and practical knowledge that is able to participate in the team that designed the aircraft or maintain

				survivability analysis, as the basic structural characteristics of the system, which are defined in the early stages of design and development of modern aircraft.	or revitalize, sublimating sizes such as reliability, maintainability, fighting tenacity and tolerance to damage aircraft in the event of forced landing.
3	MSc-0142	elective	Project Management & Air Regulation	Course objective • Understanding the importance of project management in aviation. • The creation, introduction and use of aviation projects. • Determining the functionality of your own projects. • Preparation, analysis and project management. • Understanding and preparing the necessary documents for the implementation of projects.	The acquired knowledge enables the student to: <ul style="list-style-type: none"> • Prepare, create and show their own skills, • Determine the functionality of the aviation project, • Prepare, perform and manage the development of the aviation project, • Determine technology of designing an aviation project, • Recognize the requirements of the local aviation industry in projects, • Make the necessary documentation of aviation project, • Implement and collect aviation project.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism,	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a

selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.

mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.

1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.
---	----------	------------	-------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Biomedical engineering

semester	ID		title	goal	learning outcome
1	MSc-0287	obligatory	Biomedical instrumentation and equipment	Introducing to standard measuring and diagnostically medical methods and implementation of electron devices in medicine. The focus is on the principles and operation methods of the biomedical equipment with brief description of device construction. The subject educates engineers to improve still existing and develop new biomedical equipment.	By attending the course, students will be educated to understand and analyze problems concerned with operation and usage of biomedical instrumentation and equipment. This course educate students to connect basic principals of electronics, physics and medicine and to practically implement them into modern medical equipment.
1	MSc-0272	obligatory	Fractal mechanics	The goal of this subject is to teach a student to apply multi-fractal system theory in a field of biomedical engineering; to learn to use mathematical apparatus of fractal theory and modeling of embryological process, formation	Student gains the ability for fractal processing of images and charts, and defining the parameters of tissues and biological systems that determine the functional state of organs and organism, as a basis for design of

and functioning of tissues, organs, organ subsystems and entire organism; to master knowledge about classical, quantum approach to analyse tissues; to master fractal image processing and fractal chart pattern analysis; to learn to define diagnostic parameters, algorithms and instruments for determining functional conditions of organs and organism (normal conditions and pathological conditions) on the basis of fractal analysis of para/diamagnetic data.

parameters which are meant to be measured by biomedical instrumentation in order to help in diagnostics.

2	MSc-0640	obligatory	Biomaterials in Medicine and Dentistry	Introducing students to the application of different biomaterials, previously discussed during Foundations of Biomaterials course, in order to understand and study functional behaviour of biomaterials in the human body. Analysis of the connections between the biomaterial and the body system, in order to ensure reliable implant operation. The potential co-operation with experts in the field of materials science, dentistry and medicine is allowed, which provides the ability to work in specialized laboratories and clinical facilities.	By attending this course the student will master the application of biomaterials in medicine and dentistry, using modern scientific methods. Theoretical considerations, laboratory experimental work and the application of numerical analysis using the licensed software for finite element method, enables the synergy of the previously acquired knowledge in physics, materials science, mathematics and mechanics, in order to implement them in engineering practice.
2	MSc-0559	obligatory	Biomechanics of tissue and organs	To introduce students to the application of fundamental principles and laws of biomechanics of tissues and organs in order to understand and study them. Establishment of appropriate biomechanical model of tissue and organs using modern theory of viscoelasticity, the possibility of simulations based on them in order to confirm the experimental data, the possibility of applying for the purposes of design and design basis of the same. It allows the potential cooperation with experts in medicine or work in specialized clinical institutions.	Attending the course students acquire the ability to analyze the possibility of solving the current problems related to the biomechanical properties and characteristics of human tissues and organs with the use of scientific methods and procedures as well as computer technology and equipment. In addition, students can connect basic knowledge of mechanics, mathematics, physics, anatomy, physiology, biomechanics with application in the bioengineering of tissues and organs.
2	MSc-0535	obligatory	Signal Processing	Introduction of basic concepts and knowledge related to discrete signals and systems analysis	Student is provided with basic theoretical knowledge concerning digital signal and

in time domain as well as in frequent domain, digital processing of analog signals, digital processing of discrete and stochastic signals, digital filter design. Concerning digital image processing, student is introduced to concept of digital image, image quality enhancement, frequency domain processing, morphological processing and image compression.

image processing for biomedical applications. Also during the course student is trained to actively use software such as MATLAB, with accompanied toolbox SIMULINK, for analysis and processing of 1-D and 2-D signals as well as for mathematical modeling of biological systems.

2	MSc-0654	obligatory	Spectroscopy methods and techniques	Introducing students to fundamentals of spectroscopy methods and techniques. Through theoretical lectures and practical work student masters the understanding of light-matter interaction and how this interaction can be used to acquire information about structure of the matter. Through work on seminar paper and work in the laboratory student learns to apply acquired knowledge about structure of the matter in order to improve and control quality of various products in food industry, pharmacy, and other industrial branches, as well as in characterization of new materials, applications in biomedical engineering for early detection of bio-markers, pathological changes and diseases.	Combining theoretical lectures and practical work in laboratory student learns to use modern spectroscopy equipment and different spectroscopy techniques. Through work on practical problems and seminar paper student get to know techniques of spectral data analysis in material characterization, food, medicines, and diagnostics of biological tissue samples in vitro and in vivo.
3	MSc-0571	obligatory	Biomedical Apparatus and Devices	Introducing students with problems of biomedical apparatus and devices, on example of numerous devices of last generation which are frequently in use (CT, PET, NMR, ultrasound, systems for filtration,..). Students are became able critically to approach to problem, and to define the most important biomedical and other measurements which can determine characteristics of device which should be used and constructed.	With attending this course, student is introduced with theoretical consideration, detailed analysis of modern devices, their practical application. Students also make their own seminary papers/projects, in which they embrace previously acquired knowledge's of mathematics, physics, mechanics, and all for application of what is learned in engineering practice.
3	MSc-0728	obligatory	Nanomaterial Engineering	Student will get knowledge of нанотехнологии and nanotechnology applications in medicine together with good practical laboratory work in characterization of biomaterials with	The ability of students to interpret the advantages of applications of new nanotechnology devices in medicine against the classical ones. Understanding principles of

			nanotechnological methods, techniques and instrumentation. Student will get knowledge of modern diagnostics and therapeutic nanotechnological methods in medicine and will learn how to prepare classical and biological samples and to characterize them with nanotechnological instrumentation.	functioning and specificities of the conditions in which the devices are applied. The ability of modifying technical solutions in nanotechnologies and quantum information technology in order to make applications more effective.	
3	MSc-0564	obligatory	Early diagnostics of cancer and melanoma	The goal of this course is to introduce molecular mechanisms of developing cancer and existing methods for early diagnostics. Through critical approach to existing methods, and mastering the latest noninvasive or minimally invasive methods for early detection of cancer and melanoma, student is given basis for inclusion in modern scientific research and development of new diagnostic methods, as well as application and improvement of existing methods in biomedical practice.	Student is familiar with molecular, genetic, and biochemical basis of cancer development, influential factors for pathogenesis and development of cancer. Student has mastered structural, energetic and bioinformational characteristics of pathogenesis of different types of cancer and tumor (skin cancer, melanoma, cervical cancer, oral cavity cancer, colorectal cancer, breast cancer, and brain tumor) and is familiar with existing diagnostic methods and challenges for improving specificity and sensitivity of these methods. Student is able to understand, design, improve and apply newest noninvasive methods for early detection of cancer and melanoma.
4	MSc-0233	obligatory	Skill Praxis M - BMI	Practical experiences, and work in environment where student will realize his/her professional career. Identifying the basic functions of the working system in the field of design, development and production, as well as the roles and tasks of mechanical engineering in such a working system.	Students get practical experience in organization and functioning of the environment in which they will apply their knowledge in the future professional career. Student identifies models of communication with colleagues and business information flows. Student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Personal contacts will be established and connections that they will be able to use during their studying, or by entering into future employment.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the	By gaining knowledge in this course, students

elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.

will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.

1	MSc-0685	obligatory	Fluid mechanics M	<p>The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.</p>	<p>Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.</p>
1	MSc-0201	obligatory	Mechatronics	<p>Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.</p>	<p>Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.</p>
1	MSc-0202	obligatory	Thermodynamics M	<p>Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.</p>	<p>After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.</p>

Control Engineering

semester	ID		title	goal	learning outcome
1	MSc-0566	obligatory	Automatic Control	Acquisition of knowledge from the theory of linear control systems.	Acquiring the knowledge obtained is used in engineering practice and the basis for monitoring the course of nonlinear systems and advanced courses of synthesis of linear systems.
1	MSc-0631	obligatory	Computer control	<ul style="list-style-type: none"> •Introducing of: nature of computer control systems-CCS related to types of signal transfer; real CCS as mainly presented in the practice; choice of physical model of CCS; mathematical modeling of CCS. •Mastering of: methods of determining of static and dynamic characteristics of CCS; real time computer control by discrete algorithms. •Off line use of MATLAB - but as software standard of automatic control. 	<ul style="list-style-type: none"> •Exact but not approximate treatment of CCS according to their nature. •Scientific and engineering treatment of CCS as dominantly represented in practice. •Applying the methods of analysis and synthesis of controller in CCS, as well of whole CCS. •Solving problems of calculation nature by means of computer and MATLAB in the "off line" mode, related to the analysis or synthesis of CCS. •Determining of dynamic and static characteristics of CCS.
2	MSc-0126	obligatory	Object and process dynamics	Student should be familiar with basic principle and steps of mathematical modeling of objects and processes. To be capable to form basic balance equations which describes non-stationary states of objects and processes which, after suitable choice of state variables, manipulated and control variables as well as disturbances variables enables one to form adequate and non-unique state space representations of objects and processes for the needs of further analyzing or synthesis.	To be familiar and to be capable to use the basic principle of mathematical modeling applied to: dynamics of material handling, flow processes, flow-thermal processes, machine dynamics, traffic and transportation dynamics and contemporary plants existing in area of general energetic. Moreover it is expected to be capable to perform elementary analysis of their transient response characteristics from the above mentioned list of objects and processes.
2	MSc-0628	obligatory	Nonlinear Systems 1	<ul style="list-style-type: none"> •Introduction to nonlinearities in the plants and processes. •Introduction to basic concepts of analysis of nonlinear systems. •Understanding and using the basic tools for testing the stability of nonlinear systems. •Analysis of nonlinear systems 	Knowledge and understanding of: <ul style="list-style-type: none"> •Nonlinear problems and phenomena in the processes and plants. •Mathematical description of nonlinear systems. •Basic methods for analyzing nonlinear systems in the time domain and state space. •Simulation and analysis of nonlinear systems

				using C and Matlab programming languages.	using a PC and programming languages C and Matlab.
2	MSc-0642	obligatory	Fuzzy Control Systems	<ul style="list-style-type: none"> •Understanding of fuzzy approach to modeling phenomenon, process and systems •Introduction to basic of fuzzy set theory and fuzzy control theory •Analysis, design and simulation of fuzzy control systems using Matlab/Simulink software 	<p>Knowledge and understanding of:</p> <ul style="list-style-type: none"> •Fuzzy set, fuzzy logic and fuzzy control theory •Design of fuzzy controllers and fuzzy systems •Synthesis of various fuzzy control algorithms •Simulation and practical realization of fuzzy control systems using PC and programming software C and Matlab/Simulink.
3	MSc-0609	obligatory	Nonlinear Systems 2	<ul style="list-style-type: none"> •Building the foundations of nonlinear control design and analysis. •Introducing commonly used nonlinear control tools. •Analysis and control of nonlinear systems using C and Matlab programming languages. 	<p>Knowledge and understanding of:</p> <ul style="list-style-type: none"> •The basis of analysis of certain classes of nonlinear systems. •The methods for testing the system stability by Lyapunov techniques and input-output analysis. •The techniques of control of nonlinear systems. •Simulation, analysis and control of nonlinear systems and synthesis using programming languages C and Matlab.
3	MSc-0118	obligatory	Control Systems Technology	<p>-This subject introduce candidate with detailed characteristics of computer controlled systems. Also the candidate will be educated to implement knowledge to real computer controlled systems. - Candidate will be familiar with some methodologies for selection of computer components as well as other control components. -Candidate will be familiar with mentioned control systems.</p>	<p>-To acquire basic knowledge from control systems theory and practice as well as other fields of applied sciences. -Introduction with methods for dynamic analysis and synthesis of control systems. -Methodology of analytical and/or experimental determination of static and dynamic characteristics of control systems.</p>
3	MSc-0307	obligatory	Linear System Design	<p>Student to be familiar with basic demands in control system design (synthesis) introducing the basic facts about essential system characteristics working in steady state or in transient process. To be informed with wide spectrum of different control design methods and approaches within the contemporary real control, mostly feedback automatic control</p>	<p>To be familiar, to accept and be capable to use some of offered methods in control system design and to be learned to implement them on every particular problem from the class of systems that have been treated within the course. It is expected that one should be capable to apply some of particular control design methods in real systems operating time and to implement them on real objects and processes mostly for particular class of</p>

systems.

linear feedback control systems.

4	MSc-0641	obligatory	Skill Praxis M - SAU	Practical experiences, and work in environment where student will realize his/her professional career. Identifying the basic functions of the working system in the field of design, development and production, as well as the roles and tasks of mechanical engineering in such a working system.	Students get practical experience in organization and functioning of the environment in which they will apply their knowledge in the future professional career. Student identifies models of communication with colleagues and business information flows. Student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Personal contacts will be established and connections that they will be able to use during their studying, or by entering into future employment.
1	MSc-0659	elective	Biomedical photonics	That students learn the structure and working principle of an eye, and its properties using knowledge of biomechanics and the theory of light. To acquire knowledge concerning polarization, interference and diffraction of light on the example of the eye. To learn to measure visual acuity, objective and subjective determination of diopter. To get acquainted with the principles of refractive surgery, to acquire knowledge concerning changes the curvature of the cornea and corneal turning power, and to become familiar with the production and incorporation of artificial intraocular lenses.	Mastering the knowledge gained from biofotonike, student gain ability to understand the basic laws of functioning of the eye, that is required for lens design and participation in technical assistance to a doctor at a clinic during diagnosis. The student is able to understand the function of the contact lens and optical and optoelectronic instrument for identifying and measuring the reflection, absorption, scattering and light emission of biomolecules and tissue.
1	MSc-0563	elective	Dynamic Systems Simulation and Testing	This subject introduce candidate in Matlab Simulink simulation package. This subject introduce candidate with examination of static and dynamic characteristics of automatic control systems. Candidate will be familiar with identification of dynamic systems.	Introduction in experimental determination of static and dynamic characteristics of automatic control systems. Introduction in presentation of various automatic control systems and control systems using program package for simulation of dynamic systems. Introduction for verification used mathematical models of dynamic systems by experiment and by use of program package Simulink.

1	MSc-0681	elective	Introduction to nanosystems	Introduction to basic elements of nanosystems: materials, energy, information, organization and control. Basic types and characteristics of nanomaterials and nanoparticles; fundamental methods, techniques and equipment for characterization. Intermolecular forces and potentials. Coding nanomaterials and biomimicry of nanosystems. Self-assembly and self-organization. Principles of nanorobotics design.	Acquiring of fundamental knowledge in nanosystems that could enable problem analysis and possibility of predicting solutions for nanosystem problems by application of scientific methods and procedures. Introduction to basic principles of work for STM and AFM. Integration of physics of materials knowledge, energetics and informatics in the aim of recognition of basic criteria for differentiation of nanosystems from classical technical systems.
1	MSc-0387	elective	CONTROL COMPUTERS AND AUTOMATION	<ul style="list-style-type: none"> • Introducing with: types of control by digital computer, just control computer as well its interfaces and transducers. • Mastering of: both classical automation by means of finite automata so and modern by means of PLCs. • Mastering of control both machines and equipments so and processes in real time, even by use advanced width modulation. 	<ul style="list-style-type: none"> • Knowledge needed for the proper handling of the control computers and related accessories. • Using of the methods for analysis and synthesis of combinational and sequential finite automata for the classical automation. • Using PLCs for automation. • To apply computer for control in real time with using the most sophisticated control algorithms.
2	MSc-0676	elective	bioautmatics	Introduce students to the fundamental principles of regulatory processes and adaptation in biological systems. Mathematical modeling of regulatory processes, biological data acquisition system in order to confirm the experimental results, the possibility of application in medicine and technology. Cooperation with experts from the fields of medicine, automation	Students acquire the ability to analyze issues related to the field of bioregulation mechanism, the formation of mathematical models of biological systems using contemporary analytical methods, procedures, techniques, and computer equipment. Students are trained to master the synthesis of knowledge of anatomy, physiology, automatic control and signal processing in order to achieve accurate models of biological systems.
2	MSc-0599	elective	Industrial Automation	To introduce students to the contemporary industrial control systems, design and technology of their realization, component selection and practical implementation of simple solutions.	The acquired knowledge is used in engineering practice. The student is competent to understand modern control systems in the industry, component selection and practical implementation of simple solutions.

2	MSc-0727	elective	Nanotechnology	Goal of this subject is for students to acquire knowledges of: electron tunnelling phenomena, molecular attractive and repulsive forces, nanomaterials, conversion and transport of energy on nanoscale level. Introduction of basic methodes, techniques and devices for characterisation of nanomaterials: Scanning NanoProbe microscopy and spectroscopy. Nano electrochemical cell. Characterisation of conductive, magnetic and non-conductive materials: inorganice as well as biological. Nano films: characterisation and modification of sample surfaces by STM/AFM/MFM methodes.	Student will obtain basic knowledges of nanotechnologies which will allow him to make analysis of certain problems and ability to predict solutions with scientific methods, processes and computer techniques. Student will be introduced with basic principles of operation of STM and AFM microscope and be able to integrate knowledge of material physics, energy and information on nanoscale level for engineering nano-molecular sensores and machines.
3	MSc-0586	elective	Adaptive systems	<ul style="list-style-type: none"> • Introducing with: concept of adaptive control and different types of adaptive control systems-ACS. • Mastering with: different methods for synthesis of adaptive control systems. • Mastering of working with physical adaptive control systems. 	<ul style="list-style-type: none"> • Acquiring the knowledge needed to properly understand the concept of adaptive control and various types of ACS. • Easier handling with digital computers in both hardware and software sense, as part of ACS. • Using the methods needed for analysis and synthesis of different adaptive control systems. • To apply computer to solve problems of computational nature in "off line" mode, either related to analysis or synthesis of ACS. • Analysis and design of real physical ACS.
3	MSc-0606	elective	Biomedical optoengineering	To familiarize students with materials for contact lenses and optical designs: spherical, aspherical, toric, progressive, progressive-toric, as well as production technology of contact lenses: cutting, polishing, final control, hydration, sterilization and characterization. To understand the operating principles of lasers and LEDs. To get more familiar with the application of lasers in ophthalmology.	Mastering the skills of optoengineering a student acquires the ability to design the device. The student is qualified to participate in the design and manufacture of contact lenses and optical and optoelectronic instrument for identifying and measuring the reflection, absorption, scattering and emission of light. The student will have more knowledge regarding the principle of lasers work and their application in ophthalmology.
3	MSc-0678	elective	Process identification	Student should be familiar with the basic ideas from identification and estimation	Contemporary methods of identification enables one to form mathematical models of different

theory, in order to be able to make a reconstruction of process model, based only on input - output measurements data collected over some period of time. In that sense it is expected to recognize process structure, order of process model and to estimate unknown parameters of process.

processes with much more accuracy than only based on analytical approach. Moreover this procedure, when the real time control is used, enables so called adaptive control, which can perform all desire process characteristics and achieve practically all severe demands which, today, can be very often contradictory.

3	MSc-0656	elective	Intelligent Buildings	To introduce students to the concept of intelligent buildings, technical systems in modern buildings and control systems technology and their integration.	The acquired knowledge is used in engineering practice. The student is competent to understand the technical sub-systems in modern buildings, their configuration and mutual integration of electrical and mechanical systems and management concepts.
3	MSc-0657	elective	Intelligent Control Systems	<ul style="list-style-type: none"> •Introduction to methods for the analysis and design of intelligent control systems. •Gaining practical knowledge of several of the main techniques of intelligent control and an introduction to some promising research directions. •Use of the computer for simulation and evaluation intelligent control systems. 	<p>The course involve:</p> <ul style="list-style-type: none"> •understanding of the functional operation of a variety of intelligent control techniques •the study of control-theoretic foundations, •learning analytical approaches to study properties (especially stability analysis), •acquiring of the knowledge of intelligent systems design (control, production, etc.) based on combinations of various theories: simulation, neural networks, fuzzy systems, genetic algorithms, evolutionary algorithms, etc. •use of the computer for simulation and evaluation intelligent control systems through Matlab software.
3	MSc-0682	elective	Informational Technologies in Medicine	Introducing students with fundamental principles of applied informational technologies in medicine, with a goal of examining the important characteristics of implementations of new technologies in medicine. Simulation of realistic problems and specific requirements for implementation of logical structures in hospitals, telediagnosics, and analysis of biological systems on molecular level.	By attending this course student becomes capable of analyzing the problems of organizing informational structures in medical institutions, practical application, and development of algorithms and structures applicable in telemedicine, and knowledge necessary for detailed analysis of biological structures on molecular level with application of scientific methods, procedures, computational techniques and equipment.

3	MSc-0679	elective	Stochastic Linear Systems	To be familiar with the knowledge of stochastic, ergodic random processes and with the methods for control system analysis and design in time and frequency domain. Based on essential stochastic signal characteristics to be able to estimate fundamental system behavior, when random processes are present on the inputs of the system. To able to implement some of optimization techniques in such cases.	To be familiar, to introduce as well basic principle of contemporary probability theory and mathematical statistics and all of that to implement to linear continuous time invariant automatic control systems, when they are subjected to the influence of random signals. To be capable to implement for direct implementation of different control strategies.
3	MSc-0680	elective	neural networks and fuzzy logic	<ul style="list-style-type: none"> • Introduce students to the fundamental principles of artificial neural networks • Mathematical modeling of artificial neural networks and its application to science and technology. • Consideration fuzzy approach to modeling phenomena, processes, and systems. • Understand the basics of the theory of fuzzy sets and fuzzy logic. • Using MATLAB / Simulink for analysis, synthesis and simulation of fuzzy systems. • Co-operation with experts from the medical field and automation. 	<ul style="list-style-type: none"> • Acquisition of the ability to analyze issues related to the neural network, the formation of mathematical models of biological systems using scientific methods, procedures, techniques, and computer equipment. • Connecting basic knowledge of anatomy and physiology, the automatic control system in order to achieve better process technology, more human interaction man - machine. • Knowledge and understanding of fuzzy sets, fuzzy logic and fuzzy control theory. • Knowledge and understanding of the synthesis of fuzzy controllers and different fuzzy control algorithms.
3	MSc-0677	elective	Project documentation	Objective of the course is to introduce students to different stages of construction, from technical documentation preparation and obtaining the necessary approvals to construction and exploitation. Students learn about with the contents of the project. In the second part of the course acquire basic knowledge related to activities that follow design of processing industry facilities (power supply, operating fluids, transport, water flow etc.). Part of the course deals with the economic evaluation of investments.	Main outcome of the course is to teach students to independently run object construction. This includes project documentation preparation and object construction. After successful completion of the study program, student is capable to foresee the extent of necessary design work in processing industry, as well as to plan necessary installation for production plants.
3	MSc-0683	elective	Biosystem	To meet some classes of bio-systems. To be	To be familiar, to introduce as well basic principle

**stochastic
identification**

familiar with the knowledge of stochastic, ergodic random processes and with the methods for control system analysis and design in time and frequency domain. Student should be familiar with the basic ideas from identification and estimation theory, in order to be able to make a reconstruction of process model, based only on input - output measurements data collected over some period of time. In that sense it is expected to recognize process structure, order of process model and to estimate unknown parameters of process.

of contemporary probability theory and mathematical statistics and all of that to implement to linear continuous time invariant automatic control systems, when they are subjected to the influence of random signals. Contemporary methods of identification enables one to form mathematical models of different processes with much more accuracy than only based on analytical approach. Moreover this procedure, when the real time control is used, enables so called adaptive control, which can perform all desired process characteristics and achieve practically all severe demands which, today, can be very often contradictory.

1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism,	Achievement of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main components of a mechatronical

selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.

system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.

1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.
---	----------	------------	-------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Design in mechanical engineering

semester	ID		title	goal	learning outcome
1	MSc-0285	obligatory	Axiomatic methods	Course aim is to scrutinize the design process in its entirety, from problem definition to conceptualization to embodiment and realization, in a discipline-independent framework, with the purpose of gaining insight into the process from the most general viewpoint.	Advanced application of axiomatic design theory for design of products, manufacturing processes and manufacturing systems. Ability for structuring and decomposing designs in order to systematically apply design axioms. Advanced application of design software. Teamwork abilities.
1	MSc-0270	obligatory	Product Aesthetics	Introduce students to the standards and laws of aesthetics in the process of product design, recognizing the subjective and objective factors of establishing the aesthetic judgement;	Student has gained the ability of aesthetic evaluation and the formation of aesthetic judgement, through theoretical and practical courses, student is trained to creatively use

introduction to the cultural and historical aspects and schools of aesthetics; treatment of aesthetic elements and principles, the study of geometric harmony laws, the use of traditional and modern means of creating aesthetic properties; introduction to the features of modern graphical signs and aesthetic properties of packaging and advertising.

both abstract elements and principles of aesthetics and practicality (classical and modern) means of creating aesthetic characteristics of the product;

2	MSc-0171	obligatory	Ergonomic design	Students should acquire specific practical skills that include an integrated ergonomic approach for the design of a comprehensive solution to different problems. The aim of this course is the acquisition of basic academic knowledge in the field of ergonomic design, which can be used for design of different products, as well as for redesigning and improvement on the system man - machine.	It is expected that acquired knowledge students can use in daily work and practice, bearing in mind that in almost all branches of industry there is a need for designing, which includes the human factor. By mastering of the ergonomic design program, the student acquires the ability to solve all aspects of the various engineering problems by applying science-based ergonomic methods, techniques and recommendations.
2	MSc-0302	obligatory	Decision-making methods	The aim of the course is to train the students to make decisions in the process of product development and design by using mathematical-algorithm procedures and artificial intelligence techniques. Development of students' creative abilities in improving technical/technological characteristics of a product using methods based on conceptual design points out the optimum decision function based on intelligent agents.	The complex use of IT technologies in decision-making. The implementation of developed software in solving typical technological problems within decision-making methods based on artificial intelligence paradigms. Autonomous selection of the methods based on application of artificial neural networks and genetic algorithms in seeking the optimal solution in the process of product development. Capability for team work.
2	MSc-0193	obligatory	Development of Machine Systems	The development of creative skills of students in creation of ideas for a new, previously unknown, products (mechanical systems). Establishing a correlation of environment, user needs, technology, methods and tools for developing technical solutions, the market conditions and other factors. In addition objective of this course	The student has mastered the procedure of abstract thinking and creative adjustment factors that lead to ideas for new, hitherto unknown system. He mastered the procedure and process of defining the limits and conditions to be met by a new product. Trained to use methods and tools for the

is to master methods for product development to the project as well as methods for defining and processing constraints that lead to high performance products.

development of mechanical systems. He mastered the procedures of defining individual characteristics (Design for X - DFX) as well as integrated approaches to product development.

3	MSc-0159	obligatory	Bionics in Design	<p>Introducing students to the process and the procedure of synthesis (create) a combination of mechanical systems engineering design (design) and industrial and bionic design. Besides, the goal of this course is to develop creative skills of students in the design of machines.</p> <p>Understanding the methodology and procedures to create innovative mechanical system through the phase of designing, selection of parameters, dimensions and shape of machine parts, alignment features (functional and aesthetic) with the environment, living and working environment.</p>	<p>The student is introduced to the procedure of abstract thinking and creative idea generation, the development methodology of the new principal, conceptual, based on bionic solutions. Dressed in designing machine parts and assemblies based on bionic principles, functional, technological, aesthetic, ergonomic, and others. Trained to implement budgets for the mutual adjustment of parameters of machine parts with the limitations, the development of forms and sizes.</p>
3	MSc-0127	obligatory	Eco Design	<p>The main objective of this course is to achieve competence and academic skills in the field of eco design and sustainable product development. The goal is mastery of the methodologies to define strategies to improve products and reduce the harmful effects of products on the environment, and understanding of the impact of products on the environment throughout its life cycle and innovative approach to obtaining environmentally improved products.</p>	<p>Mastering the curriculum the student acquires the ability to master the strategies of eco-design for a more innovative environmental product improvement at the work on product development. Student masters the skills, tools and practical ability to obtain sustainable products, and acquire the ability to monitor environmental directives and communication with organizations that impose environmental requirements.</p>
3	MSc-0116	obligatory	Special methods for product development	<p>The main goal of this course for the student is to give the necessary knowledge of:</p> <ul style="list-style-type: none"> • numerical analysis and optimization, • understanding general principles of design optimization • formulating the optimization problems and identify critical elements. 	<p>During this course, the student will carry out:</p> <ul style="list-style-type: none"> • Overview of design optimization • Fundamentals of engineering optimization • Problem formulation • strategies for optimization
4	MSc-0157	obligatory	Skill Praxis M -	<p>Practical experience and stay of students in</p>	<p>Students get practical experience on the</p>

DUM

environment where they will realize their professional career. Identifying the basic functions of the business system in the area of product development, production and utilization as well as the roles and tasks of mechanical engineering in such a business system.

organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Establish the personal contacts that will be able to use at school or entering into future employment.

1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main components of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.

1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.
---	----------	------------	-------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Engineering of biotechnical systems

semester	ID		title	goal	learning outcome
1	MSc-0560	obligatory	Technological processes in agro complex	1. Obtaining knowledge through a multidisciplinary approach that can be considered rational, optimizing technical processes. 2. Mastery of processes in agricultural production through the knowledge of the type and condition of soil and agricultural materials. 3. Acquisition of practical skills for working in the field of new technologies in agriculture and in agricultural machinery.	1. Opportunities for analysis and prediction of optimal solutions of agricultural technologies. 2. Control methods for the application of agricultural technology for the solution of agricultural machinery. 3. Application of knowledge through the acquisition and exploitation of agricultural machines. 4. Ability to communicate with users and producers. 5. Linking the field of agriculture and mechanical engineering.
1	MSc-0298	obligatory	Tractors and self-propelled agricultural machines	1. Master the theoretical foundations of power machines-tractors and self-propelled agricultural machine-harvesters; 2. Conception and construction of farm tractors, small tractors and self-propelled chassis; 3. Transmission systems and for connecting the working machinery and mechanisms; 4. Concept of simultaneous transmission of power through the drive wheels and auxiliary shafts,	1) Basic knowledge in theory work, the conception and construction of power machines-tractors, mowers and self-propelled chassis and universal self-propelled combine, 2) Analysis of mechanical, hydrostatic transmissions and combined agricultural tractors, self-propelled chassis and universal self-

energy balance, 5. The theory of operation, concept and design combines, budgets drive the moving parts and technological devices combine.

propelled combine harvesters, 3) Application computer facilities in the budgets and technological devices; 4) Linking the basic engineering knowledge and achieve synergy; 5) The acquisition of practical skills and application in practice.

2	MSc-0616	obligatory	Designing agricultural machines and equipment	1. Achieving competence and academic knowledge relating to agricultural machinery and equipment. 2. Mastery of specific and practical skills for carrying out of agricultural machines and equipment. 3. Findings to a multidisciplinary approach to achieve optimal results in the design of agricultural machines and equipment.	1. Mastering the methods and processes of design. 2. Fundamental knowledge of theories of agricultural machinery and equipment. 3. The use of knowledge and transfer of new technologies in the field of design and construction of agricultural machines and equipment. 4. Monitoring and implementation of new and contemporary solutions.
2	MSc-0462	obligatory	Special techniques and technology of drying	Acquire basic knowledge in the field of special techniques and technologies of drying process (drying by radiation, osmosis, ultrasound, conductive, sublimation, in a stream of high and super high frequency, etc.), which includes the development of creative abilities and mastery of practical skills for specific job performance.	The ability to use acquired knowledge to solve problems in the field of special techniques and technologies in the process of drying, kinetics and dynamics study of the drying process, the drying process and design solutions, including application of knowledge in practice, solving practical problems using scientific methods and procedures and monitoring and implementation of innovations in profession.
2	MSc-0600	obligatory	Processing technology of agricultural products	1. Student should master the basics of the process of agricultural products (fruits, vegetables, animal products and grains).. 2. Understanding the limitations and specific lines of production and food processing. 3. Introduction to the preparatory process technologies of processing agricultural products (cleaning, washing, sizing and sorting round). 4. Mastering how to process modeling and optimization processes of food preservation using high and low temperatures. 5. Acquiring knowledge about the procedures and equipment for	Upon completion of the course, students will be able to properly projected lines for the production of certain types of products. To enable students to study in the preparation and preservation of food using high and low temperatures. Design of technological processes of cleaning, washing, calibration, color sorting, heat treatment of fresh products (blanching), heat treatment of the finished food product (pasteurization, sterilization),

sterilization and pasteurization of food products. 6. Acquiring knowledge about the procedures and devices for cooling and freezing of fruits and vegetables. 7. Understanding the technology of cooling fruits and vegetables. 8. Understanding the technological procedures for freezing and storing fruit and vegetables. 9. Introduction to methods and devices for thawing food product.

cooling, freezing and storage. Knowledge of changes that could threaten the quality of agricultural products in cold storage. Implement measures to prevent damage to fruit and vegetables during storage in cold storage. Knowledge and application of international standards of quality frozen food products.

3	MSc-0615	obligatory	Geoinformation and remote control of biotechnic systems	<p>1. Master the theoretical foundations of measurement and automation of agricultural machines and equipment; 2. Principles of measurement, sensors and methods of measurement non-electrical quantities on agricultural machines and equipment; 3. Automation of tractors and machines; 4. Automation combines: automatic control, regulation of technological devices, measurement and regulation of losses, monitoring, 5. Management in precision agriculture and food processing industry. 6. Monitoring of dynamic machines and processes in real time</p>	<p>1) Fundamental knowledge in the field of measurement and automation of agricultural machines and equipment; 2. Mastering the principles of measurement, sensors and methods of measuring non-electrical quantities on agricultural machines and equipment; 3. Automation of tractors, trailers, harvesting equipment and machinery in food processing industry; 4. Management in precision agriculture GPS and processing industry; 5. Acquisition of practical skills and application in practice.</p>
3	MSc-0464	obligatory	Plant and process design and energy systems	<p>Mastering the knowledge necessary for the calculation and design of plant and process and energy systems and their use. This includes the development of creative abilities and mastery of specific practical skills for performing tasks in engineering practice.</p>	<p>Knowledge necessary for plant and process design and energy systems and their exploitation, which involves applying knowledge in practice, solving practical problems using scientific methods and procedures and monitoring and implementation of innovations in the profession.</p>
3	MSc-0596	obligatory	Managing food safety and quality	<p>1.The subject should enable students to acquire knowledge about the concept of certification and its importance for the market, environmental protection and good agricultural practice, the function of certification. 2.Introduction to basic procedures for certification, certification course, participants, their rights and obligations, the general principles of all standards relating to food and</p>	<p>1.Fundamental knowledge about the concept of certification and its role in the market of food products, environmental protection and good agricultural practices in the function of certification. 2.The student should be able to connect the basic engineering knowledge with development trends in food production</p>

industrial processing of food products and exposure with institutions and organizations dealing with food safety in Serbia and abroad. 3.The subject should enable students to acquire knowledge / understanding of contemporary approaches and principles of quality management, quality management functions of the organization, specific methods of management and quality control, new business strategies, new systems and specific quality management activities. 4.Learning about new trends in food production.

and processing along with the application of regulations and standards.
3.Introduction of skills, consistent and systematic improvement of application of modern, efficient and effective quality management system.

4	MSc-0502	obligatory	Skill Praxis M - IBS	Practical experience and stay in the student environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineering in such a business system.	Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Establish the personal contacts and poznastva that will be able to use at school or entering into future employment.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and

fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.

capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.

1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering experise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Food industry engineering

semester	ID		title	goal	learning outcome
1	MSc-0270	obligatory	Product Aesthetics	Introduce students to the standards and laws of aesthetics in the process of product design, recognizing the subjective and objective factors of establishing the aesthetic judgement; introduction to the cultural and historical aspects and schools of aesthetics; treatment of aesthetic elements and principles, the study of geometric harmony laws, the	Student has gained the ability of aesthetic evaluation and the formation of aesthetic judgement, through theoretical and practical courses, student is trained to creatively use both abstract elements and principles of aesthetics and practicality (classical and modern) means of creating

use of traditional and modern means of creating aesthetic properties; introduction to the features of modern graphical signs and aesthetic properties of packaging and advertising.

aesthetic characteristics of the product;

1	MSc-0495	obligatory	Refrigeration in Food Technologies	Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.	Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.
2	MSc-0241	obligatory	Engineering Condition Monitoring	Students are to acquire necessary knowledge to trouble-shoot the machinery, reveal main cause of malfunction and prescribe remedial action. Introduction of equipment and devices for engineering diagnosis and skills development for applying them.	In this course students prepare to accumulate engineering knowledge and skill to approach an object, use the technical documentation to understand system operation, apply appropriate methods of check out, collect relevant data, compare the the results with ISO proposed norms, make a decision and specify the list of remedial action.
2	MSc-0569	obligatory	Engineering Economy	The objectives of this course are to guide students in engineering and the respective economic and financial processes and to inform them of the relations, connections and rules by which these processes take place in the generation and selection of optimal variant of projects for the overall success in achieving development goals of enterprise	Mastering this program, student obtains the following general skills: analysis and synthesis and forecasting solutions and consequences; mastery of methods, procedures and processes of research; application of knowledge in practice. He also obtains the following subject-specific skills: solving practical problems using scientific methods and procedures, linking basic knowledge in various fields and their applications
2	MSc-0607	obligatory	Mechanism and Handling Design in Food Industry	The students to master the skills of designing and constructing the cam and Maltese mechanism. To acquire the ability to analyze them in the machines and devices used in the food industry. To become	The student has mastered the procedures for the construction of mechanisms that are mainly used in machinery and equipment in the food industry as well as

familiar with the types and working methods of handling systems, as well as the design possibilities of these structures to obtain simple functions.

to connect the work of individual machines in production lines. The student is familiar with the principles of a Working Model and thus can easily master other software package for modeling and generating mechanisms.

3	MSc-0231	obligatory	Packaging Machines	Getting started with the machines that achieve these technological solutions. Acquiring the necessary knowledge in the field of thermal processes that are necessary for certain types of packages. Introduction to various techniques for normal and sterile package closing.	This course gives the knowledge necessary for the maintenance of various packaging machinery that can be found in food and other industries. It also gives the necessary knowledge to the investors that order and purchase packaging machines. Besides this, students get all the specific technological, process and design knowledge for projecting and design of packaging machines.
3	MSc-0235	obligatory	Food Processing Machines	1. Introduction to the basic concepts necessary for understanding the material from this field. 2. Acquiring skills in preparing contemporary construction programs for designing and performance analysis of food processing equipment and plant. 3. Developing students creative abilities for designing food processing equipment, machines and systems.	1. Analysis of existing problems and their effects 2. Adopting of practical knowledge 3. Practical application of knowledge 4. Introduction and understanding the problematic of food processing machines 5. Resolving concrete problems 6. Connecting knowledge from different fields and their application 7. Tracking and applying innovations in the field.
3	MSc-0464	obligatory	Plant and process design and energy systems	Mastering the knowledge necessary for the calculation and design of plant and process and energy systems and their use. This includes the development of creative abilities and mastery of specific practical skills for performing tasks in engineering practice.	Knowledge necessary for plant and process design and energy systems and their exploitation, which involves applying knowledge in practice, solving practical problems using scientific methods and procedures and monitoring and implementation of innovations in the profession.
4	MSc-0236	obligatory	Skill Praxis M - PRM	1. Gaining practical knowledge of food processes and machines. 2. Introduction to machine materials	Successful completion of the study program the student acquires the ability

needed for applications in the manufacture of food machinery. 3. Developing creative skills of students in the design of food equipment, machines and systems analysis and design of food exploitation characteristics of machines and plants.

to: 1. Analysis of existing solutions and their effects 2. adoption of knowledge in practice 3. application of knowledge in practice

1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this

mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.

course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Hydropower engineering

semester	ID		title	goal	learning outcome
1	MSc-0443	obligatory	Pumps	Mastering knowledge of engineering applications of pumps as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a pump as a built-in element with its function.	Knowledge of types and designs of pumps. Knowledge of the energy parameters and energy balancing. Knowledge of similarity theory to implement the dimensionless parameters - characteristic performance factors. Knowledge of methods of the system working point determination. Knowledge of the energy characteristics of pumps and their significance in establishment of operating regimes of pumps, as well as in their regulation. Knowledge of the pump cavitation characteristics.
1	MSc-0281	obligatory	Theory of Turbomachinery	1.Introduction of theoretical knowledge of fluid flow in turbomachinery. 2.Studying of energy and exploitation characteristics of turbomachinery in dimensional and non-dimensional forms and their application in mechanical systems. 3. Obtaining of practical skills application of pumps, turbines and fans in power systems.	1. Gaining basic knowledge about the exchange of energy in turbomachinery. 2. Reaching the methods of fluid flow computation in turbomachinery. 3. Understanding the control and the energy efficiency of turbomachinery. Measures of preventing or reducing the undesirable effects of cavitation in turbomachinery. 4. Obtaining practical experience of exploitation of turbines, pumps and fans.
2	MSc-0447	obligatory	Fans and turbocompressors	Mastering knowledge of engineering applications of fans and turbocompressors as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a	Knowledge of types and designs of fans and turbocompressors. Knowledge of the energy parameters and energy balancing. Knowledge of similarity theory to implement the dimensionless parameters - characteristic

fan, blower or turbocompressor as a built-in element with its function.

performance factors. Knowledge of methods of the system working point determination. Knowledge of the energy characteristics of fans/turbocompressors and their significance in establishment of operating regimes of fans/turbocompressors, as well as in their regulation. Knowledge of the operating characteristics change for fans/turbocompressors working with density other than air.

2	MSc-0445	obligatory	Machine design of pumps, fans and turbocompressors	Mastering knowledge of engineering design of pumps, fans and turbochargers. Capacity to work in the design and development offices in the industry of pumps, fans, blowers and turbochargers. Training for innovation of design methods.	Knowledge of procedures for the design of pumps, fans and turbocompressors. Knowledge of the consequences of different approaches. Knowledge of hydraulics, numerical and empirical data used in the design. Practical skills acquired through the project done.
2	MSc-0624	obligatory	Hydraulic turbines	Mastering the theoretical knowledge of fluid flows through the turbine as well as conditions for energy transformation. Definition and determination of the cavitation coefficient in order to protect turbine from cavitation damage. Definition of special factors in order to scale up recalculation from model to prototype characteristics and definition of model universal characteristics and prototype hill charts.	1. Fundamental knowledge of hydraulic turbines, 2. Essential knowledge for the design of turbines, 3. Mastering the optimum turbine operating parameters, 4. Comprehension of flow processes in hydraulic turbines
3	MSc-0637	obligatory	Hydropower measurements	Measurements have a very significant role in engineering practice and research activities. The measurements in hydro energy systems include measuring fluid flow quantities and energy characteristics of hydraulic machinery in order to determine the energy performance of turbines, pumps, fans and other turbomachines. In framework of this subject, the characteristics of valves and methods for determining the cavitation characteristics of hydraulic machines and equipment are	After successful completion of the study program the student has the necessary knowledge in the field of measurements in hydro energy systems, which is extremely important in his future professional activity. Student can in the best way connect the theoretical and practical knowledge of measuring methods, which introduce him into the world of verification and proof of guaranteed or calculation parameters. In the field of research it offers him the extraordinary

studied in detail.

opportunity to discover unknown –
phenomenon research.

3	MSc-0113	obligatory	Hydraulic Torque Convertors	1. Obtaining of theoretical knowledge of hydraulic torque convertors. 2. Introducing the methods of calculating the dimensioning of the impellers and runners in hydrodynamic torque convertors. 3. Gaining of practical experiences of selection and application of torque convertors to the characteristics of the driving and driven devices.	1. Gaining basic knowledge about the energy exchange and torque transformation in the hydraulic torque convertors. 2. Mastering the methods of dimensioning of the torque convertors. 3. Mastering the methods for making constructive and manufacturing documentation. 4. Obtainig practical experience for the selection and operation of hydraulic torque convertors.
3	MSc-0626	obligatory	Hydropower plants and equipment	Connecting theoretical and practical knowledge in fluid mechanics, turbines, pumps and other subjects that can be attended at the Faculty of Engineering as a whole. The development of individual creative abilities in the profession of a designer of hydropower plants. Developing the ability of finding the optimal solution by multi-criteria methods.	1. General and special abilities to exercise the profession of hydropower plants designer well. 2. Choosing the best solution from a number of alternative ones for the specific task. 3. Confidence in professional activities.
4	MSc-0627	obligatory	Skill Praxis M - HEN	The goal of professional practice is that students in addition to theoretical work within subjects at the faculty get to know and experience the jobs in factories, institutes, laboratories and similar commercial enterprises and thereby gain insight into the activities to be performed. During the practice, students must keep a diary in which they enter a description of the tasks performed, and write down their conclusions and observations. Following the practice, students must write a report that is to be discussed about with the subject teacher.	Observing the work practices a student acquires special knowledge of specific business enterprises, production facilities, public services and utilities and the like, so their theoretical knowledge can be applied to specific business practice. It is essential to acquire and develop a talent for communication and insight into professional ethics. Also the student has the ability to meet professional experts from whom they will get a good picture of how their knowledge can be usefully applied.
1	MSc-0446	elective	Pumps and fans	Mastering knowledge of engineering applications of pumps and fans as machines for raising of fluid energy. Capacity to work	Knowledge of types and designs of pumps and fans. Knowledge of the energy parameters and energy balancing. Knowledge of similarity

in practice on energy installations, as well as design of installations that include a pump or blower as a built-in element with its function.

theory to implement the dimensionless parameters - characteristic performance factors. Knowledge of methods of the system working point determination. Knowledge of the energy characteristics of pumps/fans and their significance in establishment of operating regimes of pumps/fans, as well as in their regulation. Knowledge of the pump cavitation characteristics and operating characteristics change for fans working with density other than air.

2	MSc-0318	elective	Application of Turbomachinery	<p>1. Obtaining the theoretical knowledge on construction and design of turbomachines. 2. Training for the project documentation of a turbomachine (pump or fan). The application of practical knowledge of pumps, turbines and fans in the power systems. 3. Reconciliation of operating characteristics of driving machines and hydraulic couplings and torque convertors in the transport means.</p>	<p>1. Gaining basic knowledge about the construction of pumps, fans and other turbomachinery. 2. Mastering the methods for design and manufacturing of project and technical documentation specified machines. 3. Studying the ways of choice of hydraulic torque convertors according to the characteristics of driving and driven devices. 4. Obtaining practical experience of exploitation of hydraulic torque convertors, water turbines, pumps and fans.</p>
2	MSc-0444	elective	Design computations in turbomachinery	<p>Mastering knowledge of engineering numerical turbomachinery design. Capacity to work in the design and development offices in the turbomachinery industry. Training for innovation of design methods and acquiring the basis for academic upgrading in computational fluid mechanics application.</p>	<p>Knowledge of the procedures for turbomachinery design. Knowledge of the consequences of different approaches. Knowledge of hydraulics, numerical and empirical data used in the design. Practical skills acquired by working out the design project.</p>
2	MSc-0647	elective	Mechanical engineering measurements and sensors	<p>Research, development and practice in science and engineering cannot be imagined without the experimental methods that are combined in the field of measurement techniques. The aim of this course is to provide basic and specific knowledge in the field of experimental methods necessary for</p>	<p>Knowledge that can be applied in practice and research work: Linking theory knowledge with experimental work in mechanical engineering - Fundamental knowledge about measurements of some quantities in mechanical engineering - Practical knowledge of methods of measurements of the different quantities -</p>

				mechanical engineers. The subject involves measuring the nonelectrical quantities in mechanical engineering and their transformation into electrical quantities using sensors. Through specific measurements in the laboratory, students are introduced to the field of practical experimental methods.	Knowledge of processing measurement results and determination of the measurement error – Knowledge on possibility of converting non-electrical to electrical quantities and its processing-Knowledge of measurement techniques allows the verification of the theoretical research and modeling process.
3	MSc-0446	elective	Pumps and fans	Mastering knowledge of engineering applications of pumps and fans as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a pump or blower as a built-in element with its function.	Knowledge of types and designs of pumps and fans. Knowledge of the energy parameters and energy balancing. Knowledge of similarity theory to implement the dimensionless parameters - characteristic performance factors. Knowledge of methods of the system working point determination. Knowledge of the energy characteristics of pumps/fans and their significance in establishment of operating regimes of pumps/fans, as well as in their regulation. Knowledge of the pump cavitation characteristics and operating characteristics change for fans working with density other than air.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical

the solution in particular engineering problems which are dealing with fluid flow much easier.

engineering.

1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Industrial engineering

semester	ID		title	goal	learning outcome
1	MSc-0415	obligatory	Quantitative Methods	Goals of the course are introduction of basic and statistical methods for engineering practice. Main goals of the course is identification of problems, methods for their solving, defying problem solving procedures and systems for	After successfully completed course, students should be able to define the problem, identify and apply adequate statistical procedures and obtain competent answers. During the course students master the procedures for use of adequate statistical methods. It is expected that students could be able for interpretation of statistical results for their use in practical problems.

decision making, based on obtained results, i.e. interpretation of numerical results for use in practice.

1	MSc-0413	obligatory	Production and Operations Management 2	Studying the management process of business-production system in its interaction with the environment. Identification of problems in business-production systems and the process of solving them, with implementation procedure. Investigation and design of production macro and micro organizational structure. Management of business-production system and provision of all resources necessary for production normal operation.	Acquisition of knowledge and skills necessary for successful management of business-production systems. In addition, students are able to design production program and production processes. It is of importance their ability to analytically view the complexity of the problem and to solve it by applying contemporary methods.
2	MSc-0417	obligatory	Ergonomic designing	The aim of this course is the acquisition of basic academic knowledge in the field of ergonomic designing, which can be used for designing of different products, as well as for redesigning and improvement of system man - machine - environment. Students should acquire specific practical skills that include an integrated ergonomic approach for the purpose of a comprehensive settlement of various designing problems.	By mastering of the ergonomic designing program, the student acquires the ability to solve all aspects of the various engineering problems by applying science-based ergonomic methods, techniques and recommendations. It is expected that acquired knowledge students can use in daily work and practice, bearing in mind that in almost all branches of industry there is a need for designing, which includes the human factor.
2	MSc-0416	obligatory	Industrial logistic	Achieving competency and academic skills in the process of industrial system design. Special emphasis is focused on development of creative skills and	Curriculum overcome enables converge of the following skills: analysis, synthesis and prediction of solutions in design process based on knowledge applying in practice using professional ethics as well as development of crucial and self-critical thinking and approach.

overwhelm with specific practical skills needed for professional practice using operational research methods, procedures of analysis and synthesis for obtaining final goal which is optimal practical solution.

2	MSc-0569	obligatory	Engineering Economy	The objectives of this course are to guide students in engineering and the respective economic and financial processes and to inform them of the relations, connections and rules by which these processes take place in the generation and selection of optimal variant of projects for the overall success in achieving development goals of enterprise	Mastering this program, student obtains the following general skills: analysis and synthesis and forecasting solutions and consequences; mastery of methods, procedures and processes of research; application of knowledge in practice. He also obtains the following subject-specific skills: solving practical problems using scientific methods and procedures, linking basic knowledge in various fields and their applications
3	MSc-0521	obligatory	Database Systems	The aim of this course is to prepare students for working with complex databases in production companies. The aim of this course is usage of industrial engineering methods and techniques in the creation of different database queries and scripts. Also, the aim of course is usage of complex database for improvement of decision-making process and management of business-production system.	The outcome of this course is to use complex databases in practical work, for solving some problems of industrial engineering like: • Use of complex databases in order to rationalize resources in business- production system, • Improving the quality of decision-making process in solving problems of industrial engineering.
3	MSc-0419	obligatory	Industrial Management	The aim of this subject is that students get know basic principles, methods and techniques of management in general, and especially in industrial enterprises. The aim is that students adopt knowledge and skills which will be	To get know of content Industrial Management the students get know modern knowledge from theory and practice of management in general, and especially in industrial enterprises, when accent is on achievement of competence to strengthen innovation as a key factor of competitiveness in turbulent business environment, local and international.

solid basis for further requiring competences for autonomous and responsible participation in processes of business decisions in contemporary conditions.

3	MSc-0421	obligatory	Operations Research	Course goal is overwhelm with academic and scientific methods and quantitative techniques for obtaining alternative (optimal) solutions of real world problems on which basis user can perform analysis and synthesis of given solutions, make decision and predict consequences.	Solution of concrete problems with application of scientific methods, procedures and techniques using analysis, synthesis and prediction of solutions and consequences as well as overwhelm with methods, procedures and research processes and application of knowledge (gained skills) in practice.
4	MSc-0438	obligatory	Skill Praxis M - IIE	The goal of course is to introduce the production processes in industrial companies and to acquire practical knowledge in the field of work organization and economics of the enterprise. In this course students will be familiar with the work of diagnosing and raising the general level of organization of enterprises and economic business of enterprises. Methods and techniques will be of use to students in their daily performance of engineering jobs.	Mastering of this course students will learn about the production processes in the enterprise, internal transport, terotechnological processes, function of production planning, procurement operations and material storage, economic-financial business of firm etc...
1	MSc-0523	elective	Management Information Systems	The aim of this course is to introduce students to contemporary theoretical and practical aspects of management information systems. Students need to acquire practical knowledge and skills that will enable them to enhance the quality of decisions in the field of industrial engineering, by using the	After passing the exam the student understands the importance of using MIS in solving management problems. Student knows to apply software tools: decision support systems, expert systems, and hybrid systems in solving complex management problems.

contemporary software tools.

2	MSc-0420	elective	Design of logistic and warehouse systems	Achieving competency and academic skills in the process of industrial system design. Special emphasis is focused on development of creative skills and overwhelm with specific practical skills needed for professional practice using operational research methods, procedures of analysis and synthesis for obtaining final goal which is optimal practical solution.	Curriculum overcome enables converge of the following skills: analysis, synthesis and prediction of solutions in design process based on knowledge applying in practice using professional ethics as well as development of crucial and self-critical thinking and approach.
2	MSc-0513	elective	Risk management in Terotechnology	The aim of this course is to acquire the necessary knowledge and practical skills that will enable students to apply maintenance systems based on risk management, due to knowledge in the identification, analysis, risk assessment and decision-making on the basis of these facts.	Outcomes of this course are the following: a) The acquisition of theoretical and practical knowledge in the field of basic systems, methods and strategies of machinery and equipment b) Introduction to the methods of maintenance based on risk, c) RIMAP and RCM models, and d) Application of RCM/RIMAP model in practice.
3	MSc-0574	elective	Organization Design	The aim of this course is to acquire the necessary knowledge and practical skills that will enable students to define the interdependence of the elements of organizational structure and processes so that in a given or anticipated situation organizationally shaped organizational system (enterprise or its parts) achieves the pursued objectives and goals.	Outcomes of thid course arethe following: a) The acquisition of theoretical and practical knowledge in the field of intentional and controlled development and changes in the organization to improve efficiency and effectiveness, and working conditions in the organization b) Alignment of organizational and technical / technological factors and changing of organizational culture and climate and c) Setting the optimal model organization with respect to the objectives and available resources.By the end of the Organisation Design course student will be able to: -tackle an organisation design project -sequence and approach the design effectively - apply various tools and techniques to make good organisation -design decisions -control the consequences and risks of design changes -recognise and address design

					project blockers and challenges.
3	MSc-0520	elective	Man - machine system design	The aim of this course is the acquisition of basic academic knowledge in the field of man - machine system design, which can be used for designing of different products and industrial systems, as well as for redesigning and improvement of system man - machine - environment. Students should acquire specific practical skills that include an integrated ergonomic approach for the purpose of a comprehensive settlement of various designing problems.	By mastering of the man - machine system design program, the student acquires the ability to solve all aspects of the various engineering problems by applying science-based ergonomic methods, techniques and recommendations. It is expected that acquired knowledge students can use in daily work and practice, bearing in mind that in almost all branches of industry there is a need for designing, which includes the human factor.
3	MSc-0524	elective	Modern Quality Approaches	Purpose of the course is to introduce students to concepts and importance of quality in enterprises. Basic principles, methods and approaches are introduced to students. Three main topics are Total Quality Management, ISO 9001:2008 standards and Six Sigma.	After successfully completed projects and course, students should be able to use basic managerial and statistical quality methods. Students are informed about modern and current trends in quality, methods and software for quality improvement, with a possibility of applications.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.

and the impact theory.

1	MSc-0685	obligatory	Fluid mechanics M	<p>The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.</p>	<p>Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.</p>
1	MSc-0201	obligatory	Mechatronics	<p>Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.</p>	<p>Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.</p>
1	MSc-0202	obligatory	Thermodynamics M	<p>Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials</p>	<p>After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.</p>

and air conditioning of corresponding spaces.

Information technologies

semester	ID		title	goal	learning outcome
1	MSc-0508	obligatory	C/C++	<ul style="list-style-type: none">• Introduce to C/C++; Structure of C/C++ and usability.• Simple problems in mechanical engineering using C/C++.• Art of pointers.• Saving acquisition data in files, use that files and discussion results.	After successful completion of the program provided for in this case the student can: <ul style="list-style-type: none">• Programing simple programs in C/C++ to solve problems in mechanical engineering.• Use basic patterns in C/C++.• Use pointers and simple data structures.• Solve simple mechanical engineering problems with acquisition data in files.
1	MSc-0527	obligatory	Object oriented paradigm	<ul style="list-style-type: none">• Introduction to OOP paradigm.• Purposeful use of classes, objects, inheritance, encapsulates, methods and hiding.• Basic knowledge of classes, derived classes, methods.• Object-oriented methodology for designing data structures and applicable programs.• Problems that are naturally solved using object-oriented design and programming methodology.	With acquired knowledge student can: <ul style="list-style-type: none">• to recognize the conditions for using object-oriented design and programming methodology,• to design simple user class and link them with the system classes,• user to design simple methods and their use in system design methods,• to use the programming languages C + + and Java.
2	MSc-0390	obligatory	Algorithms and Data Structures	<ul style="list-style-type: none">• Basic facts of algorithm theory.• Abstract data type and basic implementation.• Data structures in mechanical engineering.• Using standard algorithms in solving simple problems in mechanical engineering.	After successful completion of the program provided for in this case the student can: <ul style="list-style-type: none">• To find data structure to solve the problem.• Use data structures and standard algorithms in solving simple problems in mechanical engineering.• To find suboptimal algorithm to solve smple problems in mechanical engineering.• To use standard algorithms to solve complex problems in mechanical engineering.
2	MSc-0510	obligatory	The Data Exquisite in	Course objective: <ul style="list-style-type: none">• Numerical and mathematical analysis capabilities for each	The acquired knowledge allows: <ul style="list-style-type: none">• That be entered professional do the measurements and

			Mechanical Engineering	measurement. • Design and write programs for analyzing measurements. • Comparison analysis of numerical data processing and analysis software. • Implementation of PHP and JAVA Script.	determine the necessary and forward the required size, • That the measurement is so mathematical, numerical and statistical analysis and then to be graphical and logical preparation for further analysis, • That, using PHP or Java Script, or both, make software to perform accurate data processing which is a pre-determined mathematically.
2	MSc-0190	obligatory	Programmable Control System	Acquisition of knowledge about the application, design, programming and introduction of programmable control systems into industry and contemporary manufacturing. Skill development for solving practical control problems in industry by using computer, information and control technologies and adequate scientific methods.	The student should: 1. Understand the principles, place and role of the programmable control systems in industry and programmable automation, link knowledge of related subjects to apply it in programmable automation; 2. Master scientific methods of analysis, synthesis, design and introduction of programmable control systems in programmable automation; 3. Know practical problem-solving and how to apply computer technology and contemporary programmable control systems.
3	MSc-0485	obligatory	Methods of Optimization	The main goal of this course for the student is to give the necessary knowledge of: • numerical analysis and optimization, • understanding general principles of design optimization • formulating the optimization problems and identify critical elements.	During this course, the student will carry out: • Overview of design optimization • Fundamentals of engineering optimization • Problem formulation • strategies for optimization
3	MSc-0474	obligatory	Introduction to engineering simulations	Introduces to students engineering numerical simulations on continuous media. Understanding of physical laws, boundary and initial conditions. Uniqueness of solution and well posed problems. Recognition of type of PDEs and their influence on additional conditions. How type of approximation depends on type of PDEs. Develop ability to develop simulation code to solve model PDEs.	After completion of this course student is able to recognize type of the problem, and to apply sufficiently additional conditions to get unique solution of engineering problem. Recognize basic finite difference schemes for approximation of typical model partial differential equations. Improve basic programming skills to simulate simple engineering problems. Recognize software structure used to solve engineering problems.
3	MSc-0605	obligatory	Designing	• Prepare inputs for the engineering software	After successful completion of the program

**software for
mechanical
engineers**

based on standard calculations. • Preparation of engineering calculations for effective programming and obtain efficient programs. • Testing and verification of software engineering. Validation of software engineering. • Use SQL to get information from databases. • Use SQL for engineering decision making. • Organization, normalization of data in the database. • Privacy, data archiving. Issues of software licensing.

provided for in this case the student can: • Prepare a budget for programming. • to assess the quality of information obtained from the input data that are processed program written for a defined budget. • use the database for specific problems in mechanical engineering. • use SQL as a generator of low-level information for software engineering.

4	MSc-0382	obligatory	Skill Praxis M - MIT	To provide students with practical experience of staying in an environment in which the student will realize his future career. Identifying the basic functions information system in the field of design, development and production software, as well as roles and tasks of mechanical engineering of information technology in such business system.	Training students to apply previously acquired theoretical and practical engineering and scientific knowledge of information technology to solve specific practical engineering problems in the selected companies or Institutions. Activities to introduce students to selected companies or institutions, way of doing business, management and the place and role of IT engineers in their organizational structures.
1	MSc-0597	elective	Digital system design	•Introducing with: number systems, Boolean algebra and binary logic, logic functions as well mastery of their usage and manipulation. • Mastering of: various types of logic circuits-LC and methods for their analysis and design. • Mastering of handling with integrated digital circuits and oscilloscope.	• Proper understanding of the nature of digital computers and processes inside them. • Manipulating digital computers in hardware and software sense as a part of a digital control systems (DCS). • Using the methods of analysis and synthesis of LC. • Solving of computational nature problems related to the analysis and synthesis of LC, in "off line" mode, by means of digital computers. • Analysis and design of real physical LC.
2	MSc-0522	elective	Distributed Systems in Mechanical Engineering	• Introduction to the paradigm of distributing data • Knowledge of basic protocols for the transfer and sharing of distributed data. • Designing local area networks based on different technologies • Introduction to multiprocessor distributed systems in the automotive and aircraft industry •	Стечено знање омогућава студенту: • to recognize the conditions for the formation of local area networks • to allocate names to resources on the net • to control and manage assigned resources • to understand the multi-processor and redistribution of data among them

Introduction to algorithms that are typical of multi-processor distributed systems

2	MSc-0503	elective	Statistical analysis in mechanical engineering	Goals of the course are introduction of basic and up-to date statistical methods for engineering practice. Main goals of the course is identification of problems, methods for their solving, defying problem solving procedures and systems for decision making, based on obtained results, i.e. interpretation of numerical results for use in practice. Analyses of large sets of data are especially emphases.	After successfully completed course, students obtained knowledge of statistical methods and their use for solving specific problems in practice. They should be able to define the problem, identify and apply adequate statistical procedures and obtain competent answers. During the course students master the procedures for use of adequate statistical methods. It is expected that students could be able for interpretation of statistical results for their practical usage. Also it is expected that students can use and work in available statistical software.
3	MSc-0512	elective	Information Technology Projects Evaluation	Understanding of the importance of the planning process, assessment and evaluation of projects in the field of information technologies. Getting to know different methodological approaches for analysis of IT/IS projects. Learning the sophisticated techniques of financial and economic analysis, as well as standard techniques for management of IT/IS projects. Learning the techniques and routines for identification and monetary quantification of hardly visible costs and effects implied in the implementation of IT/IS projects.	After having attended the module, the student should be able to: identify the project idea, prepare a database with all costs and effects of IT/IS projects, calculate criteria for selection of project alternatives, acquire knowledge and practices for recognition of hardly visible costs and effects of IT/IS projects, organise networks of activities, flows of project resources with choice of optimal paths and minimum costs and assess uncertainty and risk of IT/IS projects.
3	MSc-0608	elective	Information integration of business functions 2	<ul style="list-style-type: none">• Design and management of digital integrated business companies / factory, according to the business performance of integrated company,• Acquiring knowledge, skills and competencies of the information and functional integration of the company,• Integration of engineering, production and business activities• Learn about the business performance of integrated company,•	The acquired knowledge to the student: <ul style="list-style-type: none">• Understand the operation of an integrated business enterprise / factory,• Applies new information and communication technology,• Critically observe production systems and business processes,• Plans computerized activities, processes and systems,• Approves new methods of learning and design,• Develop cognitive traits of creative engineers in

				Training to use commercial software for production management, • Implementation of new information and communication technologies.	computer science, • Participates in project teams of students and experts • Is able to conduct business discussions with business partners.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main components of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge

aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.

that serves as the basis for active participation in other theoretical and applicative courses.

Internal combustion engines

semester	ID		title	goal	learning outcome
1	MSc-0294	obligatory	Engine fuelling and ignition systems	The aims of the course are to provide a comprehensive insight into the subject matter of Engine Fueling, Mixture formation and Ignition processes. Understanding the role, importance and principles of Engine Electronic Control. Broadening existing and acquiring new knowledge in hydrodynamics by studying high pressure phenomena occurring in fuel injection systems. Broadening knowledge in machine design by studying specific issues of high pressure pumps design principles. Broadening knowledge in electromechanics and electronics by studying processes occurring in Ignition Systems. Introduction into the field of Engine Sensors, Electronics and Mechatronics.	Capabilities to develop, design, calculate and chose components of Engine Fueling and Ignition Systems. Capabilities to develop and organize maintenance procedures for both Fueling and Ignition Systems. Abilities related to specific issues of laboratory testing of Fueling and Ignition Systems and components. Developing practical skills for System set up and diagnostics.
1	MSc-0278	obligatory	Engine Working Processes	The aims of the course are: Gaining basic theoretical and practical knowledge about physicality of real engine working processes. Making a complete spark ignition and diesel engine working cycle calculation. Analysis of engine working process integral working parameters and operating characteristics.	Merging a theoretical knowledge of thermodynamics and fluid mechanics, connecting and application on real object – internal combustion engine. Training for basic modeling and calculating of real engine working process, as well as acquiring fundamentals of engine designing. Mastering of engine working parameters and operating characteristics and of the influences of working process

					on operating, energetic and ecologic engine characteristics.
2	MSc-0242	obligatory	Engine Design 1	The aims of the course are to provide theoretical and practical study about engine dynamics, vibrations and design of engine parts. Through the evaluation of engine kinematics, dynamics and engine parts mechanical load and stress students acquires a sense for design of engine parts and complete engine. Basic knowledge about 3D modeling of engine parts and stress calculation using FEM is also provided and enable modern approach to engine design.	The merger of theoretical knowledge of mechanics, basics of strength of constructions and machine elements and its applications on engine design. Training students for engine parts and systems design, modeling and calculation. The acquisition of basic theoretical and practical knowledge required for complete engine designing.
2	MSc-0310	obligatory	IC Engines Mechatronics	The aim of the course is to provide comprehensive insight into the specific subject matter of mechatronics systems used in IC Engines. To gain experience on functioning and using sensors and actuators specific for state of the art IC engines. To get closer acquaintance with the structure and architecture of the IC engine electronic control units (ECU), microcontrollers functions, in general, and methods of ECU software developing and testing.	Ability to integrate specific electronic and mechanical engineering knowledge, with sound understanding of IC Engine mechatronic systems; More complete knowledge of IC Engine control; Ability to form IC Engine specific mechatronic system; Basic competence in ICE ECU programming and software testing; Knowledge in automotive bus communication, especially in ICE ECU data exchange.
2	MSc-0701	obligatory	Supercharging of IC Engines	Acquiring new knowledge on role and importance of turbocharging in IC Engines. Developing skills to calculate parameters of supercharging and match compressor/turbine to desired engine performance. Broadening knowledge of thermodynamics by studying compressor/turbine performance characteristics and processes occurring in intercooler. Broadening knowledge in machine design by studying specific issues of turbocharger design principles.	Understanding the reality of Heat Engines working cycles and complexity of their design. Establishing the Cause & Effect relationship between working cycle and machine design. Capabilities to calculate parameters of IC Engine Supercharging, to make proper selection of Supercharging System components (compressor, turbine, intercooler, Waste-Gate). Abilities related to specific issues of laboratory testing of Supercharging System Components.
3	MSc-0707	obligatory	Ecology of Mobile Power	Acquiring basic knowledge of IC engine's influence on environment. Knowledge of pollutants origin in	Understanding the influence of human activities on environment, especially of

Sources			exhaust of IC engines and the ways of their reduction. Understanding of legal obligations and emission standards. Acquiring basic knowledge of noise sources in IC engines and the methods of noise reduction.	harmful ones. Knowledge of pollutants formation chemistry, the greenhouse gases effects on global climate change, and noise of IC engines. Ability to apply solutions for pollutants and noise reduction.
3	MSc-0705	obligatory IC Engine Testing	To cover the basic knowledge of experimental work in the field of IC Engines. Broadening of measuring techniques knowledge, used in engineering, through acquaintance with specific measuring equipment, devices and software tools used for IC engine testing. Developing of skills required for developing of IC engines test facilities, choice of adequate measuring equipment, devices and auxiliaries for funding IC engine test bench. Developing of skills required for planning, organization and conducting an IC Engine testing.	Practical knowledge in IC engine testing procedures, operations and data analysis. Ability in solving and analysis of practical engineering tasks related to IC engine testing and IC engine test measuring equipment and facilities
3	MSc-0122	obligatory IC ENGINES DESIGN 2	Acquiring new knowledge on role and design features of IC Engine Auxiliary systems - engine cooling & lubricating systems and starting devices. Developing skills to design and calculate working parameters of IC Engine Auxiliary Systems. Practical application and broadening knowledge in the field of Heat Transfer, Machine Design, Tribology and Engineering Materials.	Understanding the Design of complex machines and Devices. Recognition and understanding of the importance of subsystems for proper functioning of the system as whole. Understanding the design principles and role of Cooling System, Lubrication System and Starter System. Capabilities to design and calculate vital components of IC Engine Auxiliary Systems.
3	MSc-0704	obligatory Engine Design Project	Gaining experience through practical work on the design of IC engines. The practical application of knowledge from previous IC engines courses, expansion and acquisition of new knowledge in the field of design and calculation of machines, materials and production methods of machine parts. Introduction to modern methods of design in mechanical engineering, especially in the field of IC engines. Understanding and gaining practical experience in working with computer aided design	Understanding the whole complex mechanical structures, the connection of individual parts and components, ability to design a functional and well-designed machines. The ability of practical application of modern software tools for designing in mechanical engineering. The capability to design, making good material and production methods selection of the most important parts of

and calculation methods (CAD - 2D, 3D, CAE).

internal combustion engines. Selection and dimensioning of auxiliary systems and components needed for proper engine functioning.

4	MSc-0709	obligatory	Skill Praxis M - MOT	Acquiring practical knowledge of mechanical engineer's duties. Gaining knowledge about company's structure, management and quality system. Practical knowledge of manufacturing processes and corresponding machine tools. Broadening and acquiring new knowledges in the fields of IC engines research and testing.	Understanding company's structure and connections between various company parts. To comprehend the importance of teamwork in everyday engineering practice. Gaining practical skills in the field of CAD/CAE/CAM/CAT.
1	MSc-0651	elective	Internal combustion engines	The aims of the course are to provide a comprehensive insight into the subject matter of Internal Combustion Engines (theoretical operating cycle, real operating cycle, engine systems, engine operating characteristics). It is intended for students of the Internal Combustion Engines module as an in-depth introduction into studies of specific areas of Internal Combustion Engines, as well as for students of modules which require knowledge of Internal Combustion Engines as a power unit (Motor vehicles, Naval Architecture, Railway Mechanical Engineering, and Material Handling, Constructions and Logistics).	Acquired theoretical and practical knowledge of Internal Combustion Engines. The ability to link fundamental engineering branches of thermodynamics, fluid mechanics, mechanics, strength of materials etc. into a complex unit such as engine. The ability of competent approach to engine selection, organization of exploitation and maintenance. Acquisition of solid base for tackling specific problems, design and construction of Internal Combustion Engines.
2	MSc-0702	elective	Diagnostic and Maintenance of IC Engines	Practical application of statistical methods for analysis and predictions of engine failures. Expanding knowledge in the field of tribology through study of engine parts friction, wear and lubrication. Basics understanding of On-Board Diagnostic (OBD). Application of modern computer-based diagnostic methods. Gaining knowledge of engine repair processes, especially of major overhaul.	Application of statistical methods for analysis of machine and devices failures. General structure and realization of machines and devices maintenance and overhaul processes. Ability to analyse and establish the cause of engine failure. Application of OBD procedures. Ability to organize and supervise engine maintenance and major overhaul processes.
2	MSc-0703	elective	Computer Based Measurements	The aim of the course is to provide comprehensive insight into the digital acquisition systems (DAQ),	Ability to integrate sensors and DAQ hardware in measurement chain in order

measurement systems and, mainly, their usage in the field of testing of systems covered in the Mechanical Engineering; To introduce students the world of virtual instrumentation and graphical programming environment (LabVIEW) which is dedicated to development of DAQ applications. To gain experience on functioning and using DAQ systems through numerous, real world, examples. To get closer acquaintance with the sensors, and digital acquisition software & hardware, in general, and methods of DACQ software developing and testing.

to fulfill specific requirements in the field of mechanical engineering system testing & measurements. Ability to build and test software application (LabVIEW virtual instruments) for measurement and automation of various mechanical engineering systems. Practical knowledge in computer based measurements of fundamental engineering data

3	MSc-0708	elective	Reciprocating Compressor	Acquiring basic knowledge on reciprocating compressors. Increased knowledge of thermodynamics through the study of compression of real gases, gas mixtures and moist gases, and the study of actual working cycles of reciprocating compressors. Expansion and acquisition of new knowledge in the field of Engineering, through the study of basic structural elements, systems and auxiliary equipment of reciprocating compressors. Developing skills for the design of reciprocating compressors, selection, testing, installation and maintenance in service.	Understanding of complex real working cycle of reciprocating compressors working with real gases; Understanding of complex structural design of such machines. Development of critical thinking which leads to sound understanding of cause-effect relationship between working cycle and machine design; Ability to design and accomplish selection, testing, installation and maintenance of reciprocating compressors in service.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical

				finding the solution in particular engineering problems which are dealing with fluid flow much easier.	work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Material handling, constructions and logistics

semester	ID		title	goal	learning outcome
1	MSc-0295	obligatory	Computer aided design in material handling practice	Basic goals of this course are: 1) introduction to finite element method and applications in design of structures for material handling machines, 2) gaining the practical skills for 2D and 3D design and modeling of material handling machines	Students gain the practical skills for idealization and analysis of structural systems and develop critical approach in design. Also, they get knowledge in common used software packages in design of material handling machines.
1	MSc-0187	obligatory	Facility layout and industrial logistics	Introducing the students into the factories, factory facilities, transport and warehouse systems design process logic is the main goal. Development of the	Student is introduced into design process logic and main mathematical models used in the production, transport, and

				student system design creative and innovative abilities in order to increase the production, warehouse and logistic activities efficiency, contributing to the overall country industrial development is also the main issue.	warehouse systems modeling. Student is learn how to determine main system and subsystem performances representing the design solution efficiency or designer goals fulfillment degree.
2	MSc-0173	obligatory	Structural and stress analysis	Basic goal of this course is introduction to principles in design and calculation of steel structures for wide range of material handling machines (mining machines, earthmoving machines, cableways and lifts). Also, goal is development of student creative skills for designing the light but safe structures, i.e. rational structures.	Student expands the knowledge in structural analysis for material handling machines with emphasis on identification of specific load/stress cases which may lead to failures of structures.
2	MSc-0119	obligatory	Transport and logistic systems design	Introducing the students into the advanced transport, warehouse and logistic (warehouse-distributive) systems design process logic is the main goal. Development of the student system design creative and innovative abilities in order to increase the material flow, warehouse and logistic activities efficiency, contributing to the overall country industrial development is also the main issue.	Student is introduced into design process logic and main mathematical models used in the transport, warehouse and logistic (warehouse-distributive)systems modeling. Student is learn how to determine main system and subsystem performances representing the design solution efficiency or designer goals fulfillment degree.
2	MSc-0308	obligatory	Conveying and Material Handling Machines	The main goal of this course is to acquaint students with material handling machines and conveying machines, types and design solutions and principles of work. The goal is to introduce students to master the practical skills needed to perform the engineering profession, such as the main machine parameters, load analysis, selection of drive units and calculation of the capacity.	Mastering the curriculum students obtain general abilities that can be applied in engineering practice: knowledge and understanding of the principles of material handling and conveying machines, selection of parameters, defining the load of support structure, selection and calculation of drive units and determine the capacity of machines in operation.
3	MSc-0127	obligatory	Eco Design	The main objective of this course is to achieve competence and academic skills in the field of eco design and sustainable product development. The goal is mastery of the methodologies to define strategies to improve products and reduce the	Mastering the curriculum the student acquires the ability to master the strategies of eco-design for a more innovative environmental product improvement at the work on product

harmful effects of products on the environment, and understanding of the impact of products on the environment throughout its life cycle and innovative approach to obtaining environmentally improved products.

development. Student masters the skills, tools and practical ability to obtain sustainable products, and acquire the ability to monitor environmental directives and communication with organizations that impose environmental requirements.

3	MSc-0139	obligatory	Cranes Design	The main objective of this course is to achieve competence of students to master the principles of cranes design and that is able to be incorporated into the cranes design process in the future engineering work. The goal is to master specific practical skills for the selection of drive units, calculation of support steel structures of cranes and to get the knowledge on the standards for calculation, as well as realization of technical documentations.	Mastering the curriculum students obtain general abilities that can be applied in engineering practice: the demands that are placed to the designer, linking basic knowledge in the field of material handling machines and equipment, to master methods and procedures in cranes calculations, capacity of analyzing alternative solutions in the design process, developing skills in presentation of projects.
3	MSc-0102	obligatory	Mining and Construction Machines	Basic course goals (objectives): 1) introducing students with specificities of working process, design, modeling and calculation of basic (fundamental) subsystems of construction and mining machines and appliances, primarily machines for continuous excavation and machines for crushing and screening. 2) mastering practical skills which are necessary for design and calculation of construction and mining machines.	Mastering the curriculum student gains (acquires): 1) general skills which can be used in engineering practice (analysis, synthesis and anticipation of solution and consequences; development of critical approach) 2) specific skills (use of knowledge gain in fundamental academic fields on solving of concrete problems in field of construction and mining machines).
4	MSc-0480	obligatory	Skill Praxis M - TKL	The goal of course is to acquaint students with the resources, machines and devices in the field of machinery used in various industries, especially in industry, construction, mining, transport, tourism, energy, process engineering, service industries, etc.. As well as to introduce students with the basic technology of making steel tubes volume up to 500 mm.	The successful completion of course students are introduced to: 1 Production processes in companies that produce or use the funds for machinery, 2 Intermittent and continuous internal transport, 3 Processes, maintenance of equipment and machinery for machinery, and others.

3	MSc-0491	elective	Fundamentals of Mining and Construction Machines Dynamics	Basic course goals (objectives): 1) introducing students with specificities of dynamic processes of construction and mining machines . 2) mastering practical skills which are necessary for analysis of dynamic behavior of construction and mining machines.	Mastering the curriculum student gains (acquires): 1) general skills which can be used in engineering practice (analysis, synthesis and anticipation of solution and consequences; development of critical approach) 2) specific skills (use of knowledge gain in fundamental academic fields on solving of concrete problems in field of construction and mining machines dynamics).
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics	Student should gain knowledge in thermodynamics	After completing the course, including

M	and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.
----------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Motor vehicles

semester	ID		title	goal	learning outcome
1	MSc-0711	obligatory	System Effectiveness	The objectives of the course are to provide a comprehensive insight into the issues (analysis and design) of system effectiveness, primarily in the areas of reliability and availability of technical systems (vehicles), maintenance, maintainability and life cycle. The course is intended for students of Motor Vehicles department, and it provides insight into the analysis and design of the effectiveness of the system (vehicle).	Mastering the study program a student obtains general and subject-specific skills which are in a function of the contemporary approach to the analysis and design of technical systems (vehicles). The students acquire a basic ability to access the full access to today's analysis and design effectiveness (reliability, maintenance, maintainability), a perception of the life-cycle systems, and solving complex problems in this area.
1	MSc-0437	obligatory	Vehicle Design	Mastering the methods and techniques of vehicle design considering: (a) basic requests regarding whole vehicle and vehicle systems (b) characteristics of vehicle systems and their influence on quality of vehicle (duration and cost of development, testing, manufacturing and recycling) (c) regulations considering the variety of vehicle categories and vehicle systems categories	Application of acquired knowledge in design of vehicles and vehicle systems, which implies knowledge of vehicle systems characteristics and their individual and synergetic effect on vehicle characteristics. Possibility to predict the impact

					of new solutions used in design of vehicle systems to usability of vehicle.
2	MSc-0450	obligatory	Vehicle Mechatronics	Course objectives are designed to meet the needs of the 21st Century automotive industry for graduates students with the necessary skills and understanding in mechatronics. Students should be able to deal with a wide range of activities that include researching, designing, developing, and testing of mechatronic systems in motor vehicles.	Students obtain the following general ability: ☒ analysis, synthesis and forecasting of solutions and consequences ☒ mastering the methods, procedures and processes of research, ☒ application of the acquired knowledge into practice. Students acquire and subject-specific skills: ☒ thorough introduction to the vehicle mechatronic systems, ☒ solving concrete problems by using scientific and engineering methods and procedures, ☒ development of the skills for the use of knowledge in the field of mechatronics in the vehicle.
2	MSc-0440	obligatory	Vehicle drive and running gears	Conquering of knowledge and skills for overviewing and understanding for problems related to motor vehicle design, calculation of vehicle systems and components responsible for transmission, suspension and steering, and their influence on vehicle characteristics and behaviour.	By conquering of this course, students achieve theoretical, experimental and practical knowledge and capabilities in means of methods and procedures for determination, estimation and improvement of certain vehicle systems characteristics, responsible for power transmission, as well as steering and suspension systems, which determine vehicle dynamic characteristics and behaviour.
2	MSc-0434	obligatory	Automotive Friction Systems	Student acquires necessary theoretical and practical knowledge and becomes being able to make a selection or to design a corresponding vehicle friction system (main clutch,	General: - analyze, synthesize, solution prediction, consequence estimation - acquiring research

braking system, friction materials) both in the case of building a new vehicle type of any vehicle category or in the case of reconstruction, re-make or maintenance of an existing vehicle type. Student also acquires basic knowledge on tribology of friction systems as well as knowledge necessary for formal verification of a given friction mechanisms or material.

methods, procedures and processes - development of critical and self-critical approach and approach - application of knowledge in practice - professional ethics. Subject - specific: - acquiring knowledge in teaching area (T/A) - knowing and understanding of T/A and profession - resolution to T/A practical problems - synergy of knowledge fro different T/A - follow-up and application of professional novelties - T/A knowledge application - application of ICT in T/A

3	MSc-0436	obligatory	Vehicle Testing	Primary goal of this subject is to provide objective information about vehicle and vehicle assemblies and parts quality as well as exploitation conditions and loads, environmental impact, etc., in different phases of vehicle design, manufacturing and exploitation.	1. Acquirement of theoretical-experimental knowledge in the field of vehicle testing. 2. Mastering the contemporary methods in the field of vehicle testing. 3. Training of students for testing of vehicle assemblies, parts and systems through practical examples in laboratory, field and exploitation testing.
3	MSc-0441	obligatory	Vehicle body structure	Aims of this course include achieving of competences to conquer specific knowledge and skills needed for overwiewing and understanding of problems related to construction, calculation, testing and verification of support structures of different categories of vehicles.	By conquering of this course, students achieve general capabilities for conquering methods and procedures pointed to identification of vehicle support structures behaviour, which is assumption for optimization of constructive solutions. Also, students conquer a course-specific capabilities related to design and calculation

					of support structure for specified vehicle, according to actual regulations.
3	MSc-0435	obligatory	Vehicle Maintenance	Student acquires relevant theoretical and practical knowledge about after sales activities of a vehicle manufacturer, and in particular concerning vehicle maintenance and the ways of establishing a system of authorized service organizations taking into consideration that without application of an appropriate maintenance system there will be no normal vehicle operation nor vehicle usage. An automotive engineer must know how to make a vehicle, but also how to use and maintain it in order to enable its mission to be fulfilled in all usage conditions. An automotive engineer must be educated and trained to design so called "Vehicle Maintenance System" i.e. to design programs and plan of preventive, corrective and combined maintenance as well as to design vehicle service technology and facilities in which it can be applied.	General: - analyze, synthesize, solution prediction, consequence estimation - acquiring research methods, procedures and processes - development of critical and self-critical approach and approach - application of knowledge in practice - professional ethics. Subject - specific: - acquiring knowledge in teaching area (T/A) - knowing and understanding of T/A and profession - resolution to T/A practical problems - synergy of knowledge fro different T/A - follow-up and application of professional novelties - T/A knowledge application - application of ICT in T/A
4	MSc-0452	obligatory	Skill Praxis M - MOV	Course objective is to introduce students to manufacturing and technological processes and specific activities concerning vehicle development, production, exploitation, maintenance and revitalization.	In real manufacturing conditions students acquire insight in whole process of vehicle and vehicle components production, exploitation, maintenance and revitalization according to course curriculum.
2	MSc-0712	elective	Vehicles and Environment	The goal of this subject is to give the students an insight into effects vehicles have on the environment. Preservation of the environment and minimization of the negative impacts of driver-vehicle-environment system are the basis of modern vehicle development and exploitation. Therefore a more detailed analysis of these effects in this case are a prerequisite for creating a modern engineer, not only in the field of motor vehicles.	By completing the planned activities students get to focus their engineering resources to modern trends of design and development of vehicles and their exploitation. These trends are largely based on global and local environmental requirements

which are also prerequisites of progress in this area in the modern world.

2	MSc-0451	elective	Systems Engineering	Course objectives include the achievement of competencies and academic skills as well as methods for their acquisition, in the field of engineering systems. The goals arising from basic tasks and determine the specific results that should be realized within the subject and represent the basis for the control of the results achieved.	Students obtain the following general ability: - analysis, synthesis and forecasting of solutions and consequences - mastering the methods, procedures and processes of research, - application of acquired knowledge into practice. Students acquire and subject-specific skills: - thorough introduction to systems engineering, - solving concrete problems by using scientific and engineering methods and procedures, - development of the skills for the use of knowledge in the field of engineering systems.
3	MSc-0713	elective	Intelligent vehicle systems	The goal of intelligent vehicles and accordingly intelligent vehicle systems is to augment vehicle autonomous driving either entirely or partly for the purposes of safety, comfortability, and saving energy. The tasks of intelligent vehicles become more challenging due to dynamic change of complex environment perception and necessity for sensing, modeling and prediction of different influencing factors on the vehicle performance. Autonomous intelligent vehicles have to perceiving and modeling environment in order to control the vehicles. The vehicle motion control faces the challenges of strong nonlinear characteristics due to high mass, especially in the processes of high speed and sudden steering/braking. It needs processing, modelling and prediction non-linear changes in the vehicles system operation based on large amounts of data from multi-sensors and complex dynamic changes in an environment. Course objective is to provide an understanding the design	Course outcomes are development of student's abilities to: a) understand requirements being imposed to intelligent vehicle and its systems, assemblies, sub – assemblies, and parts, b) analyze the vehicle system operation and understand influences of the new intelligent solutions in the vehicle systems design on the vehicle overall performance and quality of use c) application of artificial intelligence techniques in development of intelligent solutions of the vehicle systems, d) analyze, understand and

and development process of intelligent vehicle systems and to develop students' skills and knowledge in the area of intelligent vehicle systems development.

reconcile the new intelligent solutions in the vehicle system operation with legislation related to the specific vehicle systems and sub systems.

3	MSc-0439	elective	Forensic Engineering	Student is enabled to apply forensic engineering methods, particularly in the area of motor vehicles, which comprises analyses and reconstruction of road accidents, vehicle damage estimation and vehicle value estimation based on case study principles. Analogous methods will be applied in other filed of mechanical engineering, depending on the interest of students.	General: - analyze, synthesize, solution prediction, consequence estimation - acquiring research methods, procedures and processes - development of critical and self-critical approach and approach - application of knowledge in practice - professional ethics. Subject - specific: - acquiring knowledge in teaching area (T/A) - knowing and understanding of T/A and profession - resolution to T/A practical problems - synergy of knowledge fro different T/A - follow-up and application of professional novelties - T/A knowledge application - application of ICT in T/A
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of	Learning the topics from the course student will get the knowledge about basic principles

fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.

in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.

1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Naval architecture

semester	ID		title	goal	learning outcome
1	MSc-0273	obligatory	SHIP	The aims of the course are to familiarize students	1) Basic knowledge about ship

RESISTANCE

with: 1) fundamentals of ship hydrodynamics; how elementary ship form parameters affect ship resistance; 2) how to determine resistance for conventional ships types by applying standard engineering methods and by analyzing the results of model tests; 3) unconventional types/forms of ships from the aspect of ship resistance (shallow draught river vessels, planing and semi-displacement high speed craft, etc.).

hydrodynamics needed for the design of conventional types of ships. 2) Ability to do calculations of ship resistance at the common engineering practice level. 3) Knowledge about basics of model tests and extrapolation of results from model to ship scale. 4) Basic knowledge about unconventional ship types and their forms.

1	MSc-0288	obligatory	Ship Strength 1	The aims are to explain: basic modes of ship structure failure and limit state assessment of ship structure, general simplification of the hull mathematical model and the concept of strength calculations by using analytical and numerical methods.	A thorough knowledge about the concept of ship strength calculations in contemporary shipbuilding practice. Qualification for practical application of analytical methods of theory of elasticity in direct calculations of ship structures and analysis and development of classification societies' rules.
2	MSc-0197	obligatory	Ship Structures 2	A thorough explanation of the hull girder longitudinal strength calculation. An explanation of specific requirements that have to be met by the hull of the three most prominent ship types: a container ship, a bulk carrier and a tanker.	The student should be able to practically perform hull girder longitudinal strength calculation according to classification societies' rules. A thorough knowledge should be acquired of specifics, general conception and the hull structural members of tankers, bulkers and container ships.
2	MSc-0695	obligatory	Buoyancy and Stability of Ship 2	To cover the advanced knowledge of Naval Architecture connected to ship buoyancy and stability: ship loading, flooding, damaged ship stability and grounding. It is a continuation of the course Buoyancy and Stability of Ship 1.	Ability to solve and analyze practical engineering tasks connected to ship loading/unloading, damaged ship stability and grounding. Practical knowledge of ship flooding calculations, according to international regulations.
2	MSc-0178	obligatory	Ship Propulsion	The aims of the course are to familiarize the student with various types of ship propulsors (specifics, advantages and drawbacks, selection of the best propulsor etc.). Practical training should enable the student to select/design the most adequate propulsor by applying common engineering methods, to use computer for those	The student should be familiar with various types of ship propulsors and propellers in particular, their advantages and drawbacks, the concept of ship propeller design by applying common engineering methods, how to determine the needed ship engine power output.

activities, to know how to determine necessary engine power.

3	MSc-0121	obligatory	Marine Turbines and Boilers	Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results.	Student acquires specific capabilities which are needed for carrying out professional activities: analysis, synthesis and anticipating the results and consequences; use of knowledge from different areas for solving specific problems.
3	MSc-0706	obligatory	Marine Engines	The target of this subject is to give a comprehensive insight into the specific matter of IC marine engines, two-stroke, as well as four-stroke ones, and especially of high power engines with complex engine mechanism. The subject is intended for the students of Shipbuilding department who will be given an introduction for further later research into construction specifications of this class of engines and engine systems during professional practical work experience.	General specifications: Adopted basic theoretical and practical knowledge in the field of IC marine engines where fundamental and applied scientific disciplines are entangled. Students acquire basic ability for competent approach to the choice, organization of exploitation and maintenance of engines in the field of marine engine systems
3	MSc-0697	obligatory	Seakeeping	To cover the basic knowledge of Naval Architecture connected to ship motion in waves (seakeeping).	Knowledge in solving and analysis of practical engineering tasks connected to ship motion (roll, heave, pitch) in regular and irregular waves.
3	MSc-0696	obligatory	Ship Design	To integrate the knowledge acquired from previous courses of naval architecture, and to develop knowledge and skills for the basic ship design.	Ability to develop ship design, with the corresponding calculations, plans and technical documentation, for various ship types.
4	MSc-0089	obligatory	Skill Praxis M - BRO	The student gains practical experience in the occupational environment where he will pursue his future career. He identifies essential functions of the business system in the domain of design, development and manufacturing as well as the role and tasks of a naval architect within such business system.	The student should gain practical experience in the way of organizing and functioning of the environment where he will apply the acquired expert knowledge, identify models of communication with his colleagues and business information flows, identify fundamental processes in design,

					manufacturing, maintenance within the context of his future competence, establish personal contacts and acquaintances he will make use of during his schooling, or when applying for job in the future.
2	MSc-0312	elective	Ship Strength 2	The aims of the course are to explain the basic principles of numerical methods for structural analysis, theoretical and practical fundamentals of finite element method and to provide a thorough explanation of finite element method application in ship structure design.	A thorough knowledge about the concept of structural analysis by applying finite element method as one of the most significant methods for structural analysis in contemporary engineering practice. Qualification for practical application of a commercial FEM program package in direct computations of ship structure.
3	MSc-0143	elective	Ship Maneuvering	The aims of the course are to make the student familiar with: 1) Essential features of ship maneuverability so that the navigation is as safe as possible; 2) Standard tests and criteria for ship maneuverability estimation; 3) ITTC and IMO regulations; 4) Ship design in respect to its maneuverability (course keeping, turn ability, response to rudder deflection etc.).	The student should know: 1) Basic features of ship maneuverability and criteria for its estimation; 2) To interpret regulations for maneuverability and to conduct maneuverability tests; 3) To know which measures should be undertaken in ship design to provide satisfactory ship maneuverability.
3	MSc-0494	elective	International Maritime Regulations	To cover the basic aspects of International Maritime Regulations, their evolution and development, and (especially) their influence on ship design. Critical analysis of the present regulations.	Understanding of the basic concepts of maritime regulations, their development and their influence on ship safety, environment, and ship design.
3	MSc-0533	elective	Software Application in Ship Design	To cover the application of computer program packages for ship design and basic ship calculations.	Practical knowledge in applying computer programs for developing ship form, hydrostatic computations, power prediction, hull structure scantling, seakeeping and ship design.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system.

of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.

This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.

1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Process engineering and environment protection

semester	ID		title	goal	learning outcome
1	MSc-0292	obligatory	Mechanical and hydromechanical Operations and Equipment	The purpose of subject is for students to get knowledge about mechanical and hydromechanical processes and equipment. Through the semester students' projects, students get creative and specific practical skills for construction of process equipment. The laboratory exercises have the aim to give appropriate knowledge to students about examination of process equipment during the production as well as the exploitation process.	After successful course attending students get ability for: analysis, synthesis and predicting solutions and consequences; developing of critic and self critic thinking and approach; practical knowledge implementation; professional ethic; connecting knowledge from different subjects and their implementation; developing skills and abilities for knowledge implementation in adequate area.
1	MSc-0276	obligatory	Transport phenomena in process industry	Acquiring the necessary knowledge to understand the transport phenomena of heat and mass transfer in the process industry. Application of steady and unsteady heat and mass transfer in phases (two or more component fluids) in process equipment.	The understanding of fundamentals of heat and mass transfer processes accompanied with multiphase fluid flow. Estimation procedures for the intensity of heat and mass transport and pressure drop in chemical engineering.
2	MSc-0323	obligatory	Biotechnology	The purpose of subject is for students to get knowledge about basic processes and equipment, which is used in biotechnology. Through the semester students' projects, students get creative and specific practical skills for construction of process equipment. The laboratory exercises have the aim to give appropriate knowledge to students about examination of process equipment during the production as well as the exploitation process.	After successful course attending students get ability for: analysis, synthesis and predicting solutions and consequences; developing of critic and self critic thinking and approach; practical knowledge implementation; professional ethic; connecting knowledge from different subjects and their implementation; developing skills and abilities for knowledge implementation in adequate area.
2	MSc-0180	obligatory	Heat transfer operations and equipment	Analysis of the heat transfer operations and apparatuses and assessment of their role in modern industry. Understanding the most commonly used types of heat transfer apparatuses - their design and calculation procedures.	The mastery of calculation procedures needed to analyze the heat transfer operations - the heat balance, determination of the operational line and driving force. The mastery of calculation procedures for sizing of the most commonly used types of tubular, plate

					and contact heat exchangers.
2	MSc-0301	obligatory	Chemical and Biochemical Operations and Reactors	<p>The purpose of subject is for students to get knowledge about theories of kinetic and dynamic of physical-chemical transformations in various technological processes. Influence of process parameters to gaining conditions for physical and chemical equilibrium is separately considered. Getting knowledge about basic models of chemical reactors, types of chemical reactions, rules used for qualitative and quantitative description of complex physical-chemical phenomenon and mass and heat balance equation, gives students basic for independent projecting of technologies and systems of process industry.</p>	<p>Successful completion of the study program the student acquires the knowledge necessary to understand the kinetics of chemical reactions and to master the methodology of calculation of chemical processes and reactors. Introduction to basic models of chemical reactors and material equations and thermal balance should allow students to independently analyze the real process, that the application of engineering and scientific methods to be able to design processes and systems.</p>
3	MSc-0162	obligatory	Mass transfer operations and equipment	<p>Analysis of the mass transfer operations and apparatuses and assessment of their role in modern industry. Understanding the most commonly used types of mass transfer apparatuses - their design and calculation procedures.</p>	<p>The mastery of calculation procedures needed to analyze the mass transfer operations - the material balance, determination of the operational line and driving force. The mastery of calculation procedures for sizing of the most commonly used mass transfer apparatuses.</p>
3	MSc-0124	obligatory	Air Pollution Control	<p>The goal of course is a review of basic design devices used in facilities whose purpose is the air pollution control. This is achieved through a review of the basic construction of apparatus for the purification of gases and review of methodology for calculations commonly used types of these devices. In this way the student masters the skills of designing these facilities and individual devices.</p>	<p>Upon completion of the course is expected that the candidate has mastered the skills related to analysis and evaluation of application of air pollution control devices for a particular purpose. The knowledge that the student acquire the specific technical solutions, selection of treatment methods and equipment enabling the understanding of basic principles essential for the design of air pollution control installations and calculation of particular devices.</p>
3	MSc-0363	obligatory	Design, construction and	<p>Objective of the course is to introduce students to different stages of construction, from technical</p>	<p>Main outcome of the course is to teach students to independently run object</p>

			operation of processing systems	documentation preparation and obtaining the necessary approvals to construction and exploitation. Students learn about with the contents of the project. In the second part of the course acquire basic knowledge related to activities that follow design of processing industry facilities (power supply, operating fluids, transport, water flow etc.). Part of the course deals with the economic evaluation of investments.	construction. This includes project documentation preparation and object construction. After successful completion of the study program, student is capable to foresee the extent of necessary design work in processing industry, as well as to plan necessary installation for production plants.
3	MSc-0125	obligatory	Waste and wastewater management	In this course, students will gain a solid basic and specific knowledge in the field of waste management and wastewater management. Laboratory exercises give students the opportunity to solve the various practical problems and perceive gained theoretical knowledge.	Knowledge that students acquired about the specific technical solutions, the choice of methods of use waste and wastewater treatment equipment enabling the assessment of basic principles relevant for the design of these plants.
4	MSc-0499	obligatory	Skill Praxis M - PTH	The goal of course is to acquaint students with the resources, machines and devices used in various industries, especially in the food and pharmaceutical industry, chemical industry, oil refining, gas, non-metals and building materials, metallurgy, energy, communal activity. The practice should enable students to easily master the subject matter of vocational subjects.	The successful completion of course students are introduced to: 1.processes and equipment used in the processing industry, 2. designing methods of processing plants, 3. test methods of processing plants and equipment, and others.
1	MSc-0403	elective	Measurements and Control in Process Industry	Introducing the candidate with the principles of process measurement and control of the process using the measured values. After the course candidates will be capable to independently perform statistical processing of measurement results and evaluation of measurement uncertainty. The process of accreditation of laboratories and regulatory organizations.	Upon completion of the course is expected that the candidate is familiar with the basic measurements and instruments used in measurement and control in process systems. Also it is expected that the student is able to independently plan experimental measurements and work in laboratory and also to evaluate the measurement uncertainty. Basic knowledge about the accreditation of laboratories candidate receives through the consideration of the basic requirements of relevant standards.

2	MSc-0594	elective	Industrial furnaces and boilers	The goal of course is that students acquire the necessary skills to work on designing, maintenance and operation of industrial furnaces, and basic knowledge necessary for the maintenance and exploitation of industrial boilers. In addition to the courses students need to learn a methodology for energy balance and the basic principles of rational use of energy in industrial furnaces and boilers.	A student shall be given the necessary skills to work on design and the organization of maintenance in industrial furnaces, and the planning of maintenance and operation of industrial boilers. They give a basis to work on projects for rational use of energy in industrial furnaces and boilers.
2	MSc-0183	elective	Concepts of environmental and workplace protection	The main course objectives are related to introduce students to environmental problems, natural hazards and human impact on the environment. In order to solve problems, students will be acquainted with the physics and chemistry of the environment, atmospheric phenomena, the basics of microbiology and ecology.	Based on lessons envisaged to overcome the students will be able to make independent decisions related to environmental management, sustainable development, impact assessment of projects and facilities on the environment. Especially important is the knowledge that students acquire in terms of life cycle analysis of products and processes.
2	MSc-0589	elective	Energy in process engineering	Objective of this course is that students master basic skills of energy use in the industry in order to to adequately deal with the practical matters of rational use of energy and maintenance of energy equipment and systems in industrial companies. In addition, basic knowledge of the transformation and energy use are essential for the understanding of matter from other subjects of process engineering and environmental protection.	Understanding the operation of energy equipment and technologies and principles of their rational use; making the energy balance of industrial enterprises and implementation of methodology for defining the energy losses of equipment and installations in industrial plants.
3	MSc-0511	elective	Combustible, technical and medical gases	The aim of this course is to familiarize students with the fuel characteristics, technical and medical gases, and to acquire academic skills and competencies for selection and calculation of equipment of gas installations. Through this course student mastery specific practical skills for work in the design and calculation of pipelines and fittings, storage tanks and other equipment for gas. Through laboratory student acquire knowledge related to testing of equipment for gas.	Successful completion of the study program the student receives the following general skills: analysis, synthesis and forecasting solutions and consequences, and develop critical thinking and self-critical approach, application of knowledge in practice, professional ethics, linking knowledge from different fields and their applications, development of skill and dexterity in the use of knowledge in the

					field of distribution and transportation of natural gas storage and technical gases.
3	MSc-0145	elective	Drying and drayers	Students will be introduced to technical bases of materials drying process. The goal of this course is a review of the dryers basic constructions. Through this course students acquire skills and knowledge to recognize problems that occur in complex drying processes.	Successful completion of the study program student acquires specific skills in function of quality performance of professional activities. It is anticipated that students acquire knowledge on specific technical solutions in the fields of drying materials, as well as being able to analyze complex technical solutions.
3	MSc-0622	elective	Technical regulations	Objective of the course is that students acquire academic skills and academic competencies for application of technical regulations. Through teaching activities student acquires creative skills and master specific practical skills for carrying out professional tasks - design in general.	By successful completion of the study program student acquires the following skills: analysis, synthesis and prediction of solutions and consequences; development of critical thinking and self-critical approach; application of knowledge in practice; professional ethics; correlation of knowledge from different fields and their applications; development of skill and proficiency in the use of knowledge in field of technical documentation.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection

				engineering problems which are dealing with fluid flow much easier.	between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Production engineering

semester	ID		title	goal	learning outcome
1	MSc-0268	obligatory	Manufacturing Automation	The student should acquire knowledge of the application, design and introduction of modern manufacturing automation, master the skills of practical problem-solving in the domain of automation by using computerized, information, control, manufacturing and other technologies and appropriate scientific methods.	The student should understand the principles of modern manufacturing automation, develop critical approach to social, economic, manufacturing and other effects generated by introducing automation to manufacturing process, combines knowledge of related subjects in order to apply it in automation, master scientific methods of analysis, synthesis, design and introduction of

					manufacturing automation system, develop capability to use computerized technologies and modern control systems in manufacturing automation.
1	MSc-0290	obligatory	Industrial robots	The student should acquire fundamental knowledge of industrial robots (basic subsystems, their functioning variants and realization), knowledge needed for robot design, robotized workplaces design, robot programming, develop capability for further dealing with subject matter of the discipline.	Fundamental knowledge of robots and current issues in their design, building and application. Knowledge needed for robot design. Capability to perceive the importance of robot application (effects on productivity, flexibility, product quality and humanization of work). Knowledge and skills for introducing of robots to the plant/factory. Practical experience in robot programming.
2	MSc-0306	obligatory	PRODUCTION INFORMATION SYSTEMS	1.Acquisition of knowledge about the role and importance of computer-oriented information systems for planning and management of production systems 2. Mastery of theoretical basics of contemporary information systems architecture 3. Acquisition of practical knowledge for applications design and development in the domain of information systems for planning and management of production systems	The student should acquire fundamental knowledge of: 1. computer-oriented information systems design and development 2. contemporary database application 3. contemporary software tools in the production information systems design and development 4. applications design and development for planning and management of production system subsystems.
2	MSc-0177	obligatory	Manufacturing Systems Design	1. Understanding of modern manufacturing systems structure – a survey of main subsystems and their mutual interaction; 2. Static and dynamic properties of the manufacturing system, dynamic nature of cutting process, nonlinear phenomena of friction, chatter and other aspects affecting manufacturing system stability; 3. Fundamental knowledge of numerically controlled axes, Computer Numerical Control, control system architecture, human-machine interfacing, and manufacturing system condition monitoring; 4. Fundamental approaches to manufacturing systems design theory (Axiomatic design, TRIZ and other alternative approaches).	1. The student should be able to design, i.e., conceptualize, analyze and synthesize manufacturing system in accordance to given functional requirements. 2. The student should develop knowledge, skills and practice for using broad range of CAx modeling methods, including FEM, needed for manufacturing system design and optimization. 3. The student should understand structure of Computer Numerical Control system, its basic architecture and subsystems, and how

					to specify and/or configure it properly.
2	MSc-0665	obligatory	Computer Integrated Manufacturing Systems and Technology	A detailed study of the principles and application of computer integrated manufacturing. Advanced concepts and models related to computer-aided design, computer-aided process planning, computer aided manufacturing, production planning and scheduling.	This course will enable the student to: 1. Explain basic concepts of CIM systems 2. To gain knowledge on how computers are integrated at various levels of planning and manufacturing. 3. Develop machining programs for CNC equipment 4. Design CIM systems to fulfill certain requirements 5. Identify and solve problems in the operations of CIM systems 6. Enhance performance of manufacturing systems by applying different CIM concepts and tools 7. To understand the flexible manufacturing system and to handle the product data and various software used for manufacturing
3	MSc-0131	obligatory	Intelligent manufacturing systems	The aims of the course are to develop student ability for conceptual design and implementation of intelligent manufacturing systems and processes by using the design theory, machine learning and evolutiveness, based on artificial intelligence paradigms. After he/she becomes familiar with the structure of intelligent manufacturing system based on agents (robot, machine tool, machine learning, software, etc.) using laboratory equipment like mobile robots with sensors as well as simulation using specialized software, the student will acquire knowledge necessary for the development of advanced production technologies.	Implementation of software developed for modeling and analysis of intelligent manufacturing systems and processes. Independent selection of methods based on the application of artificial neural networks and other soft computing AI techniques in domain of conceptual design of intelligent behaviour of autonomous mobile robots in manufacturing environment. Advanced utilization of the software for simulation, with analysis and presentation of the results obtained. Capability for team work.
3	MSc-0448	obligatory	Quality Management	1.The aims of the course are to familiarize the student with goods and services quality management, necessary for each engineer in his practical and research work. 2. The student should acquire new knowledge and develop new skills in: - basic concepts, development and models of quality	Having successfully mastered the teaching contents of Quality Management, the student should be able to understand and solve issues of contemporary approaches to QM using systemic approach to business and

management (QM), - techniques for quality engineering (TQE) and their application, - research activities in TQE, - demands and application of ISO 9000 in practice, - demands of our economy for cooperation with EU and modes of meeting those demands in practice.

technological systems. The student should be competent of applying the latest generations of QM. The student should be capable of managing the processes of structuring our economy, as demanded by business operations related to QM at the markets of developed countries.

3	MSc-0104	obligatory	New Technologies	The aims of introducing new technologies to production are top quality products, low-cost and short-time manufacturing process. This course is intended for students of the Production Engineering Department. Students are familiarized with modern technologies that make possible to extend knowledge acquired in Manufacturing Technology and Production Technologies and Metrology.	Having successfully mastered the teaching contents of New Technologies, the student should be able to: design technology for building complex machine parts, design technology for manufacturing of cutting tools, tools for processing plastic masses, forging tools, supply and maintenance of accessories.
4	MSc-0542	obligatory	Skill Praxis M - PRO	The student gains practical experience and gets familiarized with the future occupational environment. The student identifies basic functions of the business system in the domain of design, development and manufacturing as well as the role and tasks of the mechanical engineer within such a business system.	Students should become proficient in the manner of organizing and functioning of the environment where they will apply the acquired knowledge in their future career. Students can identify the models of communication with the colleagues and business information flow. They can also identify basic processes in the design, manufacturing, maintenance within the context of their future competences. Establishment of contacts and acquaintances are useful during graduate studies as well as for applying for the job in the future.
1	MSc-0322	elective	Sheet-Metal Processing Tools	Acquisition of theoretical and practical knowledge in the domain of the design, calculations and construction of tools for sheet-metal processing by punching, drilling, bending, drawing, and combination of these methods. The student acquires a sound understanding of the importance of team work	1.Fundamental knowledge of sheet-metal processing tools. 2. Know-how the approach to the design process. 3. Sound knowledge and understanding of the process. 4. Fundamental practical knowledge of tools' realization in

and cooperation in the area of the design based on contemporary technologies and optimal solution. industry.

1	MSc-0240	elective	Coordinate Measuring Machines	<p>1. New knowledge of flexible metrological automation for solving ALL metrological problems in ENGINEERING, especially in production engineering.</p> <p>2. Students should be equipped with new knowledge and skills relevant to: - basic concepts, development and application of NCMM in engineering practice for measuring, control and inspection of all types of tolerances, - research in the domain of NCMM (CMM), - further development of NCMM (CMM).</p>	<p>Having successfully acquired the teaching contents of this course, the student should be able to understand and solve metrological problems and apply the NCMM (CMM) to technological systems. He should be able to efficiently understand engineering metrological problems and solve them by using the concept of flexible metrological automation.</p>
2	MSc-0722	elective	Computer Simulation in Manufacturing Automation	<p>The objective of this course is that students: acquire knowledge and skills needed for practical problems solving in manufacturing automation using computer simulation; to master the methods used for computer simulation modeling and implementation in manufacturing automation; to obtain the knowledge regarding the systematic approach to the project of computer simulation in manufacturing automation; to develop critical approach to the effects of computer simulation application in automation; to get familiar with the role of computer simulation within digital factory</p>	<p>During this course students: master contemporary methods for development of conceptual models for continuous and discrete event simulation within the manufacturing automation framework; obtain knowledge and skills needed for model coding; gain practical experiences in creation of computer simulation in manufacturing automation through generation of computer models for continuous, discrete event and combined discrete event/continuous simulation using contemporary software; master the methodology of computer simulation project management</p>
2	MSc-0331	elective	New generation of machine tools and robots	<p>1. Perception of different levels of the new generation of machine tools and robots concept. 2. Acquisition of basics of reconfigurable, high-speed, meso- and micro-machines and high-accuracy machine tools. 3. Practical knowledge about parallel kinematic machines and machines for material addition processes and multi-axis machining. 4. Development of programming skills relevant for the new generation of machine tools and robots. 5.</p>	<p>1. Knowledge about the types and use of the new generation of machine tools and robots. 2. Knowledge about different levels of the new generation of machine tools and robots concept. 3. Skill to cope with the new generation of machine tools and robots environment and to choose and prepare those machines for operation. 4. Developed programming</p>

Development of report-making skills.

skills relevant for numerically controlled new generation of machine tools and robots. 5. Knowledge about new numerically controlled systems.

2	MSc-0222	elective	Quality System and Integrated Managemet Systems	1.Acquisition of new knowledge about standardized management systems and good practice in diverse areas and sub-systems of manufacturing- technological systems. 2. Acquisition of knowledge and development of skills in: - basic concepts, development and management system standardized models, - demands and application of these systems in practice, - investigations in the IMS area, - further development of these models.	Having successfully mastered the contents of this course, the student should be able to understand and solve problems concerning contemporary approaches to quality management and other standardized models based on systemic approach in business and technological systems. The knowledge acquired will assist future engineers in our economy management, business operations' demands at EU markets and those of other developed countries, relevant to standardized management systems.
2	MSc-0319	elective	Assembly systems	1. Learning of systematic approach to the design and production of mechanical assemblies; 2. Understanding assembly process and basic assembly operations; 3. Impact of assembly process on product development – product structure and Design For Assembly techniques; 4. Part mating process, modeling and understanding relationships between precision, sensitivity and flexibility; 5. Basic concepts of assembly systems – manual, automatic and robotic systems; Assembly system design. Assembly workstation design issues; 6. Performance and Economics of Assembly Systems; 7. Product lifecycle and product disassembly.	1. Understanding what is assembly, its role in production systems, and why it is important. 2. Fundamental knowledge and engineering skills about: assembly sequence analysis and design of assembly process, design of automatic part feeding and orienting, design for assembly (DFA) techniques, dimensioning and tolerancing of parts and assemblies, design of manual and automatic assembly workstations and systems, product disassembly and its impact on product lifecycle design.
3	MSc-0217	elective	Expert Systems	1.Acquisition of new knowledge about the new generations of software products for solving various engineering problems relevant to production engineering. 2. Acquisition of knowledge and development of skills relevant to: - basic concepts, development and models of expert systems which are	The student should be able to understand, solve and develop models by means of ES in technological systems. The student should also be able to effectively understand engineering problems and develop their models by

possible to apply in production engineering, - investigations in the ES area, - further development of ES.

using contemporary software tools.

3	MSc-0218	elective	Computer Control and Monitoring in Manufacturing Automation	Acquisition of knowledge about the application, design and introduction of modern computer control systems and supervisory into manufacturing automation. Skill development for solving computer control nad supervisory problems by using computer, information and control technologies and adequate scientific methods.	The student should: 1. Uderstand the principles, place and role of the computer control system and supervising in manufacturing automation, link knowledge of related subjects to apply it to control and supervising in manufacturing automation; 2. Master scientific methods of analysis, synthesis, design and introduction of computer control systems in manufacturing automation; 3. Know practical problem-solving and how to apply computer technology and modern control systems in control and supervising in manufacturing automation.
3	MSc-0476	elective	Machine tools M	1. To develop ability to perceive typical missions of machining systems. 2. To study machine tools mechanisms and systems for their control and programming. 3. To receive training in testing procedures for machine tools. 4. To develop ability to analyze complex machine tools and machining systems equipment. 5. The develop ability to analyze the resources for machine tools development. 6. To study configuring and/or building of machine tools for planned mission. 7. To receive training for realization of one mission of machine tools through writing the seminar work. 8. To know how to make technical projects.	1. Knowledge about typical missions of machining systems. 2. Basic knowledge about machine tools mechanisms and control and programming systems of new generation. 3. Skill for quality evaluation of machine tools and machining system based on results of performed testing. 4. Skill for identifying the generation of machine tool and machining system. 5. Skill for configuring machine tool for one's own needs. 6. Knowledge about available resources for development and/or upgrading of machine tools and machining systems.
3	MSc-0342	elective	Mechatronics systems	The aim of the course in mechatronics systems is to provide a focused interdisciplinary theoretical knowledge and practical experience for	1. Theoretical and practical knowledge how to design and select analog and digital circuits, microprocessor-based

undergraduate students that encompass fundamental elements from traditional courses in mechanical engineering, production engineering, electronics and computer control engineering. These elements include sensors and measurement theory, digital systems and computation, semiconductor electronics, servoactuators and motion control, machine tools and robotics, altogether focused in deeper understanding of mechatronics aspects of modern manufacturing systems design, i.e., design of CNC machine tools, industrial robots and flexible production lines, based on contemporary numerical and computer control technology.

components, mechanical devices, sensors and actuators, so that the manufacturing equipment, i.e., machine tools, manipulating robots and manufacturing lines achieve desired function. 2. Deep understanding of basic principles of computer based numerical control systems and their application in machine tools, manipulating robots and industrial automation systems design. 3. Microcontroller programming and hardware design skills.

3	MSc-0601	elective	Micro Manufacturing and Characterization	The course's goals are: students should achieve a basic knowledge of micro-machining technologies through study manufacturing and measuring systems and their functions in the micro scale, as well as the necessary knowledge for the manufacturing and characterization of parts of contemporary materials; students should study in details the chosen method; students will be trained to write term paper, elaborate on lessons learned and be able to continue practicing this discipline in the profession either further education or research in this area.	Student understands the principles of micro-manufacturing, connecting knowledge from related items in order of their use in the manufacture of parts and characterization contemporary materials, mastery of scientific methods of analysis, synthesis and design, applied computer technology and develop a critical approach to social and economic effects of the introduction of micro-manufacturing in our economy. Skills and knowledge in this course will enable student participation in our economy, according to business requirements in the markets of developed countries.
3	MSc-0575	elective	Micro-nano Engineering Basics	Mastering the basic principles prevailing in the micron and submicron region. Introduce students to theoretical foundations, principles and methods of manufacturing in the field of micro-and nano-engineering of various materials. Developing a different engineering approach realized through access to examples and work on their own ideas.	After passing the examination the student is able to understand the principles and use different technologies for manufacturing micro and nano structures, devices and systems. The student is familiar with actual examples and encouraged towards the realization of their ideas.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the	By gaining knowledge in this course,

elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.

students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.

1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Railway mechanical engineering

semester	ID		title	goal	learning outcome
1	MSc-0282	obligatory	Rail vehicles 1	<p>1. Understanding different constructions of the freight wagons and passenger coaches</p> <p>2. Acquiring the knowledge necessary to understand the functioning of wagon or coach assemblies</p> <p>3. Application of knowledge in the design, development, repair and maintenance of wagons and coaches</p>	<p>After completion of the course the student should be able to:</p> <p>1. Explain the functional and structural characteristics of various types of rolling stock.</p> <p>2. Explain the tasks and functioning principles of the assemblies of the rail vehicles.</p> <p>3. Identify actions required to resolve failures in operation and maintenance of rail vehicles.</p> <p>4. Apply appropriate regulations and standards for design and maintenance of railway vehicles.</p> <p>5. Applicate computer tools for calculating and designing rail vehicles.</p>
1	MSc-0297	obligatory	Theory of Traction	<p>Knowledge acquiring in designing, production and exploitation of railway vehicle, in designing of rail tracks as well as the organization of railway traffic. Introducing students with:</p> <ul style="list-style-type: none"> - The Forces acting on railway vehicle, - Calculation methods for traction, resistance and braking force and the velocity, using modern computer tools, - The methods for determination of optimal movement conditions of railway vehicles, - Ways of solving practical problems related to the movement of railway vehicles and rail tracks configuration. 	<p>Understanding and ability to apply knowledge acquired in:</p> <ul style="list-style-type: none"> - Calculation of traction, resistance and braking forces and the velocity, using compatible computer software, - Defining Task and compositional functionality of railway vehicles, - Using of adequate regulations and standards in the field of traction at railway vehicles.
2	MSc-0245	obligatory	Rail vehicles 2	<p>1. Understanding different constructions of the freight wagons and passenger coaches</p> <p>2. Acquiring the knowledge necessary to understand the functioning of wagon or coach assemblies</p> <p>3. Application of knowledge in the design, development, repair and maintenance of wagons and coaches</p>	<p>After completion of the course the student should be able to:</p> <p>1. Explain the functional and structural characteristics of various types of rolling stock.</p> <p>2. Explain the tasks and functioning principles of the assemblies of the rail vehicles.</p> <p>3. Identify actions required to resolve failures in operation and maintenance of rail vehicles.</p> <p>4. Apply appropriate</p>

					regulations and standards for design and maintenance of railway vehicles. 5. Applicate computer tools for calculating and designing rail vehicles.
2	MSc-0246	obligatory	Brakes of rail vehicles	1. Introducing the brake system of railway vehicles. 2. Acquiring the knowledge necessary to understand the functioning of rail vehicle brake system components. 3. Training for the application of knowledge in the design, development, repair and maintenance of the brakes.	After completion of the course the student should be able to: 1. Explain the functional and design characteristics of various types of brakes. 2. Explain the tasks and functioning mode of brake system assemblies. 3. Identify actions required to be applied in case of malfunctions of the break system during operation and maintenance. 4. Apply appropriate regulations and standards for design and maintenance of rail vehicle brakes.
2	MSc-0243	obligatory	Locomotive 1	1. Introduction student to the basic concepts important for understanding the designing of diesel locomotives. 2. Knowledge acquiring necessary for understanding the designing of diesel locomotives. 3. Competence for use the knowledge acquired in solving practical problems in designing, use and maintenance of diesel locomotives.	In the end of the course student should be able to: 1. Explains basic concepts concerning diesel locomotives. 2. Explains tasks and operation mode of diesel locomotives. 3. Accomplish certain calculations concerning diesel locomotives. 4. Apply certain standards and regulations in the field of diesel locomotives. 5. Use computers tools for certain calculation of diesel locomotives.
3	MSc-0230	obligatory	Locomotive 2	1. Introduction student to the basic concepts important to understanding the the designing of diesel-electric and electric locomotives. 2. Knowledge acquiring necessary for understanding the designing of diesel-electric and electric locomotives. 3. Competence for use the knowledge acquired in solving practical problems in designing, use and maintenance of diesel-electric and electric locomotives.	In the end of the course student should be able to: 1. Explains basic concepts concerning diesel-electric and electric locomotives. 2. Explains tasks and operation mode of diesel-electric and electric locomotives. 3. Accomplish certain calculations concerning diesel-electric and electric locomotives. 4. Use computers tools for certain calculation of diesel-electric and electric locomotives. 5. Apply certain standards and regulations in the field of diesel-electric and electric locomotives.
3	MSc-0234	obligatory	Railway vehicles maintenance	Upon completion of the course the student should be able to: 1. Explain the basic concepts	1. Understanding the basic concepts important for understanding the reliability and

related to the reliability of rail vehicles. 2. Explain the basic concepts related to the maintenance of rail vehicles. 3. Explain the tasks and practices of the workshop for the maintenance of railway vehicles. 4. Perform appropriate calculations related to maintenance of rail vehicles. 5. Apply appropriate tools for computer calculations of electric and diesel electric locomotives.

maintenance of rail vehicles. 2. Acquiring the knowledge necessary to understand the problems of maintenance of rail vehicles. 3. Preparation to implement the acquired knowledge in solving practical problems in maintaining the railway vehicles related to the organization, implementation and projected activities in the field of application of knowledge and information and the reliability of expert systems.

3	MSc-0453	obligatory	Fundamentals of Rail Vehicle Dynamics	1. Acquiring knowledge about the dynamic behavior of rail vehicles. 2. Exploring methods for studying the dynamic behavior of rail vehicles. 3. Training for the application of knowledge in the design, development, repair and maintenance of railway vehicles.	After completion of the course the student should be able to: 1. Explain the characteristic phenomena of dynamic behaviour of rail vehicles. 2. Apply computational methods for determining the main parameters of the dynamic behaviour of the rail vehicles. 3. Participate in the preparation of the test procedures for tests of the dynamic behaviour and proper assesment of the test results. 4. Apply appropriate regulations for building or refurbishment of rolling stock in order to achive the prescribed dynamic behaviour.
4	MSc-0488	obligatory	Skill Praxis M - ZEM	Students practical experience and stay in the environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of development, designing, production, maintenance of railway vehicles, as well as the roles and tasks of mechanical engineer in such a business system.	Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the designing, manufacturing, maintenance, in the context of his future professional competence. Establish the personal contacts and acquaintances that will be able to use at school or entering into future employment.
3	MSc-0239	elective	Urban and special rail	1. Understanding the specifics of urban rail vehicles. 2. Understanding the various types of	After completion of the course the student should be able to: 1. Explain the functional and

vehicles

special rail vehicles. 3. Qualification for the application of acquired knowledge in the design, development, repair and maintenance of urban rail vehicles and special vehicles

design specificity of various types of urban rail vehicles. 2. Explain the tasks and functionality of various types of special rail vehicles. 3. Explain the specific technologies and technical requirements in combined transport. 4. Apply appropriate regulations and standards in the design and maintenance of urban rail vehicles and special rail vehicles.

1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering,	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently

thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.

perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Thermal power engineering

semester	ID		title	goal	learning outcome
1	MSc-0289	obligatory	Energy Steam Boilers 1	Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.	Student acquires specific capabilities which are needed for carrying out professional activities: analysis, synthesis and anticipating the results and consequences; use of knowledge from different areas for solving specific problems.
1	MSc-0274	obligatory	Steam Turbines 1	1. The achievement of academic competence in the field of steam turbines and thermal power engineering. 2. The achievement of theoretical knowledge about how to transform heat into mechanical work learning thermodynamic processes and equipment (steam turbine and steam turbine power plants). 3. The acquisition of practical knowledge to optimize thermodynamic cycle and steam turbines. 4. The achievement of the techniques of process modeling. 5. Mastering the methods of experimental work in thermal power engineering.	1. Academic deep knowledge of the thermodynamic cycle and flows in steam turbines and steam turbine plants 2. The development of critical thinking about energy use, fuel efficiency and environmental preservation 3. The ability of calculate heat balance diagrams and main parameters of the steam turbine power plants. 4. Ability to use computer technology for modeling and calculations

2	MSc-0300	obligatory	Gas Turbines	<p>1. The achievement of academic competence in the field of gas turbines and thermal power plant engineering. 2. Mastery of theoretical knowledge about how to transform heat into mechanical work of thermodynamic processes and equipment (gas turbines and gas turbine power plants). 3. The acquisition of practical skills for design and optimization of gas and gas turbine cycle. 4. Mastering the techniques of process modeling.</p>	<p>1. Academic deep knowledge of the thermodynamic cycle and flows in gas turbines and gas turbine plants 2. The development of critical thinking about energy use, fuel efficiency and environmental preservation 3. The ability of calculate heat balance diagrams and main parameters of the gas turbine power plants. 4. Ability to use computer technology for modeling and calculations</p>
2	MSc-0174	obligatory	Steam Turbines 2	<p>1. The achievement of academic competence in the field of steam turbines and thermal power engineering. 2. The achievement of theoretical knowledge about how to transform heat into mechanical work learning thermodynamic processes and equipment (steam turbine and steam turbine power plants). 3. The acquisition of practical knowledge to optimize thermodynamic cycle and steam turbines. 4. The achievement of the techniques of process modeling. 5. Mastering the methods of experimental work in thermal power engineering.</p>	<p>1. Academic deep knowledge of the thermodynamic cycle and flows in steam turbines and steam turbine plants 2. The development of critical thinking about energy use, fuel efficiency and environmental preservation 3. The ability of calculate the steam turbines. 4. Ability to use computer technology for modeling and calculations. 5. Ability to apply experimental methods in development and practice.</p>
2	MSc-0194	obligatory	Thermal Power Plants	<p>Familiarizing with the procedures of choosing type and sort, parameters and configuration of a thermal power plant, according to requirements of energy consumption, available sources of primary energy, energetic and economic performances and other relevant criteria. Furthermore, gaining knowledge on functional and technological characteristics of certain technological thermal power plant systems. The practice course is based on the implementation of certain practical knowledge from the course program, by solving specific examples.</p>	<p>The program provides the practical knowledge a graduated mechanical engineer needs in order to work in the field of thermal power engineering, which enables him to solve certain practical problems more easily and quickly. Such competence includes mastering the procedures of analytic and synthetic consideration of choice of type and sort of thermal power plant in the procedure of planning and design, as well as inclusion into the process of exploitation and maintenance.</p>

3	MSc-0129	obligatory	Steam generators	The aims of the subject are acquiring academic knowledge about processes and equipment for steam generation in thermal power plants, building and mastering skills in scientific and engineering methods for the prediction, analyses and research of thermal-hydraulic processes in steam generators, as well as skills in methods for the design, safety analyses and diagnostics of the operational conditions of the steam generators.	Mastering the course the students are able to simulate and analyze processes, design equipment and prescribe operational conditions in steam generators by applying the modern scientific and engineering methods for various conditions of exploitation. Also, the application of acquired knowledge and skills in every stage of design, manufacture and exploitation provide the safe, reliable and economically and energetically efficient operation of steam generators.
3	MSc-0105	obligatory	Energy Planning	The aims of the subject are to master the methods for the analyses and planning of the macro energy systems at the level of economy and industry sectors, regions and the country, including analyses and formation of energy balances, prediction of energy flows and the structure of energy consumption, classification of energy carriers and indicators of energy consumption, the relation between the economic growth and energy consumption, the state regulative in the energy sector, the environmental impact of energy consumption etc.	Students acquire a knowledge and skills related to energy planning by using statistical and econometric methods and by applying the phenomenological models, as well as related to methods for providing the basis for planning procedures, such as analyses and preparation of energy balances, prediction of indicators of energy consumption, etc.
3	MSc-0165	obligatory	Planning and Exploitation of Thermal Power Plants	The purpose of this course is to provide necessary knowledge base in the area of planning and design, contracting and acceptance testing, exploitation and maintenance of thermal power plants. The course practice program consists of the creation of a simplified conceptual project of the power plant based on the implementation of certain practical knowledge gained during the course.	The program provides the practical knowledge a graduated mechanical engineer needs in order to work in the field of thermal power engineering, which enables him to solve certain practical problems more easily and quickly. Such competence includes mastering the procedures of analytic and synthetic consideration of choice of type and sort of thermal power plant in the procedure of planning and design, as well as inclusion into the process of exploitation and maintenance.
4	MSc-0356	obligatory	Skill Praxis M -	Practical experience and residence in an	Students gain practical experience regarding the

TEN

environment where students will be able to realize their professional careers. Recognizing the principle functions of a business system in the domain of design, development and production, as well as the role and tasks of a mechanical engineer in such a business system.

means of organizing and functioning of the environments in which they will apply the gained knowledge in their future professional careers. Students will be able to recognize models of communication with colleagues and business information flows. Students will be able to recognize the basic processes in design, production, maintenance, in the context of their future professional competencies. Personal contacts and acquaintances are made, which they will be able to use during their studies, or when starting their professional careers.

1	MSc-0345	elective	Nuclear Reactors	The aims of the subject are acquiring academic knowledge about processes and equipment for nuclear energy utilization, about neutron processes and fission, principles of nuclear reactors design, reactor core cooling, nuclear fuel characteristics, transport and storage of nuclear waste, nuclear reactors safety, nuclear accidents in Nuclear Power Plants Three Mile Island, Chernobyl and Fukushima, as well as current nuclear reactors developments.	Students are able to design nuclear reactor core, determine the thermal and neutron characteristics of nuclear fuel, moderator and reactor coolant, define basic elements of nuclear power plant safety and determine basic technical, technological, ecological and economic conditions and boundaries for the application of nuclear energy.
2	MSc-0325	elective	Two-Phase Flows with Phase Transition	The aim is acquiring academic knowledge about two-phase flow patterns, mechanisms of transport processes in two-phase flows, intensity of evaporation and condensation and methods for two-phase flows simulation and analyses within design, safety analyses and prescription of operating conditions and parameters of energy plants.	The students are trained to perform computer simulation and analyses of gas-liquid two-phase flows within design of energy plants, safety analyses, operating conditions diagnostics, defining of operating conditions, etc.
2	MSc-0355	elective	Environmental Protection in Thermal Power Engineering	The aim is acquiring academic knowledge about sources and characteristics of hazardous gases emission and other harmful influences in all phases of thermal power plants exploitation, about the environmental influence of harmful emissions, about	The students master their knowledge and skills in the field of environmental protection from the harmful emissions from the thermal power plants. Besides being acquainted with the sources of harmful emissions and methods and equipment for their reduction and storage, the

possible technical solutions, processes and equipment for the emission reduction, harmful waste storage, as well as about the importance of these activities for economic and social development.

students are trained to quantify harmful emissions and to estimate the technical, ecological and economical effects of current methods and measures for environmental protection.

2	MSc-0337	elective	Thermal Turbomachinery	<p>1. The achievement of academic competence in the field of steam and gas turbines and thermal power engineering. 2. The achievement of theoretical knowledge about how to transform heat into mechanical work learning thermodynamic processes and equipment (steam and gas turbines and thermal power plants). 3. The acquisition of practical knowledge to optimize thermodynamic cycle and steam and gas turbines. 4. The achievement of the techniques of process modeling. 5. Mastering the methods of experimental work in thermal power engineering.</p>	<p>1. Academic deep knowledge of the thermodynamic cycle and flows in steam and gas turbines and turbine plants 2. The development of critical thinking about energy use, fuel efficiency and environmental preservation 3. The ability of calculate heat balance diagrams and main parameters of the steam and gas turbine power plants. 4. Ability to use computer technology for modeling and calculations</p>
3	MSc-0338	elective	Industrial and District Heating Thermal Power Plants	<p>The purpose of the course is to provide a knowledge basis in the field of specific application of thermal power plants for the combined production of electric energy and heat within industrial and utility thermal power engineering. In the development of modern thermal power engineering, application of cogeneration is gaining relevance, due to significant primary energy savings. The practice program consists of creating calculation tasks for the cogeneration regimes, based on the implementation of certain gained practical knowledge in the course program.</p>	<p>The course provides the practical knowledge a graduated mechanical engineer needs in order to work in the field of combined production of energy, which is gaining relevance and stimulus for application worldwide, due to significant primary energy savings. Given that the field of application of cogeneration of energy in the process of planning and design is the most complex area of thermal power engineering, gaining competitive knowledge in the field is of great importance for a thermal power engineer.</p>
3	MSc-0153	elective	Computer simulations of thermohydraulic processes and	<p>The aim is acquiring knowledge and skills for development and application of analytical and numerical models of thermal-hydraulic processes in energy, thermal and process</p>	<p>The students are trained to perform computer simulation and analyses of heat transfer and fluid flow processes of one-phase and two-phase gas-liquid systems with and without phase</p>

			CFD	equipment, as well as application of numerical methods for the simulation and analyses of one-phase and two-phase systems in pipelines and plant equipment, including the methods of Computational Fluid Dynamics - CFD.	transitions in energy, thermal and process equipment.
3	MSc-0585	elective	Technical and Technological Development and Innovation Activity	The aims of the subject are mastering the methods for the planning and conducting technical and technological development and innovative project, as well as acquiring knowledge in the corresponding fields, such as intellectual property, patent rights, legal regulations, economic evaluation of innovative projects etc.	Students acquire knowledge about development mechanisms of technical, technological and innovative development, methods for planning, control and conducting of development projects and research, about economic evaluation of investment, intellectual property, patent and production rights.
3	MSc-0336	elective	Turbocompressors	1. The achievement of academic competence in the field of compressors and thermal power plant engineering. 2. Mastery of theoretical knowledge about how to transform mechanical work into internal energy of fluid by learning of thermodynamic processes and equipment. 3. The acquisition of practical skills for design and optimization of turbocompressors. 4. Mastering the techniques of process modeling.	1. Academic deep knowledge of the thermodynamic cycle and flows in gas turbines and gas turbine plants 2. The development of critical thinking about energy use, fuel efficiency and environmental preservation 3. The ability to make design of compressors. 4. Ability to use computer technology for modeling and calculations
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid	Learning the topics from the course student will get the knowledge about basic principles in fluid

flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.

mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.

1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering experise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Thermal science engineering

semester	ID		title	goal	learning outcome
1	MSc-0269	obligatory	Steam Boilers elements and equipments	Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific	Student acquires specific capabilities which are needed for carrying out professional activities: analysis, synthesis and anticipating

practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.

the results and consequences; use of knowledge from different areas for solving specific problems.

1	MSc-0291	obligatory	Refrigeration Equipment	<p>Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.</p>	<p>Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.</p>
2	MSc-0304	obligatory	Fundamentals of Air Conditioning	<p>Getting knowledge in Air Conditioning - thermal comfort, heat gain and cooling load, air handling unit and its elements, mastering methods for calculating cooling loads for non-stationary conditions of heat transfer and using those methods in air conditioning project design.</p>	<p>Student acquires specific abilities and knowledge in air conditioning: he knows the elements of a central air conditioning system, methods of cooling load calculations and he can use it in practice. Student links basic knowledge and apply it in solving concrete problems in air conditioning.</p>
2	MSc-0176	obligatory	Steam Boiler processing	<p>Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.</p>	<p>Student acquires specific capabilities which are needed for carrying out professional activities: analysis, synthesis and anticipating the results and consequences; use of knowledge from different areas for solving specific problems.</p>
2	MSc-0192	obligatory	Refrigeration Systems	<p>Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.</p>	<p>Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.</p>

3	MSc-0137	obligatory	Ventilating and Air Conditioning Systems	Getting knowledge and skills in air conditioning - various central air conditioning systems; mastering methods for calculating air ducts, choosing elements for intake and extract of air, and using those methods in air conditioning project design.	Student acquires specific abilities and knowledge in air conditioning: he knows various central air conditioning system, methods of air ducts calculations and he can use it in practice. Student links basic knowledge and apply it in solving concrete problems in air conditioning.
3	MSc-0110	obligatory	Thermal Power Plants and Heat Plants	Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.	Student acquires specific capabilities which are needed for carrying out professional activities: analysis, synthesis and anticipating the results and consequences; use of knowledge from different areas for solving specific problems.
3	MSc-0166	obligatory	Heat Pumps	Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.	Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.
4	MSc-0357	obligatory	Skill Praxis M - TTA	Practical experience and the student presence in the environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineer in such a business system.	Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Students are establishing the personal contacts and acquaintances that will be able to use during studies or entering into future employment.

1	MSc-0661	elective	Central Heating Systems	Acquiring knowledge and skills in the field of central heating - hot water two-pipe systems with natural and forced circulation of hot water, hot water one-pipe systems, steam heating system of low pressure, air heating, panel heating, district heating, solar systems, mastering the methods for calculation of pipe network.	Students acquire specific skills and knowledge of central heating systems: knowledge of different heating systems, known methods of calculation of central heating systems and can apply them in practice. Connects basic knowledge and apply it to solve concrete problems in the technique of heating.
2	MSc-0313	elective	Energy Steam Boilers 2	Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.	Student acquires specific capabilities which are needed for carrying out professional activities: analysis, synthesis and anticipating the results and consequences; use of knowledge from different areas for solving specific problems.
3	MSc-0667	elective	Energy certification of buildings	Acquiring knowledge and skills in the field of energy certification of buildings - the concept of energy building certificate, building energy consumption, energy needs and significant parameters; comfort conditions and design parameters, central heating and air conditioning systems, energy sources, final and primary energy, domestic hot water systems; optimization of HVAC systems and the application of passive techniques, methodology of calculation of indicators, classification of buildings by type and energy codes; elaboration of energy efficiency, energy certificate.	Students acquire specific skills and knowledge in the field of energy certification of buildings; known methods for the calculation of indicators to determine the energy code of the building and can be applied in practice. Connects the basic knowledge and applies them to the elaboration of energy efficiency of the building.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.

general rigid body motion, the approximate theory of gyroscope and the impact theory.

1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Weapon systems

semester	ID		title	goal	learning outcome
1	MSc-0687	obligatory	Aerodynamics of	Introducing students to the fundamentals of	The student is able to work independently on

			Projectiles	aerodynamic calculations. Introducing students to the fundamentals of structure and implementation of programs for the calculation of missile aerodynamics. Introducing to the experimental methods in aerodynamics.	the calculation of aerodynamic characteristics of guided and unguided projectiles. Student is qualified for experimental work in the field of aerodynamic test methods.
1	MSc-0688	obligatory	Flight Dynamics of Projectiles	Introducing students to the fundamentals of calculation and modeling of flight dynamics. Introducing students to the fundamentals of structure and implementation of programs for modeling of flight dynamics. Introduction to experimental methods of flight testing.	The student is able to work independently on calculation and modeling of flight dynamics of guided and unguided projectiles. Student is qualified for experimental work in the field of flight tests.
1	MSc-0271	obligatory	Physics of Explosive Processes	The goal of course is that students learn the basic principles of combustion of materials and physics of explosion which are of importance for the realization of a function of weapon systems. Students should learn the contents of the process of explosion and burning of gunpowder and rocket propulsion materials as integrated chemical-technological systems.	Mastering calculations of physics of explosion processes that influence on warhead mechanisms and target efficiency. Student understand influencing parameters on the energy release by combustion processes and form a scientific and experimental base for the development and creation of new knowledge in the field of energetic materials and energy release processes in defense technologies and products.
2	MSc-0181	obligatory	Automatic Weapons	Introducing of students to the basic elements of the automatic weapons. Formation of the system of differential equations that describe the movement of elements of the mechanisms of automatic weapons during the firing cycle. The study of methods for solving these differential equations. Preliminary design of various systems of automatic weapons.	Mastering the calculation of basic parameters that characterize the function of various systems of automatic weapons. Acquiring the ability of students to create their own software tool for preliminary design of an automatic weapon. Qualifications for the design of individual elements of the automatic systems and optimisation of function of different types of automatic weapons.
2	MSc-0196	obligatory	Projectile Design	The main objective of the course is that students understand the importance, the basic concepts and methods of projectile design as an integral part of the science of weapons systems. Students	Student gets contemporary knowledge about the main types of projectiles (high-explosive, armor-piercing, special) and the basics of their design. Student could use methods of

should understand the key ideas about the types and purpose of projectiles, safety in the use and mechanisms of action.

calculation of different types of projectiles.

2	MSc-0167	obligatory	Launching equipment	<p>Goal of subject is to achieve student knowledge in two basic launcher equipment Sub systems. Sub systems of equipment and devices for shooting and missiles positioning and launching, and subsystems of equipment and devices for other defense and military integrated functions available on the self-propelled weapon launcher. Student through practical project research of concept and component integration realize knowledge of software and hardware integration on the launcher and new technologies implementation on the self propelled or portable weapon missile launching Systems.</p>	<p>Student realizes skills and knowledge for individual integrating of launcher weapon, their conceptual solutions and critical thinking and opinion about advantages for applied Systems and sub systems. Also launcher and its equipment is integrative design system test for knowledge of missile system design and defense functions. Student through practical selections of functions and its solutions gets knowledge of compromises in technology possibilities and threshold performances of practical use and its requirements.</p>
2	MSc-0689	obligatory	Missile Propulsion	<p>Introducing students to the fundamentals of determination of rocket engines performance parameters. Introducing students to the design of rocket engines with liquid and solid propellants, as well as special units of liquid rocket engines. Fundamentals of thrust vector control of rocket motors. Introduction to methods of rocket engines testing.</p>	<p>Student is capable for work on calculation and design of rocket engine with solid and liquid propellants. Student is also qualified for experimental work in the field of rocket engine testing.</p>
2	MSc-0195	obligatory	Launching Theory	<p>The basic purpose of the subject is aimed to the student knowledge and skills of applied launching ballistic mechanics, gas dynamics of missiles starting motion, on-in, the launcher, and relative interactive motions of combat platforms and launcher .The basic theoretical goal is to introduce students with simplified models of disturbances mechanics and to calculate critical disturbance cases and their influences on the launching and final missile shooting errors. Also, goals are to evaluate global design performances of launcher by functional and exploitation combat loads, as the input for strain and stress</p>	<p>Student achieve capabilities for individual analyzes, preliminary integration and syntheses of launching mechanics applied on the launcher mounted on the combat platform of any type or design. Accepted methodology provides student ability to calculate and verify missile weapon efficiency, by recognizing loads and disturbances composed in the missile weapon errors, caused by tube, rail or container launcher type and their processes, integrated and jointed with the combat platforms, of any vehicle or vessel.</p>

integration analyses.

2	MSc-0184	obligatory	Interior Ballistics	Study of methods of solving the basic task of interior ballistics and ballistic design. The study of the basic characteristics of special types of weapons. Consideration of methodology of interior ballistic tests.	Mastering the calculation of direct and indirect task of interior ballistics of various types of weapons, and the methodology of interior ballistic tests.
3	MSc-0691	obligatory	Terminal Ballistics	The main goal of the subject is that students understand the importance, the basic concepts and methods of terminal ballistics, as an integral part of the science of weapons systems. Students should understand the key ideas about the projectile/target interaction and their use in projectile design as well as ballistic protection.	Student gets contemporary knowledge about the main types of projectile effects (penetration, fragmentation and blast) and the fuzes as an important functional part of the projectile in terms of terminal ballistics. Student masters calculation methods of all types of projectile effects and their use.
3	MSc-0690	obligatory	Missile Guidance and Control	Acquiring knowledge about projectile guidance and control and its application in the areas of research and development, design, manufacturing, marketing, operational use and analysis of modern guided missiles. Mastering the methodology of calculation of dynamic characteristics of guided missiles (maneuverability, controlability, stability, eigenfrequencies, etc..) and synthesis of autopilot and guidance law for a method of "three-point" and proportional navigation.	Student obtains general knowledge in the areas of analysis and synthesis of guided missile systems, which enables participation and communication in the working teams involved in the development of guided missiles. Using modern software tools developed in MATLAB and Simulink, students are qualified for the calculation of trajectories of guided missiles, the calculation of aerodynamic transfer functions and synthesis of autopilot and guidance system of a missile. Student possess basic knowledge of verification and assessment of quality of guided missiles.
3	MSc-0123	obligatory	Optical devices and optoelectronics	The aim of this course is to enable students, future mechanical engineers - designers of military systems, the acquisition of knowledge necessary to the cooperation with the designers of complex optical and optoelectronic systems. After completion of lectures and exercises, students should be able to set and calculate basic optical systems.	The subject allows students, future mechanical engineers - designers of military systems to: - Set up basic optical systems (lenses, working systems, oculars, Kepler and Galileo's scheme of telescope system); - Calculate an optical system using sophisticated codes for optical system design.

3	MSc-0101	obligatory	Artillery Weapons Design	<p>Detailed analysis of design solutions for individual elements of artillery weapons.</p> <p>Detailed study of design methodologies for the main structural elements of weapons. Practical implementation of calculations for basic structural elements of artillery weapon through the realisation of projects.</p>	<p>Mastering the calculation of basic parameters that characterize the function of individual pieces of artillery systems. Acquiring the ability of students to create their own software tool for the design of individual structural elements of artillery weapons. Qualifications for the design of the main structural elements of artillery systems.</p>
3	MSc-0112	obligatory	Missile design	<p>Goal of subject is to achieve student in detail contents of missiles subsystems its integration and key performances of flight and terminal phase, functions. Goal of knowledge's are directed on the technology roll and influences on the particular quality and quantity of missiles performances .Missile is considered as the flight vehicle and ammunition for the different payload purposes and defense missions .Student developing detailed skills and knowledge for design, analyzes, syntheses of missiles and rockets and about its advanced technology applications on the component design its research and methodology of calculations and development.</p>	<p>Student achieve level of individual designer of tactical missiles and other jobs and purposes of missile syntheses .Also, student is accomplished for the analyzes and syntheses of all levels and types in the missile and ammunition rocket technologies by tools of applied mechanics and software analyzes of integrative rocket and missile technologies and performances .Parametric composition of missile flight mechanics, special ballistics and rocket propulsion propellants performances and other interdisciplinary integration selection and estimations, is comprehension output of subject</p>
3	MSc-0111	obligatory	Fire Control Systems	<p>Goal of subject is orientated to the student knowledge about basic technologies integrated in the battle that provides precise engagement and reliable shooting of target by direct, indirect or other type of weapon fire. Modern systems employed and design by the basic knowledge about LOS, NLOS, and other shooting elements and principles understand sensor principles, automatic devices and software proceedings, based on ballistic shooting elements. Modern navigation and position principles of weapon fire represented by fundamental vectoral battle mechanics, of platforms motion, targets and projectiles flight in FCS composition models.</p>	<p>Student is trained and educated to solve individual employment of weapon and their integrations of performances with other non weapon helping defense equipment and battle functions. Those understand shooting functions precision positioning and errors estimation, preparing weapon for selected target mission, and ballistics and flight mechanics estimation for optimal target shooting. Also student achieve basic knowledge for Command information battle technology and weapon fire precision strike technology. Software, autoimmunization and mechatronics sensor integration, in the</p>

Processes are represented by artillery, AD, BMD, and armored vehicles battle mechanics and platforms and units integrated systems. battlefield mechanics of unsteady state vectoral proposals provides FCS software and hardware knowledge, for weapon designers.

4	MSc-0692	obligatory	Skill Praxis M - SIN	Practical experience and student's stay in the environment in which he will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineer in such a business system.	Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Personal contacts and acquaintances are established that student will be able to use during study or entering into future employment.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.
1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical	Achievment of the engineering expertise in a true analysis of mechanisms, sensors,

				composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	actuators and PLCs as a main componenets of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.

Welding and welded structures

semester	ID		title	goal	learning outcome
1	MSc-0267	obligatory	Engineering materials 3	The aim of this course is to introduce students to different types of engineering materials and their properties with the goal of understanding and studying the possibility of their application for manufacturing of different elements and constructions. Special attention is devoted to studying the influence of composition, thermal processing and processing by plastic deformation on the structure and properties of the material. This course enables possible collaborations with institutes, companies and factories that make and construct engineering materials and deal with their application.	Attending this course student will develop abilities of all encompassing analysis and possibility to predict optimal technological choice of the type of engineering material using scientific methods and modern lab equipment. Due to this course a student will also develop the ability to combine knowledge from different areas of material science, physics, mechanics and strength of materials together with acquired knowledge during this course.

1	MSc-0468	obligatory	Finite element method	<p>Understanding the basic concepts of theory of elasticity and finite element method. Introducing students to the application of finite element method in the analysis of linear and nonlinear problems. Understanding and studying the problems of coupled external loads on welded structures. The development of an independent and practical work using licensed software.</p>	<p>By attending this course the student will master advanced application of finite element method, especially in the field of welding and welded structures. Theoretical considerations, computational exercises and work with the licensed ABAQUS software, will allow students to synergize the previously acquired knowledge of mathematics, mechanics, structures integrity and mechanical materials, and apply this knowledge in engineering practice.</p>
1	MSc-0266	obligatory	Fuel, Lubricants and Industrial Water 2	<p>Fuel types. Stoichiometric combustion equations. Combustion temperature. Characterization of solid fuels, technical and fundamental analysis. Solid fuel origins, derivation, applications. Liquid fuels, origins, derivation, applications. Gaseous fuels, origins, derivation, applications. Lubricants, types and main characteristics, applications. Industrial water, types and properties. Essential characteristics of the water for industrial purposes. Problems in the use of natural waters. Water treatment for industrial applications.</p>	<p>Acquisition of basic knowledge about the concept of fuel types and properties. Mastering the basic techniques of calculation of quantity and composition of the products of combustion and combustion temperature. Acquiring basic knowledge on the characterization of solid fuels, their origins, derivation and application. Basic knowledge of liquid and gaseous fuels, their origins, derivation and application. Basic knowledge about the types of lubricants, properties and application. Basic knowledge about water treatment for industrial applications.</p>
2	MSc-0373	obligatory	Design and Construction M	<p>Acquisition of basic knowledge of designing and constructing machinery elements and structures. Mastering the methods of construction and design process. Developing skills of teamwork and interconnecting knowledge and skills in various fields of Mechanical Engineering. Training for further study.</p>	<p>Students will gain knowledge, skills and attitudes in the process of constructing in the field of machinery design, as well as experience in selection of the optimal variant design based on techno economic analysis.</p>
2	MSc-0173	obligatory	Structural and stress analysis	<p>Basic goal of this course is introduction to principles in design and calculation of steel structures for wide range of material handling machines (mining machines, earthmoving machines, cableways and lifts). Also, goal is</p>	<p>Student expands the knowledge in structural analysis for material handling machines with emphasis on identification of specific load/stress cases which may lead to failures of structures.</p>

development of student creative skills for designing the light but safe structures, i.e. rational structures.

2	MSc-0305	obligatory	Operational Strength	Registration and statistical analysis of the operational load, the formation of its histograms, the distribution functions, spectra and blocks. Fatigue damage accumulation hypotheses. Calculations of working ability, operational strength, security and reliability and operational life of machine parts and machines exposed to varying operational loads. Experimental methods for fatigue strength estimation and treating of results.	Methods for registration and statistical analysis of the operational load. The definition of fatigue damage and the process flow of its accumulation using theoretical and experimental methods with appropriate damage hypotheses. Establishment of appropriate criteria for the occurrence of critical fatigue damage phenomena and determination of operational fatigue life. The reduction of results from the variable spectra to equivalent results for the full constant amplitude spectra.
3	MSc-0481	obligatory	Structural integrity	Objectives of this course are that students, after completing theoretical basic training in fracture mechanics, and with their maximum involvement in practical training (through laboratory exercises, development of computational tasks, writing seminar papers, etc.), become competent in the field of structural integrity and gain appropriate academic skills, and also develop specific creative and practical skills that are needed in professional practice.	By attending this course, provided by the curriculum of the subject, the student will be able to solve particular problems of structural integrity, and to examine the possible consequences that may occur in case of bad solutions. The student will also be able to link their knowledge in this field with other areas and apply them in practice.
3	MSc-0486	obligatory	Reliability of structures	Acquisition of basic knowledge about the reliability of mechanical components and structures. Mastering the methods of determining the reliability of simple and complex systems. Developing skills of teamwork and networking knowledge and skills in various fields. Training for further study. Consideration of the importance failure from technical and economic point of view, mastering the skills to assess the failure assessment, based on the cause-events	Upon completion of this program is expected that students will be able to: - recognize the random variables of machine elements and constructions, - apply analytical and approximate methods for determining the basic reliability indicators, - draw and use the diagrams of basic indicators of reliability, - interpret the results of basic reliability indicators obtained from calculations or tests, - solve engineering problems in the area of reliability.

established classifications.

3	MSc-0497	obligatory	Specialized joining techniques	After the completion of the course 'Specialized Joining Techniques', that includes theoretical and practical lectures (auditory and laboratory exercises, problem solving, seminar work, consultations, etc.), the students are familiar with modern processes and non-conventional material joining techniques, that are constantly being developed and applied in the new modern material joining technologies. The candidates will also master the specific practical skills needed in their profession.	Upon completion of the designed course programme, the candidate will be familiar with the processes and procedures in the research of specific fields in modern joining technologies. The applied knowledge in the field of Specialized Joining Techniques will enable the candidate to gain the ability to recognize and solve specific problems. Thus, he is prepared to link and apply the acquired knowledge to this and other fields and to track innovations, e.g. in the joining of future materials (for instance, special steels, light metals and alloys, ceramics, composites, polymers, nano-materials).
3	MSc-0469	obligatory	Welding technology	Understanding the basic principles of welding technology as a prescribed course of action to be followed when making a weld. Introducing students to techniques of material selection, preparation, preheating, methods and control of welding and subsequent thermal treatment. Understanding and solving exercises in welding technology. Development of an independent paper by creation and presentation of selected seminar papers.	By attending the course the students are mastering the basic knowledge of welding technology. Theoretical considerations and computational examples enable the student to master all the necessary principles of welding technology needed for the manufacture of welded joints. Introducing students to current modern standards and recommendations in this field.
4	MSc-0156	obligatory	Skill Praxis M - ZZK	Objectives of this course are that students, after completing theoretical training, are prepared for their maximum involvement in practical training. Objective is that students become competent in the field of welding and gain appropriate academic skills, and also develop specific creative and practical skills that are needed in professional practice.	By attending this course, provided by the curriculum of the subject, the student will be able to solve particular problems from practice, and to examine the possible consequences that may occur in case of bad solutions. The student will also be able to link their knowledge from various fields and apply them in practice.
1	MSc-0004	obligatory	Mechanics M	The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in	By gaining knowledge in this course, students will be able to efficiently solve complex problems in kinematics and dynamics of particle and material system. This knowledge

kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.

can allow students to attend classes in specialized courses that analyze the kinematic and dynamic problems.

1	MSc-0685	obligatory	Fluid mechanics M	The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.	Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.
1	MSc-0201	obligatory	Mechatronics	Quantum of knowledge acquired for a competent analysis of the mechatronical composition, design of applied mechanism, selection of appropriate control unit and creation of flow-chart diagram. Engineering skill development to synthesize an optimal mechatronical solution to fulfil specified technical requirements.	Achievment of the engineering expertise in a true analysis of mechanisms, sensors, actuators and PLCs as a main components of a mechatronical system. Based on a well studied reverse engineering (analysis), a skillful approach to the direct design (synthesis) of an original mechatronical concept.
1	MSc-0202	obligatory	Thermodynamics M	Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.	After completing the course, including quizzes and tests and successfully passed exam, students shall be ready to independently perform thermodynamic calculations of simpler thermal plants and particular devices. The result of this course is also acquiring fundamental knowledge that serves as the basis for active participation in other theoretical and applicative courses.
