Decree of the Curriculum Committee of the Faculuty of Engineering Science of 16 May 2013, approved by a decree of the Senate of 23 May 2013:

On the basis of §25 para. 1 no. 10 of the University Organisation Act 2002 – UG, BGBl. I No. 120/2002, current version, and §32,"study-law regulations" statutes section", republished in the University of Innsbruck Bulletin of 3 February 2006, Issue 16, No. 90, current version, the following is decreed:

Curriculum for the joint **Master's Degree Programme for Mechatronics** of the Leopol-Franzens University of Innsbruck (LFUI) and UMIT – Private Univesity of Health Sciences, Medical Informatics and Technology

§ 1 Outline of the Joint Study Programme

(1) Mechatronics (deriving from Mechanical Engineering – Electronic Engineering) includes all approaches and techniques for developing systems, procedures, devices and products that are marked by the integration and interaction of mechanic, electronic and information-processing components. It is this integration of methods and techniques that makes it possible that the formerly independent technical specialist fields develop modern systems marked by high-level functionality, efficiency and productivity. This synthesis of the engineering science disciplines of Mechanical Engineering, Electrical Engineering and Informatics that are based on the natural science disciplines of Mathematics, Physics and Chemistry, reflects the interdisciplinary technological challenges of modern engineering processes and appliances and is a driving force for present and future product innovations.

(2) The joint Master's Degree Programme for Mechatronics of the University of Innsbruck (LFUI) and the UMIT – Private Health and Life Sciences University is divided in a general education and a specialized education part according to no. 1 and 2. Students have to choose between the following specialist fields:

1. Industrial Mechatronics and Material Sciences (referred to as IMMS – German:IMW - hereafter) and
2. Biomedical Technology (BMT hereafter).

(3) Irrespective of the chosen field of specialization, all students have to pass four compulsory modules covering 40 ECTS-credits (ECTS-C hereafter) and two optional modules covering 10 ECTS-C.

(4) Students that choose the specialist field of IMMS have to pass two compulsory modules (15 ECTS-C) and five optional modules (25 ECTS-C).

(5) Students that choose the specialist field of BMT have to pass two compulsory modules (15 ECTS-C) and three optional modules (25 ECTS-C).

(6) The master's thesis is credited with 27.5 ECTS-C and the defence of the master's thesis, which concludes the study programme and takes place within the scope of the compulsory module of the name of "Defensio", is credited with 2.5 ECTS-C.

(7) The field of specialization must be chosen at the time of registration for the course according to §7 para. 2 no. 1 to 2 or according to §7 para. 3 no. 1 to 2 and the Dean of Studies of the University of Innsbruck and the UMIT Study Management must be informed in writing of the choice.

The field of specialization may only be changed if the responsible bodies of the two universities agree.

(8) One semester hour (SSt herafter) equals the number of course units corresponding to the number of university weeks in the semester. A teaching unit has the duration of 45 minutes.

(9) For courses held at the UMIT the same regulations for the evaluation apply as at the University of Innsbruck.

§ 2 Qualification Profile

(1) The joint Master's Degree Programme for Mechatronics at the LFUI and the UMIT belongs to the Engineering Studies. The degree of "Diplomingeneurin" or "Diplomingenieur" ("Dipl.-Ing.") resp. that is earned with the conclusion of the study programme corresponds to the international "Master of Science" ("MSc").

(2) Within the scope of the Master's Degree Programme of Mechatronics at the LFUI and the UMIT students acquire knowledge built on the latest findings of the discipline. The engineering science study programme systematically combines research and doctrine and thus enables the students to undertake independent scientific research and to apply theories, methods and instruments in practice at the same time. Graduates acquire the following competences:

1. Natural Science Competence
   a) by gaining a profound knowledge of the basic principles and the methods used in natural science,
   b) by strengthening the ability of analytical, interdisciplinary and networked thinking and of critical reflection,
   c) by improving abstraction and modelling powers;
2. Engineering Competence
   a) by improving the understanding of contexts and problems of engineering science in theory and practice with advanced knowledge,
   b) by gaining subject-specific competence to make the graduates able to apply the basic knowledge of the core areas of the application-oriented subjects,
   c) by encouraging the creative potential for independently finding problem solutions for complex task of the engineering practice,
   d) by imparting strategies for independently developing solutions to new problem statements,
   e) by imparting knowledge of state-of-the-art IT, management and presentation methods,
   f) by improving problem awareness for a holistic view of mechatronic developments in a technical, economic and socio-ecological context;
3. Social Competence
   a) by encouraging the ability to work in a team,
   b) by improving foreign language skills,
   c) by arising the interest in lifelong learning and to continue advanced education individudally.

(3) Graduates of the Master's Degree Programme of the LFUI and the UMIT can, thanks to their education, call on the competence fields listed above. They are qualified for jobs that demand an understanding, applying and developing of scientific findings and methods. Moreover, they are in particular qualified for leading positions in engineering and for subject-specific doctoral programmes which aim at independently researching and developing technical science.

(4) A central element of the Master's Degree Programme of Mechatronics is its focus on sustainability and relevance of knowledge and skills. This is why the imparting of knowledge and competences of scientific methods is given priority to specialist user knowledge. Graduates have the competence to further develop their knowledge and understanding in the field of mechatronics autonomously, also for new and unfamiliar problems or within the scope of research contexts resp. They are especially qualified for demanding tasks in industry and business enterprises in the different fields of mechatronics and the related fields of mechanical engineering, material science, electronic science, medical engineering etc. after brief training periods. There, the advantages of the university education's focus on basic and methodological competence take effect.

(5) The passing of special courses and projects in cooperation with industrial businesses reinforces the competence of using the acquired knowledge in practice and facilitates the graduates' passage to professional life.

(6) The research-oriented university education of the joint Master's Degree Programme of Mechatronics at the LFUI and the UMIT is the basis for access to a vast occupational field in the area of mechatronics, from planning, developing and construction, to production, manufacturing, quality management to consulting. The occupational fields open to the graduates are correspondingly manifold. Typical occupational fields are: (i) employment with an industrial business in the area of machine, vehicle or plant engineering, with producers of electronic, medical-technical, data processing or process control devices and employment with engineering offices, (ii) self-employed work as enterprisers or engineering consultants and (iii) working for educational and research institutions.

§ 3 Scope and Duration

The Master's Degree Programme of Mechatronics covers 120 ECTS-C and based on a workload of 30 ECTS-C per semester it has a duration of four semesters. An ECTS-C corresponds to a workload of 25 hours for the student.

§ 4 Types of Courses and Maximum Number of Participants

(1) Lectures (VO)

1. Lectures aim at conveying the subject matter with oral presentations, explanations and with examples and demonstrations. Interaction of students and lecturer is aimed at.
2. This type of course encourages e.g. the understanding and integration of knowledge based on the latest developments of the discipline.
3. Lectures are courses without continuous performance assessment.

(2) Lecture Tutorials (VU)

1. VU-type courses are a combination of lectures and tutorials, whereby the lecture and tutorial share can be adjusted flexibly depending on the requirements of the subject matter. Should it because of the number of participants be necessary to divide the group for the tutorial part, courses of the VU type have a share of 50% for the lecture part and 50% for the tutorial.
2. This course type similarly encourages the competences and skills listed in para. 1 and 2 no. 2.
3. VU courses are courses with continuous performance assessment.
4. The maximum number of participants for VU courses is usually 30, for practical training, laboratory or machine tutorials usually 15.

(3) Practical Trainings (PR)

1. Practical trainings serve the acquisition of skills by working independently with laboratory equipment. They aim at encouraging practical use of scientific contents.
2. This course type encourages et al. the ability to work in a team, reliability, communication skills, structured working and professional competence in unfamiliar situations.
3. Practical trainings are courses with continuous performance assessment.
4. The maximum number of participants is usually 15.

§5 Admission procedures for the admission to courses with a limited number of participants

The following criteria are considered for allocating places for courses with a limited number of participants:

1. Students, the study time of who would be prolonged without admission to the course, are given priority for admission.
2. If the criteria in no. 1 is not sufficient for regulating admission to a course, students, for whom it is mandatory to pass the course, come first, and students that attend the course as optional course second.
3. Should the criteria in no. 1 and no. 2 not suffice for regulating the admission to a course, the available places are drawn.

§6 Admission

(1) Precondition for being admitted to the joint Master's Degree Programme of Mechatronics at the LFUI and UMIT is the conclusion of a subject-related BA Study Programme, a subject-related BA Study Programme of a College of Higher Education or a comparable study programme of an approved higher education institution at home or abroad.

(2) The conclusion of the joint BA Study Programme of Mechatronics at the LFUI and UMIT is in any case an eligible BA Study Programme.

(3) Admission of students is regulated by the respective responsible authority on both universities. The admission process based on the contract for setting up a joint study programme will be published by the universities separately.

§ 7 Compulsory and Optional Modules

(1) Irrespective of the selected specialization the following four mandatory modules covering 40 ECTS-credits must be passed.

1.	Compulsory Module 1: Mathematics and Information Theory	Univ.	SST	ECTS-Credits
a.	**VO Digital Signal Processing** Sampling theorem; basics of analogue/digital conversion; discrete fourier transformation (DFT), fast fourier transformation (FFT); data windows; z-transformation; basics of digital filers; synthesis FIR-filters: windowing, frequency sampling; synthesis IIR-filters: impulse variability model,biliniar transformation; digitalization of noise signals;	LFUI	2	3
b.	**VO Embedded Systems** Architecture of embedded systems; sensors and actuators of embedded systems, specification languages, VHDL, real time communication, fieldbusses, CAN-bus, CANopen, real time operating systems, task management, middleware;	UMIT	2	3

c.	**VU Mathematical Optimization** Linear and convex optimization, combinatorial optimization, nonlinear optimization (gradient-based and heuristic processes), optimal control of dynamic systems, inverse problems and data adaptation;	LFUI	2	3
	Total		**6**	**9**
	Learning Objectives of the Module: Students are familiar with the mathematical basics of digital signal processing. They understand that the process of sampling in time is unlike an intuitive approach not connected to any loss of information. They know the effects and limiting factors connected to DFT spectral analysis. Students know and apply the most important hardware and software components of embedded systems and real time systems, know the most prevalent specification languages for embedded systems, the general requirements of embedded operation systems and understand the basic problems of real time processing. Students have a profound understanding of mathematical concepts, tasks and methods of optimization and optimal control. Students know and are able to apply the most important numerical procedures. Students have an overview of inverse problems, associated tasks, the most important numerical methods and questions of model adaptation.			
	Registration requirements: none			

2.	**Compulsory Module 2: Mechanics and Mechanical Engineering**	**Univ.**	**SST**	**ECTS-Credits**
a.	**VU Design of Mechatronic Systems and Computer Aided Engineering (CAE)** Product life cycle; factors of the development of mechanic and mechatronic products; designs and structures of virtual products; overview of computer-aided engineering methods in construction and simulation; overview, classification and operating modes of mechatronic components and controls; CAE process chains in the development of mechatronic products; model making in computer-aided development; 3D-CAD construction; digital mock-up (DMU); N-body simulation; finite-element simulation (FEM); product data management (PDM); computer-aided design of a mechatronic system; verification of the concept with CAE methods;	LFUI	2	3
b.	**VU Stength of Materials and Mechanics of Materials** Strength theory (Tresca, Mises, Rankine), non-linear-elastic and anelastic material behaviour, elasto-plastic material behaviour and flow plasticity theory, bearing load ratings, principles of virtual working, stress concentration, linear-elastic fracture mechanics, cyclic stress;	LFUI	3	4
c.	**VU Mechanical Engineering and Construction Technology 2** Alternative construction and calculation of specified single elements: shaft-hub joints, joining (screwing, adhesive bonding, welding), storing as specified; free conceptual design: construction and calculation on a complete prototype group or a system as specified in the product specification (e.g. from the fields of robotics or medical technology);	LFUI	3	4
d.	**VU Dynamics of Machinery** Basics of the dynamics of machinery (assembly of machines, vi-	LFUI	3	4

	bration isolation, vibration absorbers); basics of rotor dynamics; systems of generators, torsional vibration; basics of non-linear generators;			
	Total		**11**	**15**
	Learning Objectives of the Module: Students have an advanced knowledge of and skills for designing mechatronic systems with computer-aided construction and interpretation methods. They understand the relations of product development and are able to apply CAD and CAE modules in the development process. Students possess advanced knowledge of and skills in linear and non-linear strength calculation of building elements under static and cyclic stress. Students have the skills to find solutions and alternatives for problems related to machine engineering, to assess them and to realize them in a constructive way. Students possess advanced knowledge of general machine assembly and vibration decoupling and can lay classic vibration absorbers. They understand the effects of imbalances in rotors and have a basic knowledge of the theory of oscillation, oscillator chains and non-linear oscillators.			
	Registration requirements: none			

3.	**Compulsory Module 3: Electrical Engineering**	**Univ.**	**SST**	**ECTS-Credits**
a.	**VU Electromechanic Actuators** Advanced basics of electric machines, micromotors, linear and rotatory servo drives for controlling electro-mechanic actuators;	UMIT	2	3
b.	**VU Theoretical Electrical Engineering** Charges and electrostatic field; electricity and static current field; static magnetic field; time-dependent electro-magnetic field; induction and motion induction; electromotive force (e.m.f.); Maxwell‘s equations; retarded potentials; Coulomb gauge; Hertzscher’s dipole; transmission line theory; quadrupoles, skin-effect;	LFUI	3	4
	Total		**5**	**7**
	Learning Objectives of the Module: Applying the theoretical basics in the area of electric machines, the students possess an advanced competence in the area of electrical engineering/drive engineering. Students have specialist knowledge in the area of vector analysis and are thus able to describe the electro-magnetic field. They are familiar with the physical/atomic basics of electrical engineering and understand the significance and importance of Maxwell’s equations.			
	Registration requirements: none			

4.	**Compulsory Module 4: Electrical Engineering and Informatics**	**Univ.**	**SST**	**ECTS-Credits**
a.	**VU Digital Image Processing** Characteristics of digital images; histogram equalization; filtering in the spatial domain; mathematical morphology; discrete Fourier transformation; deconvolution; wavelet transform; Radon transform; Hough transform; examples for application;	UMIT	2	3
b.	**VU Computer Networks and Internet Technology** Layerd system structure; methods of the application layer; end-to-	LFUI	2	3

	end transfer in the transport layer (incl. error correction and overload check); routing and forwarding in the network layer; data link layer; physical layer; comprehensive aspects of service quality characteristics and network safety;			
c.	**VU Control of Mechatronic Systems** Design of state controllers and state observers, derivation of the Kalman filter and its application fields; implementing of digital controllers (criteria for selecting the controller, selection of the sampling time, algorithms, robust fixed-point and floating-point realisations), identification or rating of system states, system diagnosis and their integration in fault-tolerant mechatronic systems;	UMIT	2	3
	Total		**6**	**9**
	Learning Ojectives of the Module: Students are familiar with the types and characteristics of digital images and the basic spectrum of methods used for processing images in the typical application areas. Students are familiar with computer networks and have the competence to independently acquire advanced knowledge that goes beyond the scope of the course. Students posses the competence to design mechatronic systems controllers, to realise possible solutions for implementation in a competent way and to complete the regulation by extensive system observation and diagnosis. They acquire the competence to select and apply a suitable method for a given problem and to find possible solutions for complex tasks by combining or changing elementary methods.			
	Registration requirements: none			

(2) If a specialization in IMMS (IMW in German) is chosen, courses amountaing to a total of 15 ECTS-credits must be passed of the following two compulsory modules.

1.	**Compulsary Module 5: Industrial Mechatronics and Material Science 1**	**Univ.**	**SST**	**ECTS-Credits**
a.	**VU Hydraulic and Pneumatic Power Drives** Structure and modes of operation of pumps and motors and their regulation; hydraulic transformers or energy saving; discussion of open and closed circuits with circuit diagrams; discussion of energy-efficient drives without throttles; discussion of oscillating and linear motors; special constructs for automation; telescopic cylinders – single- double-acting and with a constant process rate; basics of proportional and servo technology; differences and use of drives and regulators; discussions of problems of controlling differential cylinders with proportional valves; design of circuit diagrams; detecting and discussion of faulty drives; laying and calculating of machines; discussion of pneumatic sequence control systems with isolation of the control circuit and cyclic chain control with the help of circuit plans;	LFUI	2	3
b.	**VU Process Automation** Control circuits with PI/PID-controllers; anti-windup, analysis of control circuits with limits and non-linearity by applying the describing function method, choice of sampling time for digital control circuits, frequency-response characteristics method for time-discrete control circuits, quantification of the control quality and performance with appropriate system norms and quality criteria, modern frequency domain methods, Youla-parametrization and advanced-loop-shaping;	UMIT	2	3

	Total	**4**	**6**
	Learning Objectives of the Module: Students possess, subject-specific for hydraulic and pneumatic drives, advanced knowledge and skills regarding regulated open and closed circuits of hydraulic and pneumatic systems. They have a profound knowledge of the uses of proportional and servo technology. They understand the correlation of electro-hydraulic and electro-pneumatic drives and controllers. The students possess the competence to design circuit diagrams and to calculate machines. They are able to analyse circuit diagrams, recognize and eliminate errors. Students also have a deep understanding of classic control circuits and their practice-relevant extensions and methods of analysis and their time-discrete realisation. They are familiar with modern frequency range methods and advanced methods of control technology.		
	Registration requirements: none		

2.	Compulsory Module 6: Industrial Mechatronics and Material Sciences 2	Univ.	SST	ECTS-Credits
a.	**VU Manufacturing Techniques 2** Advanced knowledge of the DIN 8580 manufacturing techniques with special focus on manufacturing of mechatronic and miniaturised compoments; introduction to industrial production and the corresponding manufacturing planning and cost planning;	UMIT	2	3
b.	**PR Industrial Mechatronics and Material Sciences – Laboratory** Interdisciplinary laboratory on themes attuned to the subject areas: design of mechatronic systems, electric drive technology and power electronics, control and automating technology, digital signal processing, mechanics, real-time systems and NanoLab - material analysis;	LFUI, UMIT	2	3
c.	**VU Material Engineering 1** Structure and mechanic characteristcs of materials; alloyal structure of metal materials (crystallisatioin, observing of thermodynamic stability, diffusion, precipitation reactions); stabilizing mechanisms; warmth treatments; fatigue; creepage; residual stress; steel for construction and machine engineering; synthetic materials and composite materials;	LFUI	2	3
	Total		**6**	**9**
	Learning Objectives of the Module: The students have a detailed knowledge of the manufacturing processes that can be used for making mechatronic components. They are able to select suitable processes for specific tasks and to plan the manufacturing process for industrial production as well as to estimate the manufacturing cost. Students have practical skills in the field of mechatronics and are able to deal with and solve interdisciplinary tasks target-oriented by considering the sub-disciplines and their interactions. They are able to independently study the lab documents and to independently approach the tutorial with professional guidance. Students have an advanced knowledge of the structure of materials and of their mechanical characteristics. With regards to metallic materials, they are familiar with the micro-structures that are the result of alloys and warmth treatments and with their characteristics. Thanks to their deep understanding of the metallographic mechanisms regarding the mechanical characteristics like strength, deformability, creepage or fatigue, students are able to assess an individual load situation appropriately and to develop strategies for solving the problems. They also have an advanced knowledge of the different materials, from simple steel for construction or machine engineering, tool steel to synthetic materials and complex compound materials.			
	Registration requirements: none			

(3) If a specialization in BMT is selected courses covering a total of 15 ECTS-credits must be passed of the the following two compulsory modules.

1.	Compulsory Module 7: Biomedical Technology	Univ.	SST	ECTS-Credits
a.	**VU Anatomy, Physiology and Biochemistry** Microscopic and macroscopic structure of the human body, musculoskeletal system, organs, organ systems, basic knowledge of physiological processes of the organs and biochemical metabolic processes;	UMIT	2	3
b.	**VU Clinical Medicine** General pathology, overview of the individual specialist fields of clinical medicine, individual pathologies and basics of diagnostics and therapy;	UMIT	2	3
	Total		**4**	**6**
	Learning Objectives of the Module: Students know the basic anatomic structure of the human body and can name the parts. They understand basic physiological correlations and have a command of the basic medical terminology for naming anatomic and physiological terms. They understand basic medical contexts (pathologies, diagnosis and therapy approaches) and are able to understand medical specialist conversation.			
	Registration requirements: none			

2.	Compulsory Module 8: Biomedical Technology 2	Univ.	SST	ECTS-Credits
a.	**VU Biomedical Imaging** Imaging, basic characteristics and types of biomedical images, histogram equalization, local filters in the domain of space, mathematical morphology, geometric transformation, interpolation, segmentation, classification, visualisation; application fields in diagnostics, therapy and medical technology;	UMIT	2	3
b.	**VU Biomedical Technology - Laboratory** ECG-amplifier, recording and interpreting standard ECGs, cardiac pacemakers, biomedical sensors; ultrasound and sonographic applications (US principles, A-, B-, M-mode, 3D-US, foetal pulse detectors); high-frequency technology, transmission line theory, Smith-diagram, adaptation, filtering, λ/4-transformation, measurement of scattering parameters (S-matrix), skin-effect; neurostimulators, functional electrical stimulation (FES), transcutaneous transmission of data and energy, cochlear implants;	LFUI, UMIT	2	3
c.	**VO Biomedical Technology 1** Introduction to medical devices (classification and classes, MPG, technical safety, norms); electro-cardiology – model forming and simulation (ion current model, action potential, ECG amplifier and signal analysis); biomedical sensors (electrodes, blood pressure measurement, chemical sensors, optical sensors); bio materials (micro engineering, tissue engineering); technical assist systems (prosthesis, pump systems, cardiac pacemakers, defibrillators, artificial organs);	UMIT	2	3

	Total	**6**	**9**
	Learning Objectives of the Module: Students have a command of the basic methods of creating, editing, analysing and visualising biomedical image data. Students are able to assess possibilities and limits of biomedical systems and components. They have the competence to independently study laboratory documents and to independently carry out the laboratory exercises under professional guidance. They know about the basic physiological principles and methods, concepts and systems of biomedical technology and their practical use in electro-cardiology, biomedical sensor systems and technical assist systems.		
	Registration requirements: none		

(4) Irrespective of the chosen field of specialization, the compulsory module of "Defensio" covering 2.5 ECTS-credits that finalises the studies must be passed in addition to the Master's Thesis.

	Compulsory Module 9: Defence of the Master's Thesis (Defensio)	**Univ.**	**SST**	**ECTS-Credits**
	Oral defence of the Master's Thesis in front of an examination board;	LFUI, UMIT	-	2.5
	Total		**-**	**2.5**
	Learning Objectives of the Module: Reflection of the Master's Thesis in the overall context of the Master's Degree Programme of Mechatronics; Emphasis is on theoretic understanding, methodological foundations, imparting of results of the Master's Thesis and presentation skills.			
	Registration requirements: positive evaluation of all compulsory modules and the required optional modules, plus the Master's Thesis.			

(5) If IMMS (IMW in German) is the chosen field of specialization, courses covering a total of 25 ECTS-credits have to be passed of the following optional moduels.

1.	**Optional Module 1: Industrial Mechatronics and Material Sciences 3**	**Univ.**	**SST**	**ECTS-Credits**
a.	**VU Design Methods and Manufacturing Theory** Methods and tools for structured manufacturing and designing; inventive problem solving and methodical innovating: problem analysis, problem description, problem-solving methods, structure analysis and synthesis, functional analysis; simultaneous engineering; failure mode and effect analysis (FMEA); TRIZ; SWOT evaluation analysis; morphological analyis; stress-strength theory; experimental methods; trial and testing in the development process;	LFUI	2	2.5
b.	**VU Power Electronics and Electrical Drives** Semiconductor devices and basic circuits of power electronics, power amplifiers, line commutation inverters, chopper converters, electromagnetic tolerance of power electronics;	UMIT	2	2.5
c.	**VU Surface Technology** PVD (physical vapour deposition or vacuum or thin film technology) process technologies as modern industrial engineering techniques for functionalization of surfaces; manufacturing of thin	LFUI	2	2.5

	films for application in the field of mechanical engineering, tools, optics, electronics, motorcars; materials and material characteristics of thin films; technical plasmas for supporting the manufactoring processes and for influencing the surface features;			
d.	**VU Optimization of Material Engineering** Multi-scale concept; experimental characterization (NanoLab) and scale changes; methods of optimization; bionics; computer-based design of new materials;	LFUI	2	2.5
e.	**VU Robotics 2** Advanced knowledge of the different robot systems (serial, parallel and rolling robots); singularities, dynamics, route planning, collison avoidance;	LFUI	2	2.5
f.	**VU Technical Logistics** Introduction to industrial logistics and the technical problems faced in a business environment; material handling engineering (consignnment, transport and sorting systems); identification and localization of goods (RFID-systems, 2D-codes); methods of material handling systems, especially material handling analyses, depiction of work sequences with flow diagrams and function charts and the corresponding planning methods to be applied; dimensioning and calculation of logistics facilities; case studies;	LFUI	2	2.5
	Total Courses covering 5 ECTS-credits have to be passed from the courses listed from a to f.		**4**	**5**
	Learning Objectives of the Module: Students have the competences and skills for innovatively designing mechatronic systems. They can resort to an advanced basic knowledge in the area of technical engineering, material sciences and power electronics and can develop innovative solution and application approaches for technical problems in relevant industrial areas, assess their suitability for application and eventually constructively imply the measures.			
	Registration requirements: none			

2.	Optional Module 2: Industrial Mechatronics 1	Univ.	SST	ECTS-Credits
a.	**VU Process Measurement Technology** Measuring of non-electrical quantities, principles of computer-aided measurement technology, basic structures of measurement systems, spatial distribution, synchronization and processing power requirement of processes); sensor technology in MES (sensor systems in automisation technology, sensors in material measurement technology); data mirgration in computer architecture (principle, hardware, software); computer concepts in measurement systems and data logging by means of conventional and graphic-object-oriented programming.	UMIT	2	2.5
b.	**VU Regulation of Non-Linear Systems** Mathematical models of non-linear systems, fundamental differences of the behaviour of linear and non-linear systems: existence and uniqueness of the solutions, chaos, finite exhaust time, rest positions, limit cycles and general invariant fields of the state space, Lyapunov-stability, exponential stability, Lyapunov functions and Lyapunov-based control, backstepping and differentialgeometrical techniques: input, output and state stability, exact linearization, flat systems and flatness-based control;	UMIT	2	2.5
c.	**VU Robot Control** Robots in industry, structure and overview of robot controls and their programming, forming of kinematic and kinetic models for serial robots, mathematics of the motion of rigid bodies, rotations, translations, homogenous transformations, direct and inverse kinematics, die Denavit-Hartenberg-convention, Jacobi-matrices, dynamics of link drives and controllers, robot dynamics, multivariable systems and motion control, impedance control, exact linearization of equations of motions of serial robots, planning of paths and trajectories;	LFUI, UMIT	2	2.5
d.	**VU Industrial Mechatronics 1 – Advanced** Alternatingly courses on special module-relevant themes, eg. applied automatisation, optimized filtering, robust and optimized control are offered;	LFUI, UMIT	2	2.5
	Total Courses covering a total of 5 ECTS-Credits have to be passed from the courses listed from a. to d.		**4**	**5**
	Learning Objectives of the Module: Students have an advanced understanding of the the theme complex of automation and control, which is vital to the functional design of mechatronic systems. Additonally to their basic knowledge of this specialist area the students are able to use advanced methods for system-modeling, analysis and synthesis and to apply them in a targeted and innovative way.			
	Registration requirements: none			

3.	Optional Module 3: Industrial Mechatronics 2	Univ.	SST	ECTS-Credits
a.	**VU Mechatronic Systems for Generating Renewable Energies**	LFUI	2	2.5

	Basics of biological waste treatment, generating of renewable energies from organic waste, conditioning and possible uses of biogas and mechatronic systems used for that purposes; if possible in cooperation with an industrial business;			
b.	**VU Converter Technology** Rectifiers, inverted rectifiers, frequency inverters, circuit feedback, power factor correction, thermal stress and cooling, safety technology, field-oriented control of induction machines;	UMIT	2	2.5
c.	**VU Thermofluid Dynamics** Basic terms of technical thermo-dynamics, fluid dynamics and thermal transfer (heat conduction and convection); similitude theory, dimensionless parameters, kinematics of fluids, continuity equation, Navier-Stokes-equations, Euler equation of movement, Bernoulli-equation, application of Bernoulli's equation, one-dimensional transient flows; flows with friction, laminar and turbulent flows, flow processes with thermal transfer, basics of fluid flow enginges; introduction to CFD;	LFUI	2	2.5
d.	**VU Industrial Mechatronics 2 - Advanced** Alternatingly courses on special module-relevant themes, eg. electric systems engineering, multi-body dynamics, structure dynamics are offered;	LFUI, UMIT	2	2.5
	Total Courses covering 5 ECTS-credits have to be passed from the courses listed from a. to d.		**4**	**5**
	Learning Objectives of the Module: Students have an advanced knowledge of industrial applications of mechatronic systems and are able to implement them on the basis of practical examples. They are familiar with complex, interconnected mechatronic processes, their subject-specific principles and selected fields of application that are relevant to industry and thanks to the research-oriented doctrine they are able to approach the development and implementation of independent, innovative approaches towards the solution of problems.			
	Registration requirements: none			

4.	Optional Module 4: Material Sciences 1	Univ.	SST	ECTS-Credits
a.	**VU Composites** Manufacturing, laying and designs of composite structures; material science: fiber materials, matrix materials, core materials; manufacturing technique: draping, weaving, automated fiber placement etc; hand-lamination technology; autoklav method, infusion and injection technology etc; elastic behaviour of composites; fracture behaviour of composites; joining technology (mechanic, adhesive bonding); composite building techniques;	LFUI	2	2.5
b.	**VU Lightweight Design** Concepts and strategies of lightweight design, design principles, criteria for selecting the materials, lightweight design potential of isotropic and anisotropic leightweight design structures, structural-mechanics basics of leightweight design, structure optimization, reliability proofs;	LFUI	2	2.5
c.	**VU Material Engineering 2** Durability and fracture mechanics; fracture behaviour and types of fracture; residual stress and its effect on metallic materials; mechanisms of corrosion and corrosion prevention; chemical resistant steel (austenites, duplex steel etc.); introduction to high-performance materials (ni-base supperalloys, titan etc.);	LFUI	2	2.5
d.	**VU Material Sciences 1 - Advanced** Alternatingly courses on special module-relevant themes, eg. special materials and technologies, materials in mechatronics – electronic compenents, materials in mechatronics – precision engineeering are offered;	LFUI	2	2.5
	Total Courses covering 5 ECTS-credits have to be passed from the courses listed from a. to d.		**4**	**5**
	Learning Objectives of the Module: Students have an advanced knowledge of mechatronic systems and their applications and are thus able to select and optimize the material and structure of mechatronic components for a specific application. Thanks to their advanced understanding of mechanic and material science theories they are able to provide innovative solutions.			
	Registration requirements: none			

5.	Optional Module 5: Material Sciences 2	Univ.	SST	ECTS-Credits
a.	**VU ASIC-Design** Design of digital circuits with VHDL (Very High Description Language): basic structures (entity/architecture/packages); programme structures (if-clause, case-clause, process-statement); testing of digital circuits: oberservability and controllability, test vectors, test structures; manufacturing process of ASICs (Application Specific Integrated Circuits) and VHDL; design input via design synthesis, integration of component libraries, simulation, to "first silicon" testing;	LFUI	2	2.5
b.	**VU Joining Manufacturing Techniques** Advanced knowledge of the manufacturing techniques in the area of joining technology (soldering, welding, adhesive joining, shaping etc.); examination of the resp. machine tools and the reqirements for the application of the techniques;	LFUI	2	2.5
c.	**VU Micro- and Precision Processing** Manufacturing techniques for micro- and precision processing (sanding, HSC-milling, lapping, honing etc.) of shapes and surfaces; requirements and limits of the respective techniques; advanced knowledge of manufacturing techniques for precison processing; relation between production cost and precision;	LFUI	2	2.5
d.	**VU Material Sciences 2 - Advanced** Alternatingly courses on special module-relevant themes, e.g. treating of special and new materials, computer-aided methods of product development and manufacturing, tool machines are offered;	LFUI	2	2.5
	Total Courses covering 5 ECTS-credits have to be passed from the courses listed from a. to d.		**4**	**5**
	Learning Objectives of the Module: Students have an advanced knowledge of and skills in the area of material sciences and industrial mechatronics. They are familiar with the physical basics, the manufacturing processes and techniques and can realistically assess their possible applications for the problems in questions, select appropriate techniques and apply them, as well as develop new ones.			
	Registration requirements: none			

(6) If BMT is the chosen field of specialization, courses covering 25 ECTS-credits of the following three optional modules have to be passed.

1.	Optional Module 6: Biomedical Technology 3	Univ.	SST	ECTS-Credits
a.	**VU Biostatistics** Problems of descriptive statistics, probabilities and distributions, formulating and testing of hypothesis, evaluaters, comparison of statistic values, regression and correlation, biologic applications, biostatistical software;	UMIT	2	2.5
b.	**VO Basics of Biomechanics** Biomechanic basics of the musculoskeletal system, the cardiovascular system and the respiratory system; forces of the musculoskeletal system; fluid dynamics (blood) in the heart, lung, arteries and veins;	UMIT	2	2.5
c.	**VO Technical Principles of Active and Passive Implantable Systems** Basic principle of functional electric stimulation (FES): coupling of electric fields to neurons; problem of inverse recruitment; energy supply of active implants; data supply of active implants (date transmission principles: optical, ultrasound, high frequency); stimulation electrodes: critical current density; biocompatible surfaces of active and passive implants; concrete examles: cardiac pacemakers, cochlear implants;	LFUI	2	2.5
	Total Courses covering 5 ECTS-Credits have to be passed from the courses listed from a to d.		**4**	**5**
	Learning Objectives of the Module: Students have a deep understanding of theoretical and practical aspects of several application areas of biomedical technology. They have an advanced knowledge of the methods as a basis for acquiring advanced knowledge in related areas of medical technology. The students are familiar with complex, interrelated bio-mechatronic processes and apply this knowledge for special developmental tasks in this area.			
	Registration requirements: none			

2.	Optional Module 7: Biomedical Technology 4	Univ.	SST	ECTS-Credits
a.	**VU Biomedical Technology** European safety strategy, Medicinal Devices Act, structure of the standard specifications, clinical engineering, medical device technology, safety concepts for medical devices, conformity evaluation, risk factors, safety and effects of electric impacts on the human body; hospital technology (electric installations in rooms used for medical purposes, emergency batteries, classification of rooms, explosion protection); quality management in medical technology;	UMIT	2	2.5
b.	**VU Biological Regulation** Introduction to the mathematical descripton of physiological systems, model formation, basic principles of biological regulation: basic terms, models and classification, exchange processes and	UMIT	2	2.5

	their mathematical description, general system-analytic reflection of physiological regulatory circuits, sensors and receptors, regulation of the blood chemistry and the nervous system, temperature regulation, blood pressure regulation, regulation of the circulatory system, regulation of the respiratory system, metabolism and energy rate;			
c.	**VU Biomedical Technology 2** Forward and inverse problems of electrocardiology, model formation and simulation, brain-computer-interface and neurostimulation, functional diagnostics and patient monitoring, advanced methods of biomedical signal processing, accompanying laboratory tutorials to the lecture;	UMIT	2	2.5
d.	**VU Advanced Methods of Medical Image Analysis** Modelling and simulation of form and structure changes, registration methods (point- and intensity-based), model-based segmentation, analysis and classification; applications in diagnostics and therapy, especially in surgery, radiation therapy and pathology;	UMIT	2	2.5
e.	**VU Materials in Mechatronics – Medical Technology** Biocompatible organic and inorganic materials; methods for determining biocompatibility; absorbable materials; polymers; metals; ceramic materials;	LFUI	2	2.5
f.	**VU Biomedical Technology 4 - Advanced** Alternatingly courses on special module-relevant themes, e.g. special themes of biomedical technology, microscopic techniques are offered;	LFUI, UMIT	2	2.5
	Total Courses covering a total of 10 ECTS-credits have to be passed from the courses listed in a. to f.		**8**	**10**
	Learning Objectives of the Module: Students have an advanced knowledge of and skills in biomedical technology and are able to put these in practice in the area of system development. They are familiar with complex biomechanic processes and acquire independent solutions for the development of components, devices and systems of medical technology based on the research-focused doctrine.			
	Registration requirements: none			

3.	Optional Module 8: Biomedical Technology 5	Univ.	SST	ECTS-Credits
a.	**VU Biomedical Mass Spectrometry** Principles of modern mass spectrometry (MS) like time of flight mass spectrometry, ion traps-MS and chromatography and their applications for biomedical purposes; functionality and limits of the respective technologies; strategies for analysing the data;	LFUI	2	2.5
b.	**VU Biomedical Modelling and Simulation** Introdcution to modelling and simulation, spatial and temporal discretization; special applications of numeric methods for solving ordinary and partial ODEs, Finite-Difference-Method (FDM), Finite-Elements-Methode (FEM), iterative solution procedurees, convergency studies; physical relations of biomedical models and systems; concrete models like e.g. Hodgkin-Huxley-modell, characterics of models and systems, linearization, model validation, tutorial with Matlab/Simulink;	UMIT	2	2.5
c.	**VU Data Mining in Biomedicine** Statistic principles, data preparation (data transformation, integration, selection of attributes), classification (quality measures, validation, binary logistic regression, K-NN, Bayes, decision trees, SVM, neuronal networks, esemble methods), clustering (k-means, EM-algorithm, density-based methods, hierarchic methods), clusterin in high-dimensional data;	UMIT	2	2.5
d.	**VU eHealth** Concepts, definitions and terms; basic decision and financing structures in the Austrian health sector; concepts of electronic files: electronic health files, electronic patient files etc.; standardization of information systems (et al. IHE, DICOM, HL7, CDA etc.); information system architectures; electronic health files in Austria and Europe: concepts and architectures; data safety; legel principles of eHealth; quality of the electronic files;	UMIT	2	2.5
e.	**VU Hospital Information Systems** Modules and functionality of hospital information systems, types of architecture, static modelling with 3LGM, integration of heterogenous information systems (data integration, semantic integrationn etc.), communication standards (HL7, DICOM, CDA), electronic patient file, site visits, HL7-interface tutorial;	UMIT	2	2.5
f.	**VU Biomedical Technolgoy 5 - Advanced** Alternatingly courses on special module-relevant themes, e.g. molecular-biological methods for diagnostics and therapy, system biology are offered;	UMIT	2	2.5
	Total Courses covering 10 ECTS-credits have to be passed from the courses listed from a to f.		**8**	**10**
	Learning Objectives of the Module: Students have an advanced knowledge of biomedical technology and informatics and can assess the possible use of relevant devices and software for targeted applications of medical technology. They are familiar with the methods for analysing, designing and developing special applications in medical technology and informatics and to independently develop the required problem solutions.			

	Registration requirements: none

(7) Irrespective of the selected field of specialization, courses covering 10 ECTS-credits have to be passed from the following two elective moduels.

1.	Optional Module 9: Advanced Mechatronics	Univ.	SST	ECTS-Credits
a.	**VU Adaptive and Intelligent Control Systems** Decision processes, performance measures, stability, neuronal networks, genetic algorithms;	LFUI	2	2.5
b.	**VU Computer-Vision** Geometric principles, transformation groups, 3D-scene geometry, camera geometry, diction of features in images: edges, corners, SIFT-features, epipolar geometry, reconstruction of 3D-information from image pairs and series, motion detection in image series, shape from shading;	UMIT	2	2.5
c.	**VU Electronic Speech Recognition** Principles of digital speech signal processing, features of a speech signal, recognition of individual words, recognition of continuous speech (verification, identification), fields of application of speech processing, experimental research;	UMIT	2	2.5
d.	**VU Fuzzy-Methods** Principles of fuzzy quantities and fuzzy numbers, fuzzy-logics, fuzzy-inference system, analysis and processing of fuzzy data, arithmetics of fuzzy numbers, fuzzy-input-output models, draft of fuzzy regulators;	LFUI	2	2.5
e.	**VU RF-Engineering** Transmission line theory; solving of the wave equation – wave functions; S-parameters; Smith-diagram; parallel waveguides; hollow conductors; microstrip lines; band filters, LC-oscillators; quartz oscillators:	LFUI	2	2.5
f.	**VO Information Theory** Principles of the information theory acc. to Shanning; information content, entropy; channel capacity; channel coding; mutual information analysis; coding acc. to Huffman; features of technical codes; cyclic redundancy check (CRC); cyclic codes; Galois fields; principles of cryptography; trapdoor functions; public-key systems (knapsack systems, RSA);	LFUI	2	2.5
g.	**VU Microelectronics and Electromagnetic Compatibility** Basic structures of analogous integrated MOS-circuits (bias sources, band-gap references, on-chip oscillators, differential amplifiers, comparators, power sources); switched-capacitor technology; 1/f-noise; technical principles of electromagnetic compatibility; shielding; effects of ionising radiaton on integrated MOS-circuits;	LFUI	2	2.5
h.	**VU Physical Principles Principles of Semiconductor Devices** Binding model: intrinsic conduction, impurity conduction; electrical features: drift current, diffusion current, conductibility; energy-band model, pn-junction, diode, bipolar construction elements, MOSFET, memory cells, techniques of bulding elements engineer-	LFUI	2	2.5

	ing;			
i.	**VU Signals and Systems** Continuous control Fourier, Hilbert and Laplacet transformation; LTI-systems; convolution; causality and stability; transfer function; analogous filters (e.g. Butterworth filter, Bessel filter); sigma-delta-modulation; spread spectrum systems (satellite communication)	LFUI	2	2.5
j.	**VU Advanced Mechatronics - SelectedThemes** Alternatingly courses on special module-relevant themes, e.g antennas, production measurement technology, software design are offered;	LFUI, UMIT	2	2.5
	Total Courses covering a total of 5 ECTS-credits have to be passed from the courses listed in a. to j.		**4**	**5**
	Learning Objectives of the Module: Students have an advanced knowledge and skills in different specialist fields of mechatronics. They have the competence to independently address complex problems of advanced mechatronics in methodological appropriate way and to develop innovate problem solutions.			
	Course requirments: none			

2.	**Optional Module 10: Additional Qualifications**	**Univ.**	**SST**	**ECTS-Credits**
	Courses covering a total of 5 ECTS-credits; one course can be passed in the area of "Equality and Gender". Also courses from other Master's Degree Programmes of the LFUI and UMIT can be passed. It is also recommended to attend courses that encourage competences for imparting knowledge of the subjects. Suitable courses are in particular: Introduction to Economics and Management (LFUI) Foreign Language 2 (LFUI) Gender Aspects in Technology 2 (LFUI) IT-Project Management (UMIT) Standards and Rules in Mechatronics (UMIT) Patent- and Copyright (LFUI) Social Competences 2 (LFUI) Mechatronics Practice 2 (UMIT) To attend the seminar "Mechatronics Practice 2" proof of an appropriate practical experience covering 160 working hours is required.	LFUI, UMIT	-	5
	Total Courses covering 5 ECTS-credits must be passed.		**-**	**5**
	Learning Objectives of the Module: Students have the qualification to get involved in a scientific discourse in a constructive, responsible and gender-sensitive way that also goes beyond the boundaries of their specialist discipline.			
	Course requirements: The course requirements specified in the respecitive Curriculum must be met.			

§ 8 Master Thesis

(1) In the Master's Degree Programme of Mechatronics a Master's Thesis covering 27.5 ECTS-credits must be written. The Master's Thesis is a scientific piece of work that serves as proof that the students are able to independently deal with a scientific theme in a methodologically and thematially responsible way.

(2) The theme of the Master's Thesis is to be taken from an area of Mechatronics.

(3) Students may suggest a theme for their Master's Thesis themselves or select from given themes.

(4) The Master's Thesis must be handed in at the university the main supervisor belongs to. The thesis must be submitted in writing and in the electronic form specified by the responsible authority of the respective university.

§ 9 Examination Regulations

(1) Course lecturers inform the students on the evaluation criteria before the course starts and determine an examination method as listed in para. 2 to 5.

(2) An exam takes place at the end of the course to assess the performances of each lecture of a compulsory or optional module. Examination method: written and/or oral examination.

(3) Tutorials and practical courses of a compulsory or optional module are courses with continuous performance assessment all through the course.

(4) Lecture-tutorials of optional and compulsory modules are courses with continuous performance assessment for the tutorial part and a final examination at the end of the course for the lecture part of the course. Examination method: tutorial: continuous performance assessment; lecture: written and/or oral examination.

(5) Seminars of compulsory and optional modules are courses with continuous performance assessment and a final examination at the end of the course. Examination method: continuous performance assessment and written and/or oral examination.

(6) A compulsory module is passed with the positive evaluation of all required courses of the respective module.

(7) Optional modules are passed with the positive evaluation of all courses required for reaching the amount of ECTS-credits according to §7 para. 5 to 7.

(8) Requirements for registering for the Master's Thesis is the successful completion of the compulsory modules 1 and 2 acc. to §7 para. 1, no. 1 and 2.

(9) According to the cooperation agreement for realizing the joint Master's Study Programme for Mechatronics with the UMIT University of 8 March 2013, the defense of the Master's Thesis must be made at the university where it was written. The defense is an oral examination in front of an examination board of three persons. The examination board must consist of persons from both universities, who are chosen according to the respective effective regulations of the University of Innsbruck.

§10 Academic Degree

Graduates of the joint Master's Degree Programme of Mechatronics, of the Leopold-Franzens-University of Innsbruck and UMIT – Private Univesity of Health Sciences, Medical Informatics and Technology earn the academic degree of "Diplon-Ingenieurin" or "Diplom-Ingenieur" abbreviated as "Dipl.-Ing." or "DI" resp.

§11 Coming into Force

This curriculum comes into force on 1 October 2013.

For the Curriculum Commitee:
Ao. Univ.-Prof. Dipl.-Ing. Dr. Rudolf Stark

For the Senate:
Univ.-Prof. Dr. Ivo Hajnal