Agency for Quality Assurance and Accreditation Austria

Expert Evaluation Report "Mechatronics" (M.Sc.) Joint Master's Study Programme

Vilnius Gediminas Technical University & Technical University of Braunschweig

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1 General information

Vilnius Gediminas Technical University and Technical University of Braunschweig mandated AQ Austria with the mandatory accreditation of the Joint Master Programme in Mechatronics according to the Rules for the Accreditation of Study Programmes and for System Accreditation of the German Accreditation Council. The study programme is being assessed in the following report.

1.1 Basic principles of the procedure

AQ Austria is the Austrian agency for quality assurance and accreditation in higher education. The agency is operating in Austria and other countries of the European Higher Education Area (EHEA). It is committed to serving the common good and is based on the values of the European Higher Education Area, in particular the autonomy and diversity of higher education institutions and independent quality assurance.

By granting accreditation to the study programme, AQ Austria confirms its compliance with:

- Rules for the Accreditation of Study Programmes and for System Accreditation, 20.02.2013, German Accreditation Council
- Common Structural Guidelines of the Länder for the Accreditation of Bachelor's and Master's Study Courses, 04.02.2010, The Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany
- Methodology for Evaluation of Higher Education Study Programmes, 20.12.2010, The Director of the Centre for Quality Assessment in Higher Education (Lithuania)
- Procedure of the External Evaluation and Accreditation of Study Programmes
- General Requirements of Joint Study Programmes, 03.02.2014, Minister of Education and Science of the Republic of Lithuania

Before the procedure was initiated, AQ Austria also consulted with the Lithuanian accreditation agency SKVC - Centre for Quality Assessment in Higher Education with regard to the compliance of the two accreditation systems and their according rules.

The expert report is structured accordingly to the following criteria:

Criterion 1: Qualification objectives of the Study Programme Concept
Criterion 2: Conceptual Integration of the Study Programme in the System of Studies
Criterion 3: Study Programme Concept
Criterion 4: Academic Feasibility
Criterion 5: Examination System
Criterion 6: Programme-related Co-operations
Criterion 7: Facilities
Criterion 8: Transparency and Documentation
Criterion 9: Quality Assurance and Further Development
Criterion 10: Study Programme with a Special Profile Demand (Joint Programme)
Criterion 11: Gender Justice and Equal Opportunities

The accreditation pursues the principles of a peer-review and follows the procedural steps:

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- In the acquisition phase the AQ Austria informs the Higher Education Institution making the application about essential contents, procedural steps and criteria of the accreditation proposal. In connection with this, the AQ Austria ensures a complete specification and determines the fees.
- The higher education institution has to submit a well-founded self-evaluation report, which covers a presentation of the study programme(s) and documents the compliance with the criteria for the accreditation of study programmes.
- AQ Austria appoints an expert group, which ensures the assessment of all areas relevant for the review (e.g. professional aspects, study-related structural and formal aspects, social aspects). The relevant interest groups, particularly representatives of the sciences, students and practitioners from the profession, are part of the expert group.
- AQ Austria ensures the impartiality of the experts and observes fairness towards the applying Higher Education Institution. To this end, AQ Austria gives the Higher Education Institution a right to object. The Higher Education Institution does not have a right of proposal or a power of veto.
- AQ Austria briefs the experts on the assessment activity, their specific role, and the concrete accreditation procedure. The briefing also includes conversational proficiency and the preparation of reports.
- The assessment is essentially based on
    - the analysis of the application rationale and
    - an on-site visit, which among other things includes separate discussions with the management of the Higher Education Institution, teaching staff and students.
- AQ Austria can dispense with an on-site visit (unless in the case of a first accreditation), if it has evaluation results, which are not older than two years and which were obtained according to the appropriate rules of the Accreditation Council for programme accreditation.
- The experts prepare a report including their recommendations for the decision, which documents the assessment of the singled Criteria for the Accreditation of Study Programmes (of the Accreditation Council) in a well-founded manner.
- Before the decision, the Higher Education Institution receives the experts' report without the experts' recommendation for the decision for its comment.
- AQ Austria takes a decision on the basis of the experts' report and the recommendation under consideration of the comment of the Higher Education Institution. It declares or denies the accreditation (with or without conditions). The accreditation decision may be supplemented by recommendations and/or propositions. A one-time suspension of the procedure is possible for 18 months.
- Following the procedure AQ Austria publishes the decision, the experts' report and the names of the experts. In case of negative decisions instead of a publication according information is sent to the Accreditation Council. AQ Austria ensures confidentiality regardless of its obligations to report to the Accreditation Council.
- AQ Austria gives reasons for its accreditation decision. This includes also accreditation decisions limited by conditions or negative decisions, decisions on the suspension of a procedure and accreditation decisions differing from the experts' assessment.
- AQ Austria documents the procedure in a suitable manner and publishes the result, in the case of a positive decision, by a corresponding entry in the database of accredited study programmes.
- AQ Austria verifies the fulfilment of the conditions placed while granting the accreditation by the Higher Education Institution.

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The expert report and the higher education institution's statement constitute the basis for the accreditation decision, which is taken by the 14-members-board of AQ Austria. There are three options for the decision:

Accreditation without conditions
The quality requirements are being met. Any recommendations given in the expert opinion are supposed to help the higher education institution continuously develop the study programme. The agency grants the accreditation for a period of five years.
Accreditation with conditions
Deficiencies have been detected which are likely to be corrected within nine months. The higher education institution proves that the conditions have been met, and this will be verified by AQ Austria.
Denial of accreditation
Serious deficiencies have been detected which are not likely to be corrected within nine months.

If the accreditation decision is positive, AQ Austria will issue a certificate to the higher education institution.

1.2 Accreditation procedure

Vilnius Gediminas Technical University and Technische Universität Braunschweig mandated AQ Austria with the accreditation of the Joint Master Programme in Mechatronics in December 2015 after preparatory discussions during summer and autumn 2015.

Timetable of the accreditation procedure

Procedural step	**Date**
Delivery of self-evaluation report by VGTU/TUB	08-12-2015
Decision on review team members by the Board of AQ Austria	10-12-2015
Preparatory virtual meeting of the review team	13-01-2016
Site-visit at VGTU by review team	19-01-2016
Final report of the review team	18-02-2016
Statement on the final report by VGTU	29-02-2016
Accreditation decision by the Board of AQ Austria	17-03-2016
Fulfilment of conditions	03-03-2017
Decision on conditions by the Board of AQ Austria	23/24-05-2017

Members of the review team

Name	**Institution**	**Role**
Catherina **Burghart**	Hochschule Karlsruhe	Reviewer from academia, head of the review team
Vytautas **Ostaševičius**	Kaunas University of Technology	Reviewer with professional experience
Vidmantas **Tomkus**	Lithuanian Space Association	Student reviewer
Sebastian **Hübner**	TU Dresden	Reviewer from academia

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AQ Austria Coordinator

Robert Neiser

1.3 Brief description of Vilnius Gediminas Technical University and Technical University of Braunschweig

Vilnius Gediminas Technical University (VGTU) specialises technological science education, ensuring modern studies, orientated to the labour market. Scientific research and experimental development is performed by 14 institutes, 2 research centres and 33 research laboratories. Founded on 1 September 1956, the university was first a Vilnius-based evening division of the Kaunas Polytechnic Institute. In 1969, the division separated from the Kaunas Polytechnic institute and became the Vilnius Civil Engineering Institute. On 22 August 1996, the Lithuanian Government awarded the name of Gediminas, a 14th-century Grand Duke of Lithuania, to VTU, and the university became known as Vilnius Gediminas Technical University. According to the QS World University Rankings, VGTU is in the top 4 percent of world universities. QS has given VGTU five stars in teaching, facilities, and innovation. Measuring student mobility in the ERASMUS exchange program, VGTU is the most popular university in Lithuania for foreign students. It has roughly 11,000 students inscribed.

The Techniches Universität Braunschweig (TUB) is the oldest Technische Universität in Germany. It was founded in 1745 as Collegium Carolinum and is a member of TU9, an incorporated society of the most renowned and largest German institutes of technology. It is commonly ranked among the top universities for engineering in Germany. Today it has about 19,000 students, making it the third largest university in Lower Saxony after the University of Göttingen and the University of Hanover. Research projects include micro air vehicles, hybrid engines, and digital video broadcasting. It has roughly 19,000 students inscribed.

2 Profile and concept of the study programme

The following information derives from the self-evaluation report of VGTU and TUB resp. their websites.

Master of Science "Mechatronics"

Date of introduction:	Autumn 2014
Regular study period:	4 semesters
Number of ECTS credits:	120

The Programme was accredited by the National Centre for Quality Assessment in Higher Education in Lithuania (www.skvc.lt) on 30 May 2014 and received the permission for implementation of the Programme for the 3 academic years. The application of the international evaluation is reflecting the interest of both partners to increase international credibility and attractiveness of the Programme.

The aim of the programme is to prepare high qualification mechatronics specialists that are able to carry out independently research, lead projects of mechatronics development, maintenance and process improvement, apply their knowledge in different areas of application, make decisions on the basis of available information and provide logical, unambiguous and clear

arguments and solutions both for specialists and non-specialists. The Programme objectives are as follows:

- To deliver the most advanced knowledge of mechatronics and related sciences, which are necessary for specialists creating mechatronic systems; develop ability to analyse and apply this knowledge.
- To train the skills to apply obtained knowledge and understanding as well as modern research methods in practical activities requiring integration of analytical abilities, innovation, and know-how, including scientific research.
- To train the abilities to apply obtained knowledge, understanding, and solve the problems in a new, unknown, or constantly changing international environment and within context of different areas of study.
- To train the need and ability to learn and critically assess theoretical and practical novelties by means of continuous independent learning throughout one's life, apply innovations and develop high-tech mechatronic systems and facilities in the field of production and operation.
- To develop the skills to justify conclusions and to customise and adjust them for different audiences, creatively solve technical, administrative, and legal problems related to professional activities, comprehend ethical and social consequences of one's knowledge and the decisions made based on it as well as responsibility for said consequences.

3 Assessment results

3.1 Criterion 1: Qualification objectives of the Study Programme Concept

The study programme concept orients itself towards qualification objectives. These comprise of technical and interdisciplinary aspects, particularly • scientific or artistic qualification, • competence to take up a qualified employment, • competence for involvement in society, • and personality development.

The Universities describe the Qualification objectives as follows:
"**Expected learning outcomes of the programme** were formulated on the basis of the requirements raised for the second cycle university study programmes in the description of study cycles (EQF qualification level VII). Learning outcomes are divided into five groups:

- knowledge and its application;
- ability to conduct research;
- special competencies;
- social competencies;
- personal competencies.

The symbiosis of expected learning outcomes of the Programme produces creative and critically thinking mechatronics specialists with broad engineering and scientific intelligence, capable of undertaking scientific and technological development efforts in the field, creating innovative technologies and products.

The objectives and the expected learning outcomes of studies are designed to meet the professional requirements for graduates of the Programme, and ensure that students acquire the knowledge, abilities and competences required for their professional activities. The correlations between the objectives, expected learning outcomes and the subjects (modules) are defined in Table 1.1.

Table 1.1. Correlations between the Programme objectives, expected learning outcomes, and study subjects (modules).

Objective		
1. Provide the most advanced knowledge of the field of mechatronics and understanding of its connection and correlation with knowledge in other fields of study, introduce to new theories, research methods, and technologies in the field.		
Description of learning outcomes	Expected study outcomes	Study subjects (modules)
Knowledge and its application	The student will know and be able to apply the main scientific and innovation concepts, laws, digital research and modelling methods.	Fundamentals of research and innovations; Experimental research of mechatronic systems; Master graduation thesis 1.
	The student will master the phenomena and processes as well as their mathematical models from such special fields as mechatronics, information technologies, finite elements and their application, and mechatronic system modelling.	Finite elements in continuum mechanics; Modelling of mechatronic systems; Master graduation thesis 1; Diagnostics in mechatronics.
Ability to conduct research	The student will be able to apply subject knowledge both in research and solving practical tasks.	Experimental research of mechatronic systems; Mechanics of mechatronic and robotic systems; Adaptronics.
Special competencies	The student will be able to develop and independently apply new scientific achievements in the field of mechatronics.	Fundamentals of research and innovation; Master graduation thesis 1, 2, 3.
Social competencies	The student will be able to practically communicate with specialists from his/her professional area and beyond.	Master graduation thesis 1, 2, 3.
Personal competencies	The student will be able to responsibly and independently organize his/her work and make decisions.	Fundamentals of research and innovation; Master graduation thesis 1, 2, 3.
Objective		
2. Teach skills to apply obtained knowledge and contemporary research methods in practical activities requiring integration of analytical abilities, innovation, and know-how, including scientific research.		

Knowledge and its application	The student will know about linear and non-linear system fluctuations, mechatronic and robotic system mechanics, electric drives of mechatronic systems, smart materials, and sensors.	Mechanics of mechatronic and robotic systems; Applications of mycrosystems engineering with laboratory micromechatronics; Sensors in mechatronics; Smart materials in mechatronics.
Ability to conduct research	The student will be able to choose effective experimental research tools and equipment.	Diagnostics in mechatronics; Control of mechatronic systems; Modelling of mechatronic systems; The use of finite elements method in continuum mechanics; Modelling of complex systems; Sensors in mechatronics; Systems of measurements of non-electric volumes.
	The student will be able to employ scientific information and skills to evaluate, calculate, and process obtained experimental data.	Modelling of mechatronic systems; Smart materials in mechatronics; Master's thesis 1, 2, 3.
Special competencies	The student will be able to choose effective experimental research tools and equipment for mechatronic systems research.	Experimental research of mechatronic systems; Method of finite elements in mechanics; Sensors in mechatronics; Vibration measurement technology; Master's thesis 1, 2, 3.
Social competencies	The student will be able to plan and perform research, both independently and in a group.	Experimental research of mechatronic systems; Method of finite elements in mechanics; Master's thesis 1, 2, 3.
Personal competencies	The student will be able to think critically and constructively, evaluate qualitative and quantitative information, analyze it, formulate conclusions.	Modelling of mechatronic systems; Method of finite elements in mechanics; Smart materials in mechatronics.
Objective		
3. Train the ability to apply obtained knowledge, understanding, and abilities to solution of problems in new, unknown, or constantly changing international environment and within context of different areas of study.		

Knowledge and its application	The student will know and be able to apply the skills to execute the research of experimental mechatronic systems, microprocessor control, mechatronic diagnostics, equipment, physical and chemical phenomena and occurring processes, as well as use the physical parameter measurement tools, equipment and result processing methods.	Experimental research of mechatronic systems; Industrial robots; Vibration measurement technology;
Ability to conduct research	The student will be able to think critically and constructively, analyse, formulate conclusions, and make independent decisions; will be able to provide information and debate appropriately with specialists from other fields.	Master graduation thesis 1, 2, 3.
Special competencies	The student will be able to assess the efficiency and reliability of mechatronic systems and to identify malfunctions as well as create and implement new improvement technologies for corresponding systems.	Experimental research of mechatronic systems; Diagnostics in mechatronics; Master graduation thesis 1, 2, 3.
Social competencies	The student will be able to work in a team of specialists from different areas and of different competence.	Sensors in mechatronics; Vibration measurement technology; Master graduation thesis 1, 2, 3.
Personal competencies	The student will be able to apply subject knowledge to solve the mechatronics tasks while learning throughout one's life.	Sensors in mechatronics; Mechanics of mechatronic and robotic systems; Master graduation thesis 1, 2, 3.
Objective		
4. To train the ability to learn and critically assess theoretical and practical novelties by means of continuous independent learning throughout one's life, apply innovations and implement high-tech mechatronic systems and facilities in the field of production and operation.		
Knowledge and its application	The student will know and be able to apply mechatronic control systems.	Control of mechatronic systems; Application of commercial FE software.
Ability to conduct research	The student will be able to create new and troubleshoot existing mechatronic systems as well as understand their structure.	Diagnostics in mechatronics.
Special competencies	The student will be able to interpret theoretical and experimental results and to classify them according to their importance and reliability of underlying theories.	Smart materials in mechatronics; Master graduation thesis 1, 2, 3, 4.

Social competencies	The student will be able to present publicly his/her knowledge and experimental research results.	Diagnostics in mechatronics; Mechanics of mechatronic and robotic systems; Master graduation thesis 1, 2, 3.
Personal competencies	The student will be able to critically assess own innovative solutions and those of others while understanding possible etchical and other consequences of said solutions.	Diagnostics in mechatronics; Application of commercial FE software; Master graduation thesis 1, 2, 3,4.
Objective		
5. To train the skills needed to justify the conclusions and to adjust them for different target audiences, creatively solve technical, administrative, and legal problems related to professional activities, comprehend ethical and social consequences of one's knowledge and the decisions made based on it as well as responsibility for said consequences.		
Ability to conduct research	The student will be able to think critically and constructively, analyse, formulate conclusions, and make independent decisions; will be able appropriately to provide information and debate with specialists from other fields.	Fundamentals of research and innovations; Master graduation thesis 1, 2, 3
Special competencies	The student will be able to comprehend ethical and social consequences of one's knowledge and the decisions made as well as responsibility for said consequences.	Fundamentals of scientific research and innovations; Mechanics of mechatronic and robotic systems; Master graduation thesis 1, 2, 3,4
Social competencies	The student will be able to asses the violations of scientific ethics and maintain the civil responsibility.	Master graduation thesis 1, 2, 3,4
Personal competencies	The student will be able to perform scientific research while understanding the social responsibility for this activity and the effect of its results for the society, its economic and cultural development, country's prosperity, and environment.	Fundamental of research and innovations; Experimental research of mechatronic systems; Vibration measurement technology; Master graduation thesis 1, 2, 3,4

Learning outcomes are achieved when students attend the lectures, participate and make presentations in seminars, carry out laboratory work, read professional and research literature, do practical training in enterprises, conduct research, prepare and defend the graduation thesis.
Having implemented the planned objectives of the Programme graduates will become highly competent specialists able to work in high-tech companies, R&D laboratories, and enterprises established in not only Lithuania and Germany but also in other European countries as well as continue studies in the third, PhD, cycle."

The objectives defined for the Programme are adequate for a Master's study programme. The qualification profile is that of mechatronics with a strong focus on mechanical engineering, in

contrast to approaches which would rather focus on electrical engineering, computer sciences for example. This specific profile reflects the two originating departments or divisions of mechanical engineering, both at VGTU and TUB, where the Programme was developed. To the experts the objectives seemed to be harmonised to some extend between the two universities but not completely. Within the self-evaluation report and also in the conversations during the site visit it was stated several times that students will be trained to either pursue an academic degree and, hence, shall be able to continue with the third cycle, or for the respective job market in Germany and/or Lithuania.

Both parties expressed a strong interest to further expand the internationalisation of activities and the adaptation to the local requirements. Lithuania has to conform to the expectations of investing countries (primary Scandinavia and Germany) in availability of human resources with full scope of engineering qualifications. VGTU shall correspond to the needs of emerging new technologies, trans-disciplinary knowledge of mechanics, electronics, ICT, project management and understanding of differences of social and corporate standards. TUB is interested in the extension of English-language study programmes and will benefit from broadening their markets and from educating students, prospective employees at German enterprises in Lithuania, with specific knowledge of the country.

While it seems quite clear to the experts that graduates will be able to enter a PhD programme, the experts would expect further elaboration on how students are prepared to work for companies from the industrial sector. In doing so, the Universities should specify their respective roles within the Joint programme regarding their contribution to either career path. Such elaborations could include further intensification of stakeholder involvement, or teaching on specific computer/software programmes used in the relevant industrial sector. On a different yet related matter, the experts see room for improvement with regard to how social skills might be implemented into the curriculum to a further extent.

3.2 Criterion 2: Conceptual Integration of the Study Programme in the System of Studies

The study programme complies with
(1) the requirements of the Framework of Qualification for German Degrees of 21 April 2005 in the respective valid version,
(2) the requirements of the Common Structural Guidelines of the Länder for the Accreditation for Bachelor and Master's Study Programmes of 10 October 2003 in the respective valid version,
(3) Länder-specific structural guidelines for the accreditation for Bachelor's and Master's study programmes,
(4) the binding interpretation and summary of (1) to (3) by the Accreditation Council.

The requirements of the Framework of Qualification for German Degrees will be fulfilled by the study programme. The Programme encompasses 2 years and 120 ECTS credits, thus with a preceding bachelor's qualification of at least 3 years and 180 ECTS credits graduates will achieve a total of 5 years and 300 ECTS credits. Also, the Master-level is achieved with regard to knowledge and understanding, capability, and formal aspects. Moreover, the admission process is adequate in order to guarantee qualification on Master's level.

The Programme, in general, is in accordance with the Common Structural Guidelines of the Länder. Yet for the modularisation, the peers found that (1) not all modules offered at VGTU are equivalent to 5 or more ECTS credits, and (2) the description of some modules does not

fulfil the expectations with regard to the points a) through i) of 1.1 Modularisation of the annex Framework Guidelines for the Introduction of Credit Point Systems and the Modularisation of Study Courses. With regard to the module size, the universities stated they fit the Lithuanian accreditation requirements and legal regulations. In addition, the peers found that a reasonable examination load is not exceeded – especially since most of the modules with less than 5 ECTS credits are those of the "free choice" module section. Anyway, each module is composed in a coherent manner (cf. the binding interpretation of the Common Structural Guidelines by the Accreditation Council, p. 4 – in its German version).

The Programme is not in conflict with the Länder-specific Structural Guidelines of Lower Saxony.

3.3 Criterion 3: Study Programme Concept

The study programme concept covers the imparting of specialised knowledge and interdisciplinary knowledge as well as of technical procedural and generic competences.
It is built up coherently in the combination of the individual modules with regard to the formulated qualification objectives and provides adequate forms of teaching and learning. Possibly planned practical components are so organised that credit points (ECTS) can be acquired.
It lays down the admission requirements and if necessary an adequate selection procedure and rules for both the recognition of credits achieved at other higher education institutions in accordance with the Lisbon Recognition Convention as well as externally achieved credits. Regulations are provided for compensating disadvantages of handicapped students. Possibly planned mobility windows are integrated in the curriculum.
The organisation of studies ensures the implementation of the study programme concept

The Programme's study concept covers specialised knowledge in the field of mechatronics which is derived of mechanical engineering, electrical engineering, electronics, computer sciences, and their neighbouring disciplines. The two participating universities', respectively departments, are those of mechanical engineering. Hence, the study programme's concept is influenced by mechanical engineering rather than it is influenced by other relevant fields.

The admission is granted up to 15 people each academic year. The according process is determined as follows:

"The places are awarded by the participating universities in a common procedure. The local admission regulations remain unchanged and are valid for each respective period of study, i.e. at VGTU and at TUB. Prerequisite for the access to the Programme is that the applicant:

a. holds a Bachelor Degree from a university from Bologna signatory states in engineering science or applied physics;

and

b. has the skills and competences listed below:

Subject area	Skills	Competences	Min. ECTS
Mathematics	Real and complex numbers, sequences and series, differential and integral calculus for real functions having one or more variables, analytical geometry in the two- and three-dimensional space, vector algebra, eigenvector	Comprehensive knowledge in mathematical fundamentals of their subject of study, ability to use relevant mathematical methods and apply them in solving the problems of engineering	15

	analysis, extrema with constraints, Fourier series, partial differential equations.	science.	
Programming and IT	Basics and methods of automated information processing, e.g. computer architectures, operating systems, algorithms, data formats and networks. Basic programming skills in programming languages C/C++ or Java.	Knowledge in automated information processing and programming.	6
Design	Technical drawing, CAD-drawing, fundamentals of design, strength calculation. springs, basic machine elements like springs, shafts and axles, separable connections and inextricable bonds.	Ability to interpret and produce technical drawings. Knowledge of functional design as well as design properly proportioned for stress and strain of machine elements. Ability to design machines of limited complexity.	8
Mechanics/	Fundamental terms of mechanics, cutting principles, system properties, structure properties, statically determinate frameworks, ropes, stresses, distortions, hook's law, temperature induced strain, bending of beams, beam torsion, statically determinate systems, fundamentals of dynamics.	Knowledge of fundamental terms of static and strength calculation. Ability to modelize simple elastomechanical components and dimension simple structures.	8
Control	Fundamentals of control, feed forward control, feedback control, system modelling, linear and non-linear systems, time domain and frequency domain representation, laplace-transformation; transfer function, impulse response and step response, frequency response, state space representation of linear and non-linear systems, stability, controllability, observability, identification; control unit design.	Knowledge of fundamental structures, terms and methods of control technology. Ability to apply their knowledge by establishing equations for control loop elements. Ability to analyze linear systems in the time domain and frequency domain and to design control unit for various applications.	5
Thermodynamics or Electrodynamics	Thermodynamics: Fundamental terms of thermodynamics, balances and conservation laws, thermodynamic relations, fundamental equations, and state equations and processes, equilibrium conditions, working capacity and exergy, ideal gas, reale substances, thermodynamic processes. Electro Physics: Electric/ magnetic fields in matter, polarizability and susceptibility, magnetic moments, Maxwell equations, Poynting's theorem, Greens functions, dipole fields, electromagnetic waves and wave propagation, polarization, radiation of oscillating sources.	Fundamental physical and technical knowledge of relevant energy conversion processes. Ability to balance open and closed system by means of mass, energy and entropy balances. Ability to calculate constitutional changes.	6
Materials Science or Solid States	Material Science: Elastic behaviour of materials, plasticity and failure, notches,	Ability to apply materials savely in the vocational praxis and to solve complex questions related	6

Physics	fracture mechanics, mechanical behavior of metals, ceramics, and polymers, material fatigue. <u>Solid States Physics:</u> Structure and properties of solid state materials, electrons in solid state matter, types of bond, lattice vibrations, phonons, amorphous and crystalline states, reciprocal space, surfaces, Interfaces, experimental methods for analysis of solid state properties, theory of solid state physics, free electron gas, Fermi-Dirac distribution, semiconductors, technological applications.	to the behavior of materials.	

Applicants shall have command of the English language not lower than B2 level of foreign language ability according to Common European Framework of Reference for Languages."

The experts agree on the importance of the qualifications listed above, yet see the necessity to add "electronics" resp. "electronical engineering", and "computer science" to the stated requirements since they are core competences needed to continue studying mechatronics at Master's level.

The Programme's organisation is sufficient to ensure the implementation of the study programme concept. Especially this is the case since both partners already conduct study programmes of mechatronics individually. Accordingly, the experts don't see the Joint Programme's quality endangered. However, the master study programme should be more concretised and goal oriented. The programme should enable students to develop high tech mechatronic components which increase performance and energy efficiency, as sought after by industries worldwide. The courses related to new innovative product development as well as to modern, self-powering wireless communication between mechatronic components such as sensors-actuators-controllers could be included in the curriculum.

Study programme modules have to be constantly adapted to the latest technological developments, especially in the Information and Telecommunication field, for example 3G, LTE wireless communication networks, "Internet of Things," Autonomous system and new social trends of consumer market. To prepare better to the job market it would be noteworthy to follow the existing trends of usage of specific software in different countries, for example CAD packages like Solidworks, Catia, Siemens NX. Experts from industry also underlined the necessity of being able to create programmes for the control of machines/production lines.

The effective approach of maintaining the constantly changing goals would be to offer a wider range of free-to-choose topics that can lead further away from the core curriculum. Here, involving experts from industry would help to insure a continuous proliferation and adaptation of the curriculum to the latest needs.

Teaching latest technologies and adapting the curriculum also requires a continuous adaptation of the course book descriptions. Looking at the course book the experts found some descriptions either insufficient with respect to language, to the literature recommended (partially

not compliant to the topics taught), or to examination procedures (especially participation in labs). Additionally, experts from industry stated during their interview that they would prefer some additional knowledge of the students with respect to project management, managing of staff, and product development.

From the experts' point of view, social and personal skills should be highlighted in all module descriptions. This applies equally to courses explicitly taught on the subject as well as others where social and personal skills are taught along with other subjects.

In general, the modules are connected and interdepended in a coherent way. Yet the experts recommend deepening the content-related linkage between the modules offered at both partner universities, focussing to a higher extent on their goal to prepare for the master thesis. Those modules which concern the preparation of the Master's thesis (called Master Graduation Thesis 1 through 3) have to be renamed and described to further detail in order to make clear what purpose they serve, and that they are not part of the Master's dissertation.

3.4 Criterion 4: Academic Feasibilty

The academic feasibility of the study programme is ensured through:

- consideration of the expected entry qualifications,
- an appropriate curriculum design
- the information on the student workload, which is checked for plausibility (or, in the case of the first accreditation, estimated according to empirical values),
- frequency and organisation of examination, which is adequate and has a reasonable workload,
- corresponding offers of support as well as
- technical and interdisciplinary course guidance.

The interests of handicapped students will be taken into consideration.

Apart from the above mentioned constraint, the experts agree with the entry qualifications defined by the universities. But the experts also noted that the prerequisites of the skills and competences are linked with a minimum amount of ECTS credits. The experts recommend comparing competences according to the Lisbon Convention rather than ECTS credits in order not to exclude excellent applicants form other universities, countries or fields.

The curriculum design does not compromise the academic feasibility of the Programme at all. Students who were interviewed during the site visit described the study course as challenging but not at all overburdening. To further enhance the students' individual progress and growth, the experts recommend an even larger catalogue of free-choice modules and/or courses.

The student workload was estimated in advance, calculated according to the ECTS, and is currently evaluated with regard to the first two cohorts that have already entered the programme. The workload is reasonable, also with regard to examinations and the final Master's thesis. Additional support is guaranteed through the academic advisors (each student gets assigned their individual advisor), the International Offices of both universities, as well as their student support centres. For all required, i.e. study-related lab work trainings are given to enable students to use labs and their materials independently. Experienced lab assistants are available during regular working hours. The first batch of students, presently doing their courses at TUB, stated that they are additionally supported by grants to help financing their basic needs. Special support and grants for young families could be addressed by an addition-

al programme/procedure (see Criterion 11 below). Interests of handicapped students will be taken into consideration.

3.5 Criterion 5: Examination System

The examinations serve the purpose of determining, whether the formulated qualification objectives have been accomplished. They are module-related as well as knowledge and competence oriented. Every module, as a rule, concludes with an examination covering the entire module. Compensating disadvantages of handicapped students with regard to time-related and formal guidelines in the studies as well as in the final performance tests and those during the studies is ensured. The examination regulations were subjected to legal verification

The examination regulations follow each universities standard guidelines and regulations. Since they are derived from existing study programmes they are subject to legal verification. For the sake of further transparency, the experts demand examination regulations tailored to the Joint Programme in particular, and provided in English at both universities to their respective students. The provided guidelines and regulations have to contain statements with regard to the compensation of disadvantages of handicapped students and how the procedure is designed to recognise acquired competences from inside and outside the universities.

Additionally, competence orientated exams were not transparently described in the course book as well as in the study programme. The experts could not see any descriptions stating how labs, experiments, tests, team projects added to the individual course grades.

As it became clear from interviewing VGTU and TUB teaching staff as well as students, already participating in the programme, the final grades of each course mainly consist of written exams. Tests, labs etc. contribute to a far smaller extent to the final grade. The experts, therefore, recommend including further examination methods into the programme in near future and to describe them in a transparent way them in the course book.

3.6 Criterion 6: Programme-related Co-operations

The Higher Education Institution ensures the implementation and the quality of the study programme concept, if other organisations are involved or commissioned by the former to carry out parts of the study programme.
A written record is kept of the extent and nature of existing co-operations with other higher education institutions, companies and other organisations as well as for any agreements upon which the co-operation is based.

The Programme's focus lies on the co-operation between the two universities. Other organisations were not involved. For the Joint Programme a cooperation agreement exists. It was subject to this accreditation. The experts found no obstacle in it which would compromise the cooperation in any case. However, the involvement of stakeholders from international and local companies working in the mechatronics field should be intensified. Alumni and professionals could contribute to the improvement of the Programme i.e. by advising students with respect to the choice of master thesis topics related to the industry demands. Here, expectations might differ between Germany where the students are trained with a stronger focus toward an academic career, and Lithuania where the training is rather industry-oriented.

3.7 Criterion 7: Facilities

The adequate implementation of the study programme is ensured with regard to the qualitative and quantitative facilities with regard to personnel, material and space. In this interdependence with other study programmes is taken into account. Measures for a personnel development and qualification are available.

During the site visit at VGTU several facilities, including the faculty building, were visited by the experts. They visited company "Standa" who manufactures laser measurement techniques and offers students to either perform their work for a thesis, student project or practical semester at the company.

It is essential to familiarize the students with the actual production environment and latest equipment used by industrial companies operating in a global context. Teaching staff, Master thesis supervisors taking part in the research and development could provide the students with the opportunity to participate in the actual projects required by the industry.

Therefore, both universities have either training facilities for students, labs or cooperations with enterprises offering premises for student training during projects. VGTU mainly offers working places in labs for students' projects whereas labs at TUB focus on research. The role of industrial partners in research at both universities could be better advertised and reported with respected to interests of the joint study programme.

3.8 Criterion 8: Transparency and Documentation

The study programme, course of study, examination requirements and the prerequisites for admittance including the regulations for compensating disadvantages of handicapped students are documented and published

The study programme, course of study, examination requirements' and the prerequisites for admittance exist, most of them are available to prospective students, while all are available to active students. Yet the publication and documentation show major lacks with regard to transparency, including availability on the websites of both universities. Hence, the experts demand the publication of common study and examination regulations (*Studien- und Prüfungsordnung*) as required for study programmes.

3.9 Criterion 9: Quality Assurance and Further Development

Results of quality management internal to the Higher Education Institution are taken into consideration in the further developments of the study programme. Here the Higher Education Institution takes into consideration evaluation results, studies of the student's workload, academic accomplishment and the whereabouts of the graduates

Both universities have established quality assurance systems and tools, which are also applied to the joint programme. They should encompass the entire Programme, beginning with its development, also including alumni and stakeholder involvement. Procedures and means to further enhance the Programme are to be established. It was not quite transparent to the experts by which methods the programme committee intends to further develop the programme besides reacting to evaluation reports and in what way any changes and improvements are going to be published and announced.

3.10 Criterion 10: Study Programme with a Special Profile Demand (Joint Programme)

Study programmes with a special profile demand have special requirements. The aforementioned criteria and rules of procedure have to be applied under consideration of these requirements.

The site visit was held at VGTU, including interviews with persons in charge from both universities.

The expert panel was composed of experts from Germany and Lithuania, representing those with academic qualification, qualification in the relevant field of work, and student expertise.

This report is jointly written for all locations.

The joint study programme shows some characteristics of both the Lithuanian as well as the German system of studies, i.e. the number of actual working hours per credit or courses comprised of less than 5 ECTS. In this case, the experts recommend a statement provided by Lithuanian educational legislation to clarify country specific requirements and practices.

The experts also require as a condition to clearly distinguish all modules / courses referring to the master thesis. Courses serving as preparation of the actual master thesis should be renamed with respect to their topics, i.e. scientific writing. Only the master thesis itself should be called master thesis with 30 ECTS assigned.

3.11 Criterion 11: Gender Justice and Equal Opportunities

The concepts of the Higher Education Institution for gender justice and for the promotion of equal opportunities of students in special situations such as students having health impairments, students having children, foreign students, students with migration background and/or from so-called educationally disadvantaged classes are implemented at the level of the study programme.

While the universities were aware of the particular importance of gender justice within study programmes of engineering, they yet have to present a formalised concept to promote equal opportunities of students within this Programme.

4 Summary of results

4.1 Final assessment

Summary statements on the programmes and compliance with each standard (scale: not compliant – partly compliant – compliant)

Criterion 1

The programme does mainly comply with the criterion, but the experts still recommend to reconsider the actual objectives of both universities with respect to the joint programme. There seems to be a discrepancy between producing either good researchers or good engineers ready to be employed in Lithuanian industry.

Criterion 2

The programme mainly complies with the Common structural guidelines of the Länder.

Criterion 3

The Joint Programme does not totally comply with this criterion yet.

The experts also recommend involving more intensely actual stakeholders from international companies focusing in mechatronics in order to further improve the curriculum with respect to social skills as needed in companies.

Criterion 4

Academic feasibility is warranted within the programme, but minor changes should be implemented. For example it is desirable to strengthen the possibility of students to interact with the studying programme through a larger pool of free-choice modules. It is desirable to permanently monitor quality, workload, and feasibility of the studying course by all stake holders within the process of quality management.

Criterion 5

The examination system is mainly compliant with the Rules of the Accreditation Council.

Criterion 6

Apart from the cooperation of the Universities there is hardly any existing cooperation regarding the studying course. The experts recommend an intense cooperation with interested parties from the industry and the scientific community as well as the alumni to enhance the pro-

gramme and develop new perspectives. The strengths of both locations should be put into consideration. However, the programme's quality is not jeopardised.

Criterion 7

The facilities at VGTU support students for learning and doing their projects, yet research labs are to be mainly found at TUB. The experts recommend to advertise better the benefits students of the programme have by being able to move from Lithuania to Germany with respect to lab equipment.

Criterion 8

The Joint Programme does partly comply with this criterion.

Criterion 9

The Joint Programme states that the individual systems for quality assurance of both universities are applied. Still, statements as to how an improvement of the Programme is to be achieved besides reacting to evaluations by students are missing. The reviewing team recommends the programme committee to work out the specific methods of quality assurance with respect to the joint programme better.

Criterion 10

The joint study programme shows some characteristics of both the Lithuanian as well as the German system of studies, i.e. the number of actual working hours per credit or courses comprised of less than 5 ECTS. In this case, the experts recommend a statement provided by Lithuanian educational legislation to clarify country specific requirements and practices (see Criterion 2).

Criterion 11

The programme is partly compliant. The experts see form the interviews that the universities are aware of the existing issue of gender and equal opportunities. However, a written concept is missing.

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5 Accreditation Decision & Conditions

According to the Accreditation Council's Rules for the Accreditation of Study Programmes and for System Accreditation, and based on the findings and judgements of the peers, the Board of AQ Austria has decided in favour of the Programme under the following conditions:

5.1 Condition 1

The module descriptions must be clarified regarding points a) through i) of 1.1 "Modularisation" of the "Framework Guidelines for the Introduction of Credit Point Systems and the Modularisation of Study Courses" (annex to the "Common structural guidelines of the Länder for the accreditation of Bachelor's and Master's study courses"). All module descriptions must be available in English (according to criteria 3 and 5).

5.2 Condition 2

The examination regulations and rules of the Joint Programme need to be made transparent to all students and interested parties, and published in English by both institutions (according to criterion 8).

5.3 Condition 3

A written concept how to address the issue of equal opportunities and gender justice has to be delivered (according to criterion 11).

The Universities were officially informed about the decision and the above listed conditions on March 29, 2016. Full compliance had to been shown within nine months after this date.

On May 23/24 2017 the Board of AQ Austria decided that all conditions were fulfilled. Thus, accreditation will be granted for the duration of five years.

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EVALUATION OF THE STUDY PROGRAMME

No	Evaluation area	Evaluation of the area, points
1	Programme aims and learning outcomes	4
2	Curriculum design	4
3	Teaching staff	4
4	Facilities and learning resources (facilities, equipment, learning materials)	3
5	Study process and students' performance assessment (student selection, performance assessment, support)	4
6	Programme management (administration of the programme, internal quality assurance)	3
	Total:	22 of 24

EVALUATION SCALE

Level/ Score	Evaluation	Description
1	Unsatisfactory	There are essential irregularities to be eliminated
2	Satisfactory	Meets the minimum requirements, requires improvement
3	Good	The area is systemically developed and possesses original
4	Very good	The area is exceptionally good

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