ASIIN Seal & EUR-ACE® Label

Accreditation Report

Bachelor's Degree Programme
Chemical Engineering

Master's Degree Programmes
Process Chemistry
Chemical and Process Engineering
Chemical Engineering for Water Treatment

Provided by
Lappeenranta University of Technology

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A About the Accreditation Process

Name of the degree programme (in original language)	**(Official) English translation of the name**	**Labels applied for** [1]	**Previous accreditation (issuing agency, validity)**	**Involved Technical Committees (TC)**[2]
Kemiantekniikan kandidaatin tutkinto-ohjelma	Bachelor's Programme in Chemical Engineering	ASIIN, EUR-ACE® Label,	ASIIN 1.4.2011 – 30.9.2016 Prolongation until 30.9.2017	01, 09
Prosessikemian diplomi-insinöörin tutkinto-ohjelma	Master's Programme in Process Chemistry	ASIIN, EUR-ACE® Label,	ASIIN 1.4.2011 – 30.9.2016 Prolongation until 30.9.2017	01, 09
Master's Programme in Chemical and Process Engineering	-	ASIIN, EUR-ACE® Label,	-	01, 09
Master's Programme in Chemical Engineering for Water Treatment	-	ASIIN, EUR-ACE® Label,	-	01, 09
Date of the contract: 18.08.2016 **Submission of the final version of the self-assessment report:** 23.02.2017 **Date of the onsite visit:** 05. - 06.04.2017 **at: Lappeenranta**				
Peer panel: Prof. Dr. Sebastian Engell, Technical University Dortmund				

[1] ASIIN Seal for degree programmes; EUR-ACE® Label: European Label for Engineering Programmes

[2] TC: Technical Committee for the following subject areas: TC 01 – Mechanical Engineering/Process Engineering; TC 09 – Chemistry

Prof. Dr. Wolfgang Jaumann, Technical University of Applied Sciences Nuernberg Dr. Nikolaus Nestle, BASF AG, Ludwigshafen Prof. Dr. Norbert Sewald, University of Bielefeld Jens Back, Åbo Akademi University, Turku, Student	
Representative of the ASIIN headquarter: Rainer Arnold	
Responsible decision-making committee: Accreditation Commission for Degree Programmes	
Criteria used: European Standards and Guidelines as of 10.05.2015 ASIIN General Criteria, as of 10.12.2015 Subject-Specific Criteria of Technical Committee 01 – Mechanical Engineering/Process Engineering as of 09.12.2011 Subject-Specific Criteria of Technical Committee 09 – Chemistry as of 09.12.2011	

B Characteristics of the Degree Programmes

a) Name	Final degree (original/English translation)	b) Areas of Specialization	c) Corresponding level of the EQF[3]	d) Mode of Study	e) Double/Joint Degree	f) Duration	g) Credit points/unit	h) Intake rhythm & First time of offer
Bachelor's Programme in Chemical Engineering	Tekniikan kandidaatin tutkinto / Bachelor of Science in Technology	-	6	Full time	-	6 Semester	180 ECTS	Autumn semester / 2011
Master's Programme in Process Chemistry	Diplomi-insinöörin tutkinto / Master of Science in Technology	-	7	Full time	-	4 Semester	120 ECTS	Autumn semester / 2011
Master's Programme in Chemical and Process Engineering	Diplomi-insinöörin tutkinto / Master of Science in Technology	-	7	Full time	-	4 Semester	120 ECTS	Autumn semester / 2011
Master's Programme in Chemical Engineering for Water Treatment	Diplomi-insinöörin tutkinto / Master of Science in Technology	-	7	Full time	-	4 Semester	120 ECTS	Autumn semester / 2016

[3] EQF = The European Qualifications Framework for lifelong learning

According to the Self Assessment Report, the general purpose of the Bachelor's degree programme is:

"Studies leading to the Bachelor's degree shall provide students with

- knowledge of the basics of intermediate specialisation studies and minor subjects or equivalent modules or studies included in the degree programme, as well as the competencies required to follow the development of the field
- a capacity for scientific thinking and the application of scientific working methods
- the knowledge and skills required in education leading to the higher university degree and in life-long learning
- the ability to apply their knowledge and skills in working life
- sufficient communication and language skills."

According to the Self Assessment Report, the general purpose of the Master's degree programmes is:

"Studies leading to the Master's degree shall provide students with

- a good knowledge of their core and specialisation studies and a fundamental knowledge of their minor subjects
- a capacity for applying scientific knowledge and for critical thinking
- the ability to take on duties as an expert and developer of their professional field
- the capacity to carry out scientific doctoral studies
- good communication and language skills
- good presentation, cultural and leadership skills."

For the Bachelor's degree programme Chemical Engineering LUT has presented the following profile in the Self Assessment Report:

"A person who has taken the degree of Bachelor of Science in Chemical Engineering has fundamental knowledge and skills in the field of natural sciences and chemical engineering, is able to follow the development in the field of chemical engineering and apply the skills learned in working life. The student deepens her/his scientific thinking and working methods in the intermediate specialisation and minor subject studies. Already in the course of the Bachelor's studies, the student may have an opportunity to participate in

research projects, e.g. through an internship at the university, and thus get practical work experience and insight into scientific research.

In addition to technical competences, a student may complement his/her professional skills by business studies. For example, those interested in establishing an enterprise can take studies in business in the elective studies of the degree. For students interested in developing or deepening their communication, language and cultural skills, the university provides a large array of language studies as well as excellent opportunities for student exchange and training abroad."

For the Master's degree programme Process Chemistry LUT has presented the following profile in the Self Assessment Report:

"The MSc programme in Process Chemistry provides sufficient scientific and technological knowledge for the career of chemical and process engineers in different fields of process industry where chemical reactions play a crucial role.

A Master of Science in Chemical Engineering is able to think and work in a scientific manner, acquire information and formulate solutions to complex problems and tasks. He/she has the ability to work as a member of a team, is able to organise, carry out and lead projects and has the required communication skills. A Master of Science is aware of the ethical aspects of the field and its effects on society, and is capable of critically assessing the future prospects of the field.

A Master of Science in Process Chemistry is able to apply the essential theories of chemical engineering. A graduate from the programme is able to apply his/her knowledge in various R&D tasks, in process operation, in technical sales and in management of the above mentioned functions. The MSc programme also prepares a student for doctoral studies and continuous learning. In addition to technical competences, a student may complement his/her professional skills by business studies. For those interested in establishing an enterprise, there is an opportunity to include studies in business in the elective studies of the degree. For students interested in developing or deepening their communication, language and cultural skills, the university provides a large array of language studies as well as excellent opportunities for student exchange and training abroad."

For the Master's degree programme Chemical and Process Engineering LUT has presented the following profile in the Self Assessment Report:

"The MSc Programme in Chemical and Process Engineering is strongly industry-oriented, focusing on fine and commodity chemicals, biorefining and metallurgical industries.

A Master of Science in Chemical Engineering is able to think and work in a scientific manner, acquire information and formulate solutions to complex problems and tasks. He/she has the ability to work in teams, is able to organise, carry out and/or lead projects and has the required communication skills to do so. A Master of Science is aware of the ethical aspects of the field and its effects on society, and is capable of critically assessing future prospects of the field.

A Master of Science in Chemical and Process Engineering is able to invent, design, develop and promote new sustainable solutions as a response to major global challenges. Diverse teaching methods and multicultural and multidisciplinary study groups offer the student the opportunity to develop good skills in team and project work, communication and languages, presentation, culture and leadership. The MSc programme also prepares a student for doctoral studies and continuous learning. In addition to technical competences, a student may complement his/her professional skills by business studies. For those interested in establishing an enterprise, there is an opportunity to include studies in business in the elective studies of the degree. For students interested in developing or deepening their communication, language and cultural skills, the university provides a large array of language studies as well as excellent opportunities for student exchange and training abroad."

For the Master's degree programme Chemical Engineering for Water Treatment LUT has presented the following profile in the Self Assessment Report:

"In the MSc programme in Chemical Engineering for Water Treatment the student learns how water can be purified in a sustainable and economical manner and obtains knowledge and skills that can be used to solve water related challenges in the future. The student builds competence to act as a professional in the rapidly developing field of water and environment.

A Master of Science in Chemical Engineering is able to think and work in a scientific manner, acquire information and formulate solutions to complex problems and tasks. He/she has the ability to work in teams, is able to organise, carry out and/or lead projects and has the required communication skills to do so. A Master of Science is aware of the ethical aspects of the field and its effects on society, and is capable of critically assessing future prospects of the field.

A Master of Science in Chemical Engineering for Water Treatment has comprehensive knowledge in water treatment. Diverse teaching methods and multicultural and multidisciplinary study groups offer the student the opportunity to develop good skills in team and project work, communication and languages, presentation, culture and leadership. The MSc programme also prepares a student for doctoral studies and continuous learning. In addition to technical competences, a student may complement his/her professional skills by business studies. For those interested in establishing an enterprise, there is an opportunity to include studies in business in the elective studies of the degree. For students interested in developing or deepening their communication, language and cultural skills, the university provides a large array of language studies as well as excellent opportunities for student exchange and training abroad."

C Peer Report for the ASIIN Seal[4]

1. The Degree Programme: Concept, content & implementation

Criterion 1.1 Objectives and learning outcomes of a degree programme (intended qualifications profile)

Evidence:

- Self Assessment Report
- Homepage of LUT: http://www.lut.fi/web/en/ (access: 04.04.2017)

Preliminary assessment and analysis of the peers:
The auditors hold the view that the objectives and intended learning outcomes of the Bachelor's degree programme Chemical Engineering are comprehensive and well founded: The students acquire a sound fundamental basis in chemistry, mathematics, physics and engineering. They learn to understand the different steps of industrial production from a chemical point of view. A special focus is laid on mechanical separation techniques and process development; the students become familiar with the methods by which the various raw materials can be separated from each other and with a variety of chemical engineering production methods and chemical phenomena. In addition, they are able to take advantage of the different separation methods and materials, as well as to plan and implement the sustainable use of natural resources. Finally, they become familiar with the safety of the processes used in the industry as well as financial management.

The auditors are convinced that the intended academic qualification profile of the Bachelor's degree programme Chemical Engineering is reasonable and useful: The students are capable to apply their acquired skills and knowledge in the areas of water treatment, recycling of industrial waste, bio-refineries or plants for the production of fuels from renewable resources. The graduates can play an active role in handling major environmental challenges such as the availability of clean water, recycling of materials, the depletion of natural resources and the reduction of emissions.

[4] This part of the report applies also for the assessment for the European subject-specific labels. After the conclusion of the procedure, the stated requirements and/or recommendations and the deadlines are equally valid for the ASIIN seal as well as for the sought subject-specific label.

From the viewpoint of the peers, the intended learning outcomes of the Bachelor's degree programme Chemical Engineering should also take into account that the graduates should be able to work in the private sector. The Bachelor`s degree should be more than just an intermediate degree. The programme coordinators explain that there is a distinctive difference between the Bachelor`s graduates from a research oriented university such as LUT and the Finnish universities of applied sciences. The universities of applied sciences prepare their students to join the labour market after completing their Bachelor`s degree, whereas the Finnish universities expect their Bachelor`s graduates to continue their academic education and join a Master`s degree programme. The representatives of the industrial partners confirm this policy, but the peers think that such an approach is not fully in accordance with the Bologna process. As a result, the peers ask the programme coordinators to re-write the learning outcomes of the Bachelor's degree programme Chemical Engineering in order to make obvious that the degree has a higher aim than just the qualification for a following Master degree but also provides the qualification for starting a professional career. They also expect that the curriculum is updated in order to convey the necessary practical experiences to the students so that they are able to find a suitable employment after finishing their Bachelor's degree.

The auditors next examine the objectives and intended learning outcomes of the Master's degree programme Process Chemistry: The students become familiar with advanced inorganic and organic chemistry, and bioreactor technology for industrial applications, and acquire the ability to develop new innovations to improve resource efficiency and environmental friendliness. The Master's degree programme Process Chemistry focuses on the chemistry of industrial processes and the related chemical and physical phenomena with the aim to impart the necessary skills and knowledge to be able to develop new environmental-friendly processes and to improve existing processes. In addition, the students learn how to do independent work in a laboratory, and how to cope with different project tasks in order to be able to follow the different steps of product development, and to participate in research projects.

The graduates of the Master's degree programme Process Chemistry have several job opportunities, they can work in the chemical industry, the food, pharmaceutical and cosmetics industry, as well as in research institutes, the public administration or the trade sector.

The auditors hold the view that the objectives and intended learning outcomes of the Master's degree programme Chemical and Process Engineering are comprehensive and well founded: The students gain in-depth knowledge of core chemical engineering subjects, of fine and commodity chemicals, biorefining and metallurgical industries, operation and management. They also learn how to design advanced energy systems, with an

emphasis on sustainability, energy efficiency, and the use of renewable energy sources. In addition, the students learn how to plan, conduct and manage a complex project, to do independent work in a laboratory, and to participate in research projects. They acquire the competences to tackle some of society's greatest challenges such as supplying clean, safe drinking water and creating sustainable energy sources.

Chemical and process engineers work in areas such as renewable energy, biofuels, environmental control, fermentation, waste treatment, food industry, biotechnology and pharmaceuticals. Other graduates are employed helping to make aluminium, steel, fertilisers, food, pharmaceutical and medical products, and in related areas such as project coordination, waste treatment, research, consulting, marketing, and management.

The peers point out that the learning outcomes should make the differences between the Master's degree programme Chemical and Process Engineering and the Master's degree programme Process Chemistry more obvious. In addition, the peers judge the intended qualification profile of the Master's degree programme Process Chemistry in comparison to the very well formulated and adequate learning outcomes of the Master's degree programme Chemical and Process Engineering disappointing and lacking in ambition. As a consequence, the peers ask the programme coordinators to re-write the intended learning outcomes for the Master's degree programme Process Chemistry in order to clearly differentiate them from the intended learning outcomes of the Master's degree programme Chemical and Process Engineering and to better align them with level of qualification aimed at.

Furthermore, the peers point out that the learning outcomes of the two degree programmes taught in Finnish (Master's degree programme Process Chemistry, Bachelor's degree programme Chemical Engineering) should be available to all stakeholders, e.g. by publishing them on LUT`s website.

The auditors are convinced that the objectives and intended learning outcomes of the Master's degree programme Chemical Engineering for Water Treatment are reasonable and well founded: The students learn how waters are purified not only efficiently but also in a sustainable and economical manner and obtain knowledge and skills that can be used to solve water related challenges in the future. In addition, the students acquire the knowledge of the science involved in water treatment and get hands-on experience at water treatment related problems. The students also acquire the necessary competences with respect to laboratory work, water and wastewater technology, plant operation and water treatment systems in order to be able to act as a professional in the multidisciplinary area of water and the environment.

The graduates of the Master's degree programme Chemical Engineering for Water Treatment are able to play a major role in the development of new materials, food processing, water treatment, pharmaceuticals, transport and energy resources as well as addressing present environmental issues such as climate change. Typical areas of occupation are the chemical industry, engineering companies, research institutes, and the public sector.

While analyzing the intended learning outcomes of the Master's degree programme Chemical Engineering for Water Treatment the peers notice that the ethical and social aspects of the natural resource water are not mentioned and they ask the programme coordinators to include this aspect. These important topics should also be reflected in the curriculum.

Finally, the peer group judges the objectives and learning outcomes of the degree programmes to reflect the intended level of academic qualification (Bachelor: EQF 6, Master: EQF 7) and to correspond with the ASIIN Subject-Specific-Criteria (SSC) of the Technical Committee 01 – Mechanical Engineering/Process Engineering.

Furthermore, LUT applied for the EUR-ACE® (European Accredited Engineer) Label. The EUR-ACE® Label is a quality certificate for engineering degree programmes and is recognised Europe-wide. During the accreditation process, the reviewers verified that the degree programmes comply with the criteria fixed in the EUR-ACE® "Framework Standards for the Accreditation of Engineering Programmes". The Subject-Specific Criteria (SSC) of the Technical Committee for Mechanical Engineering and Process Engineering are closely linked to the EUR-ACE® Framework Standards; consequently, the analysis of the Subject-Specific Criteria encompasses the EUR-ACE® Framework Standards.

For the award of the ASIIN subject-specific label and the EUR-ACE® Label for degree programmes distinctive learning outcomes have to be achieved by First Cycle and Second Cycle Programmes respectively. Programme Outcomes as defined by the SSC have been divided into the categories "Knowledge and Understanding", "Engineering Analysis", "Engineering Design", "Investigations", "Engineering Practice" and "Transferable Skills". The SSC are the result of an assessment, regularly performed by ASIIN Technical Committees, which summarise what is considered as good practice by a professional community formed equally by academics and professional practitioners in higher education and is required as future-oriented quality of training in the labour market. Since all degree programmes under review have a proportion of more than 50 percent of mechanical engineering and/or process engineering contents they are overseen by the Technical Committee Mechanical Engineering/Process Engineering.

Based on the Self Assessment Report and the discussions during the on-site-visit, the peers see that the students of the Bachelor's degree programme acquire the necessary subject-related competences, such as a broad and sound knowledge in mathematics and natural sciences that are applicable to engineering, in-depth knowledge and methodological competence of sub-disciplines of engineering, and the ability to apply engineering methods to specific machines and equipment. With respect to interdisciplinary competences the graduates are able to evaluate technical products and procedures relating e.g. their economic and ecologic effects, and to work and communicate in national and international teams. Finally, they also gain some competences in work methodology such as the knowledge and skill to work independently on scientific tasks in engineering sciences and to present work results, but their ability to autonomously undertake practical tasks in engineering within a professional environment is somewhat limited. For this reason, the peers recommend strengthening the work-related competences of the students.

With respect to the Master's degree programmes the peers confirm that the students acquire the necessary subject-related competences, such as an in-depth knowledge in mathematics, in the field of engineering sciences for the solution of complex tasks, and enhanced knowledge, skills and methodical competences for the analysis and synthesis of process technological products and processes. In addition, the graduates are able to judge and evaluate how engineering problems are dealt with and have acquired the skills to work independently with methods of engineering on research and development tasks, to document them, and to present work results. They have gained enough practical engineering experience in order to be able to find a suitable employment in the fields of research and engineering.

Taking the mentioned shortcomings into consideration, the peers confirm that the demands of the SSC and the EUR-ACE® Framework Standards regarding the intended learning outcomes are fulfilled by all degree programmes under review.

Criterion 1.2 Name of the degree programme

Evidence:

- Self Assessment Report
- Homepage of LUT: http://www.lut.fi/web/en/ (access: 04.04.2017)

Preliminary assessment and analysis of the peers:

The auditors hold the view that the names of all degree programmes under review correspond with the intended aims and learning outcomes as well as the main course lan-

guage. The Finnish names of the degree programmes and their official English translation are mentioned in the Self Assessment Report and published on the LUT homepage.

Criterion 1.3 Curriculum

Evidence:

- Self Assessment Report
- Module descriptions
- Study Guide
- Curricular overview

Preliminary assessment and analysis of the peers:

The curriculum of the Bachelor's degree programme Chemical Engineering comprises the following classes of studies: general studies, language and communication studies, intermediate specialisation studies, minor studies and elective studies. The Bachelor's studies start with obligatory general studies which include mathematics (modules „Statistics I", „Numerical Methods I", „Functions, Linear Algebra and Vectors", „Differential Calculus and Applications", „Integral Calculus and Applications", „Basic Course on Differential Equations", „Functions of Several Variables and Series"), physics (modules „Fundamentals of Heat Transfer", „Fluid Dynamics I", „Basics of Mechanics", „Basics of Thermal Physics", „Wave Motion and Wave Phenomena"), chemistry and chemical engineering (modules „Introduction to Studies of Chemical Technology", „General Chemistry", „Biorefineries", „Renewable Energy"), and practical training (modules „Safety in Chemistry Laboratory", „Work Internship in Bachelor's Degree").

After completing the general studies, the student has acquired the necessary knowledge and skills to broaden and deepen his academic education in his chosen area of specialisation and minor studies. As a result, the first year of studies consists mainly of general studies, whereas specialisation courses increase in number for the second year, where in turn general studies are reduced. Courses of intermediate specialisation studies are obligatory in order to assure that all students achieve the basic technological and scientific competences. They include classes in chemistry (modules „Basic Inorganic Chemistry", Inorganic Analysis", „Organic Chemistry", „Organic Syntheses", „Basic Biochemistry", „Basic Analytical Chemistry", „Characterization of Solid Materials", „Chemical Thermodynamics", „Chemical Dynamics"), laboratory work (modules „Analytical Chemistry Laboratory Works", „Physical Chemistry Laboratory Course", „Laboratory Course of Unit Processes", „Applied Chemistry Laboratory Course") engineering (modules „Introduction to

Chemical Process Industries", „Process and Plant Design", „Introduction to Process Simulation", „Process Safety", „Chemical Reaction Engineering"), and the Bachelor's thesis and seminar. The obligatory intermediate specialization studies must amount to a minimum of 80 ECTS credits, the general studies to a minimum of 63 ECTS credits. In addition, the Bachelor students must attend language and communication classes (Swedish is obligatory). Finally, the degree programme includes minor studies (20 ECTS credits) and elective studies. Minor studies can be chosen without restrictions out of the courses provided by LUT or they can be taken as exchange studies at another university. Elective studies are chosen in order to complete the workload of the Bachelor's degree. Also another minor subject or internship can be included in the elective studies. All classes in the Bachelor's degree programme Chemical Engineering are taught in Finnish.

The peers discuss with the programme coordinators about the minimum length of the internship (at least four weeks, 2 ECTS credits). They learn that the students should gain some practical experience already during their Bachelor's studies. The students have to write a short report about the internship which has to be approved by the teacher, but the internship can be done in any area, there does not have to be a strong link to chemical engineering. According to the programme coordinators, the reason for the low requirements is that the students sometimes do not find suitable internships for a longer period. The students confirm that is currently not easy to find an internship but almost all the Bachelor students work during the summer because they must earn money to finance the cost of living during their studies. The summer jobs are very important to the students for several reasons. First of all, they need the money, secondly, they gain valuable practical experience, and last but not least they, establish a contact with possible employers. The peers understand the reasons for the current regulation concerning the internship in the Bachelor's degree programme Chemical Engineering, but they think it would be useful to extend the length of the compulsory internship and to demand that there is some connection with the actual field of studies.

The Master's degree programme Process Chemistry aims at preparing the students for a professional career as chemical engineers. The curriculum includes classes in the core and specialisation studies that are obligatory. The core studies (21 ECTS credits) consist of the modules „Industrial Organic Syntheses", „Inorganic Chemistry and Industrial Applications", „Technical Polymer Chemistry", „Surface and Solution Chemistry" and „Environmental and Process Analytics & Monitoring". They are all taught in the first year of studies. The specialization studies include the modules „Biopolymers", „Bioprocess Technology ",„Hydrometallurgy", „Biobased Platform Chemicals", a „Research Project" (10 ECTS credits) and the Master's thesis and seminar (30 ECTS credits). The thesis is an advanced

research project requiring approximately six months of full-time work. In total, the specialization studies add up to 61 ECTS credits.

The minor studies (20 ECTS credits) and the elective studies (19 ECTS credits) allow the students to follow their personal interests and to lay an individual focus in the course of study. The alternative minor subjects are Separation Technology, Green Process Technology, Process Design, and Advanced Water Treatment. The elective studies may also include an internship carried out in a field specialised in chemical engineering. Moreover, some students choose to go abroad for an international exchange and those studies can by application be fully transferred into Master's degree (e.g. to cover elective studies). Most classes in the Master's degree programme Process Chemistry are taught in Finnish.

The curriculum of the Master's degree programme Chemical and Process Engineering consists of obligatory core and specialisation studies. Core studies (21 ECTS credits) include the modules „Modelling of Unit Operations", „Process Control", „Advanced Process Design", and „Fluid Dynamics in Chemical Engineering". They are all taught in the first year of studies. The specialisation studies (61 ECTS credits) consist of the modules „Process Intensification", „Product Design", „Project on Process and Plant Design", „Bioenergy Technology Solutions ", and „Processing of Biomaterials". The degree programme is finalised with the Master's thesis and seminar (30 ECTS credits) which is also is a part of the specialization studies. The Master's thesis must be written in English as the Master's degree programme Chemical and Process Engineering is completely taught in English. The thesis is an advanced research project requiring approximately six months of full-time work.

The curriculum is supplemented by minor studies (20 ECTS credits) and elective studies (19 ECTS credits) that allow the students to put an individual focus on their studies. The alternative minor subjects are Separation Technology, Green Process Technology, and Advanced Water Treatment. Elective studies can include any courses offered by LUT. Studies at other universities (also from abroad) can be included upon application.

The Master's degree programme Chemical Engineering for Water Treatment aims at preparing the students for a professional career in the area of water purification. The curriculum includes classes in the core and obligatory specialisation studies. The core studies (20 ECTS credits) consist of the modules "Advanced Water Treatment", "Biological Waste Water Treatment", "Advanced Materials in Adsorption and Ion Exchange", "Solid-Liquid Separation " and "Environmental and Process Analytics & Monitoring". The specialisation studies consist of the modules "Water Treatment in Mining", "Membrane Technology ", and "Advanced Oxidation Processes & Electrochemical Methods in Water Treatment". The Research Project Course in Water Treatment (10 ECTS credits) and the Master's the-

sis and seminar (30 ECTS credits) are also included in the specialisation studies. The Master's thesis must be written in English as the Master's degree programme Chemical and Process Engineering is completely taught in English. The thesis is an advanced research project, requiring approximately six months of full-time work.

The minor studies (20 ECTS credits) and the elective studies (19 ECTS credits) allow the students to follow their personal interests and to lay an individual focus in the course of study. The alternative minor subjects are Separation Technology, Green Process Technology, and Process Design. The elective studies may also include work internship carried out in a field specialised in chemical engineering. Moreover, some students choose to go abroad for an international exchange and those studies can by application be fully transferred into Master's degree (e.g. to cover elective studies).

The peers notice that thermo-processing and distillation techniques are not done practically in the laboratory classes by the Bachelor students but are only addressed theoretically. The peers are convinced that for many students practical work in labs incidental to theoretical background taught in lessons is the key for deeper understanding. That is why lab work should include a wider choice of unit operations of process technology. Since the students should also get acquainted in practice with these important areas of chemical engineering and not only learn the basic theoretical background, they recommend introducing laboratory works in thermo-processing and distillation techniques into the curriculum of the Bachelor's degree programme Chemical Engineering.

The peers also enquire if all Bachelor students learn the basics of materials for process equipment and find out that these topics are missing in the curriculum; only in the module "Process and Plant Design" some aspects of construction materials and material selection are discussed. Competences with respect to materials used in the construction of process equipment are important for assessing the safety and durability of the used equipment within different process media. The peers judge this to be an important subject for chemical engineers and therefore recommend making all students of the Bachelor's degree programme Chemical Engineering acquainted with the aspects of materials sciences.

Lab experience in chemical reaction engineering and important general process techniques like heat exchange or industrial process measurement are also not part of the study programmes. In addition, experience in commissioning or operating plants shows that process control is very crucial in chemical and process engineering. Therefore, already Bachelor graduates need to have basic competences in this field because hands-on experience with different pieces of basic process equipment is important to give students a background for the safe operation at plant scale level. As a consequence, the peers rec-

ommend moving the module "Process Control" from Master's level to Bachelor's level. In the course of the discussion with the peers, the teachers agree with this suggestion and approve of such a shift. On the other hand, the peers conclude that it not necessary to offer so many advanced classes in mathematics such as the modules obligatory Basic Course on Differential Equations" or obligatory Numerical Methods I" already in the Bachelor's degree programme Chemical Engineering. Those modules could be moved to the Master's programmes to even out the workload in the Bachelor's degree programme Chemical Engineering.

In summary, the auditors are convinced that the intended qualifications profiles of the Master's degree programme under review allow the students to take up an occupation that corresponds to their qualification. Diverse teaching methods and multicultural and multidisciplinary study groups ensure that the students in all degree programmes will have good skills in team and project work, communication and languages, presentation, culture and leadership. The degree programmes are designed in such a way that they meet the objectives set for them, including the intended learning outcomes. They appreciate that LUT aims for high standards as to give their students good chances in the national and international job market as well as a good starting point to transfer to other academic programmes to complete a PhD-programme.

Criterion 1.4 Admission requirements

Evidence:

- Finnish Universities Act (558/2009 and 428/2013)
- Guideline for the recognition of prior learning and credit transfer of September 1st 2014
- University Regulations on Education and the Completion of Studies, approved on 22nd June 2016
- Self Assessment Report

Preliminary assessment and analysis of the peers:

The admission to LUT is regulated according to the Finnish Universities Acts (558/2009 and 428/2013) and is organised by joint application system (Studyinfo.fi) that is used by all Finnish universities. An applicant for a Bachelor's degree programme can apply for six degree programmes in order of preference in one or several universities or universities of applied sciences using the same application form. Condition for an application is the completion of the Finnish matriculation examination, a three-year vocational degree or an equivalent international high school degree. Students can be selected based on their

success in the Finnish matriculation examination or by their success in the entrance examinations. The entrance examinations are organised jointly by the seven technical universities in Finland. The entrance examination is based on the Finnish high school curriculum in mathematics, physics and chemistry. Prospective students must pass the entrance examination to be selected even if there are fewer applicants than places available. This guarantees the minimum required knowledge in natural sciences and mathematics of all first year students. The further details are regulated in Sections 36 and 37 of the Finnish Universities Act (558/2009).

Distinctive admission criteria for the Master's degree programmes do not exist: All students admitted to a Bachelor's degree programme are also allowed to continue their academic studies in a Master's degree programme (as in all universities in Finland).

Since 2016, students graduating with a Bachelor's degree may continue to any Master's degree programmes of the same area. For example, the graduate of the Bachelor's degree programme Chemical Engineering can choose either the Master's degree programme Process Chemistry, the Master's degree programme Chemical and Process Engineering, or the Master's degree programme Chemical Engineering for Water Treatment. The students have already to choose the Master's programme when they are applying for the Bachelor's degree programme. Usually, the students make separate personal study plans for the Bachelor's degree and the Master's degree already during the Bachelor's studies.

The students are encouraged to apply for a Master's degree programme as soon as their Bachelor's studies are finished and they are allowed to take Master's level studies even before their graduation, which assures a smooth transition from the Bachelor's studies to the Master's studies. The peers inquire how LUT handles the applications of Master students from other countries. They learn that the Master's programmes are open for all graduates with a Bachelor`s degree. The admission is based on the final grade of the Bachelor`s degree (50%) and on an interview with the programme coordinator (50%). The interviews with international applicants are done via Skype. In addition, all applicants must provide an English language certificate. Bachelor's students from LUT are admitted automatically to the Master programmes without any further application or selection procedure. At LUT approximately 50% of the new Master's students are from Finland, whereas another 50% come from foreign countries. International students from outside the EU will have to pay a tuition fee of 10.000 € per year from next fall semester. The programme coordinators expect the number of international applications to drop but hope that the quality will improve.

In the field of Chemical Engineering also graduates with a Bachelor's degree from another university or from a University of Applied Science, in the relevant field of study or in a closely related field, can apply for admission to the Master's degree programmes. The Bachelor's degree must be completed by the end of the application period. The Head of the degree programme decides upon the admission of the applicant and any possible complementary (bridging) studies required. The admission and selection procedure is organised by the joint universities' application system, Studyinfo.fi. The further details are regulated in Sections 36 and 37 of the Finnish Universities Act (558/2009).

The auditors confirm that the requirements and procedures for admission are transparent and clear. All applicants are treated according to the same standards and regulations.

According to the university guideline for the recognition of prior learning and credit transfer, students may apply to have classes completed outside of LUT recognised as a substitute for a course at LUT or as part of the minor or elective studies. The decision is made based on the learning outcomes achieved, contents, equivalences and applicability to the degree. The student must apply for the credit transfer in written form and the application can be accepted entirely or partly, or rejected. If the application is rejected, the grounds for rejection must be stated in the decision. The peers acknowledge that the rules for the recognition of achievements and competences acquired at other higher education institutions are in accordance with the Lisbon Recognition Convention.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 1:

The peers appreciate that LUT has revised the learning outcomes of the Bachelor's degree programme Chemical Engineering and the Master's degree programme Process Chemistry. The revised learning outcomes are publicly available in the UNI-portal. After analyzing the updated learning outcomes the peers come to the conclusion that the learning outcomes of the Bachelor's degree programme Chemical Engineering still do not make obvious that the degree programme provides the qualification for starting a professional career. For this reason the peers retain the respective requirement.

Concerning the revised learning outcomes of the Master's degree programme Process Chemistry the peers are satisfied with the change and can now see a distinctive profile that differs from the qualification profile of the Master's degree programme Chemical and Process Engineering and that is better aligned with level of qualification aimed at. For this reason the peers abstain from issuing a requirement with respect to the learning outcomes of the Master's degree programme Process Chemistry.

Since LUT has made the qualification objectives of all degree programmes under review accessible for all relevant stakeholders by publishing them on the UNI-portal, the peers see no need to issue a corresponding requirement.

The peers thank LUT for pointing out that all degree programmes in the field of technology include a compulsory internship of 2 ECTS credit points. Usually, the internship is done in a relevant industry, but all kinds of work assignments are accepted. If it is not possible to extent the length of the compulsory internship, the peers think it should have at least a link with the specific degree programme. The introduction of a new course on "labour market, working life and job search" might help in this respect.

The peers take notice that various distillation techniques are covered during the course "Organic Syntheses" and that aspects of material science relevant for the design of chemical processes are addressed in the courses "Process and Plant Design" and "Process Safety"; LUT has updated the respective module descriptions. Nevertheless, the peers think that the focus is too much on mechanical separation techniques and that it would be useful to introduce laboratory experiments in thermal separation techniques, to offer a course in process controls, to make all students acquainted with the aspects of materials for process equipment and to update the laboratories and the equipment accordingly.

As LUT emphasises the students learn about process control during their Master's studies and based on the feedback from their alumni LUT feels that the current arrangement serves the industry and therefore LUT does not plan to change the curriculum in this respect. The peers understand that almost all Bachelors' students also complete a Master's degree programme, but they still think that it would be useful to offer a course in process control already at Bachelor's level. Of course, his does not exclude the possibility to have additional courses in process control on a Master's level.

Taking the statement of LUT into account the peers assess criterion 1 to be mostly fulfilled.

2. The degree programme: structures, methods and implementation

Criterion 2.1 Structure and modules

Evidence:

- Self Assessment Report
- Module descriptions

Preliminary assessment and analysis of the peers:
The academic year at LUT is divided into two semesters and four periods, the length of a period is seven weeks. The length of a course can be 1-4 periods depending on the content and the scheduling. The schedule for each academic year is published in the UNI portal of LUT.

At the beginning of the Bachelor's studies, every student prepares his own personal study plan together with his academic advisor. This includes the selection of the minor subjects and the electives as well as a possible choice for the following Master's studies. The students appreciate the flexibility of the degree programmes and the possibility to prepare an individual study plan. The peers judge this procedure to be one of the strong points of LUT.

All degree programmes under review are divided into modules. Most of the modules of the Bachelor's degree programme Chemical Engineering encompass between 1 and 5 ECTS credits, whereas the modules of the Master programmes are larger in scale, between 4 and 10 ECTS credits. The Bachelor's courses include more in-class teaching than Master courses, which are more based on variable teaching methods and independent studies. The small modules with 1 or 2 ECTS credits in the Bachelor's degree programme Chemical Engineering are typically introductory courses, internship courses or compulsory language courses, which are often based on attendance-based learning. Within the last few years, the Master level courses have been standardised to 5 ECTS credits with only a few exceptions. This increases the flexibility in curriculum development and allows the students to better integrate their minor studies.

From the auditors' point of view, the structure of the degree programmes ensures that the qualification level and the intended learning outcomes can be achieved and that the students can complete the degree programmes successfully without any delay.

By choosing their minor studies and the elective studies the students are able to define an individual focus in their course of studies. All working practice intervals are integrated into the curriculum and the modules have been adapted to the requirements of the respective degree programme.

The peers discuss with the programme coordinators for what reasons the new Master's degree programme Chemical Engineering for Water Treatment was developed and who was involved in the process. They learn that the programme was established by the for-

mer head of the degree programmes because the School of Engineering wanted to lay a special focus on this area and there is a research facility located at Mikkeli that belongs to LUT and is concerned with research in the field of water treatment. The programme only started in the fall term 2016; it is therefore still in its early stages and there are not any graduates yet. The programme coordinators are somewhat concerned by the low number of students starting in the programme, but they hope that there will be more applications after the degree programme has become more known. The students add that they have to go to Mikkeli for classes only if a research project is done there so that they might have to spend some time at the research centre; the costs for accommodation and travelling are covered by LUT. The peers regret that neither the students nor the industrial partners of LUT were involved in the design of the new degree programme.

The students confirm the impression of the peer group that the academic mobility of the Finnish students is not as high as it could be. There are more incoming international students than outgoing Finnish students. Although, there are several international co-operations, e.g. with other EU-Countries, and Russia and LUT`s Student Services Centre organises international student exchange programmes, offers advice and support, only a few students take this opportunity and study abroad. During the meeting with the peers especially the Bachelor's students express their interest in spending some time at a foreign university but also state that it is sometimes complicated to get compulsory core classes replaced by courses taken abroad so that most students use the electives and the minors for this purpose.

The programme coordinators explain that the imbalance between incoming and outgoing students is not valid on university level but admit that in the School of Engineering there is a difference. The outgoing students sign a learning agreement and usually receive a scholarship if they at least gain 20 ECTS credits, although the aim is to acquire 30 ECTS credits during one semester abroad. Since LUT has an outspoken international focus and wants its students to study abroad, the peers recommend facilitating the recognition of achievements and competences acquired at foreign higher education institutions.

Criterion 2.2 Work load and credits

Evidence:

- Self Assessment Report
- Module descriptions
- Study Guide

- Curricular overview

Preliminary assessment and analysis of the peers:
The Bachelor's degree programme Chemical Engineering is designed for 180 ECTS credits, whereas the three Master's degree programmes encompass 120 ECTS credits. One ECTS credit equals 26 hours of work, including face-to-face teaching hours, individual studying, as well as preparation for and taking the examinations.

The Bachelor's degree programme Chemical Engineering as well as the three Master's degree programmes under review are structured in such a way that by following the respective study guide the programmes can be completed within the intended time frame. The students should take 60 ECTS credits per year on average, and the maximum of 75 ECTS credits per year should not be exceeded. The Students' workload of each course is evaluated by the course feedback questionnaire.

An attachment to the Self Assessment Report describes the performance indicators of the four degree programmes under review. Especially the data concerning the Bachelor's degree programme Chemical Engineering is surprising to the peers. They notice that according to the provided statistics, an average Bachelor's student acquires only 33 ECTS credits per academic year and only 28% of the Bachelor's students manage to gain at least 55 ECTS credits per academic year. As a consequence, the average time to complete the Bachelor's degree should be approximately 12 semesters. This number seems to be very high and leads to the question if the statistical data is correct, and what the reasons for the low number of acquired credits are.

The programme coordinators confirm the formal correctness of the statistical data but they cannot explain how the data is processed and what students are included in the statistics. They assume that there are basically two reasons for the low number of acquired credits. First of all, it is usual in Finnish universities that the Bachelor's students automatically continue their studies in a Master's degree programme even if they have not completely finished their Bachelor's degree. For this reason, several students complete their Bachelor's degree only shortly before they complete their Master's degree. Secondly, there are some Bachelor's students that take several years before they submit their final thesis and they stay enrolled during this time in order to be able to receive the students' benefits. This will not be possible any longer, because a new regulation was issued in Finland that limits the time during which a student can be enrolled in a degree programme. This also applies to the time allowed for the completion of the Bachelor's thesis. New rules will be established that will limit the time the students have to finish their Bachelor's thesis.

During the discussion with the peers, the students confirm that most of them will take five to six years to finish their combined Bachelor's and Master's programmes and that there are no structural problems in the organisation of the Bachelor's degree programme Chemical Engineering that hinders them to finish their studies within the expected timeframe. The peers conclude that it is necessary to analyze the available statistical data in more detail and to find out the reasons for the long average time of studies and the low number of average credits acquired per year in the Bachelor's degree programme Chemical Engineering and if the new legislation has a positive effect.

The peers notice that the study plan of the Master's degree programme Process Chemistry seems to be very unbalanced with respect to the work load in the different periods. In the course of the fourth period of the first academic year the study plan shows a total workload of 35 ECTS credits (15 ECTS credits in minors, 20 ECTS credits in compulsory courses) whereas the third period has a total workload of 0 ECTS credits. Even taken into account that the compulsory module „Surface and Solution Chemistry" is taught in the third and fourth period the workload distribution is 2,5 to 32,5. The programme coordinators explain that not all minors are offered every period which may lead to the imbalance in the workload as mentioned in the study plan. The students confirm in their discussion with the peers that depending on their choice of minors the workload can be very high in one period and very low in another one. So is up to the students to design their personal study plan accordingly in order to distribute the workload evenly between the periods. The peers understand that every student has an individual study plan and can therefore balance the distribution of the workload, but this is only possible to a certain extent and they expect the programme coordinators to re-design the curriculum of the Master's degree programme Process Chemistry in order to avoid peaks in the workload.

In summary, the auditors conclude that there is no structural pressure on the quality of teaching and the level of education due to the workload. The total workload seems to be realistic but peaks in the workload should be avoided.

Criterion 2.3 Teaching methodology

Evidence:

- Self Assessment Report
- Module descriptions

Preliminary assessment and analysis of the peers:
The teaching methods applied in the four degree programmes under review include lectures, classroom and laboratory exercises and assignments, project work, and seminars. Practice-oriented, problem-based teaching methods are applied and the courses also encompass group and project work in order to develop the social competences of the students.

To improve the quality of teaching, LUT has published some guidelines for the planning and implementation of teaching methods and the LUT Teacher's Quality Manual. In addition, LUT offers pedagogical training for teachers. Finally, there is a short meeting for all staff members of the chemical engineering programmes approximately every two weeks to discuss current issues in teaching.

In summary, the peer group judges the teaching methods and instruments to be suitable to support the students in achieving the learning outcomes. The diversity in teaching methods (in-class teaching, problem solving individually or in groups) is highly appreciated. The peers consider the degree programmes to be well balanced between attendance based learning and self-study.

Criterion 2.4 Support and assistance

Evidence:

- Self Assessment Report

Preliminary assessment and analysis of the peers:
LUT offers a wide range of guidance for the students, it includes information and instructions provided in the UNI portal and assistance and supervision by the members of the academic staff. Professors and associate professors are responsible for thesis supervision of Master's students, while other academic staff members supervise the theses of Bachelor's students. They help students in choosing the topic, and give instructions and feedback.

Each degree programme has a study advisor and tutors, who are responsible for the guidance of the students in the respective degree programme. The guidance includes peer tutoring for newcomers, orientation days and welcoming information, discussions on the degree structure and personal study and career plans, and advice on international exchange. In addition, there are several teacher tutors who assist the study advisor and the study counselor. The tutors are also involved in helping the new students to cope with the requirements of university studies and to help with the problems caused by the transition

from high school to university. The study progress of new students is monitored actively by Study Services and the best achieving students/tutor groups are awarded. Finally, general study guidance is organised by Study Services of LUT.

Each student at LUT has an electronic personal study plan (PSP) that is based on the degree structure described in the study guide. The first version of the PSP is designed in accord with the study counsellor at the beginning of the studies and is updated regularly. The roles and duties of all people involved in student support and assistance are described in the Self Assessment Report.

The peers learn that the members of the teaching staff are available on any issues regarding the degree programmes and offer academic advice. They appreciate this "open door policy".

The peer group notices the good and trustful relationship between the students and the teaching staff; there are enough resources available to provide individual assistance, advice and support for all students. The support system helps the students to achieve the intended learning outcomes and to complete their studies successfully and without delay. The students are well informed about the services available to them.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 2:

The peers appreciate the head of the degree programme will propose for the academic year 2017/18 a list of recommended exchange universities where appropriate chemical engineering studies can be taken and courses in the student's major can be substituted according to the already established process. This should facilitate the recognition of compulsory parts of the curriculum taken at other universities. Since LUT plans to make suitable changes with respect to the recognition of achievements and competences acquired at foreign higher education institutions the peers see no need for issuing a recommendation in this direction**.**

The peers understand that it is not easy for LUT to provide detailed statistical data concerning the average length of studies and the average number of credits acquired per year in the Bachelor's degree programme because almost all students continue their studies in a Master's degree programme without a break and both programmes seamlessly blend into each other. The peers still see a need for LUT to better analyse the available statistical data in order to find out the reasons for the long average time of studies and the low number of credits acquired in average per year. For this reason they retain the respective requirement.

As LUT points out, the curriculum of the Master's programme Process Chemistry has been redesigned for the academic year 2017-18 in order to even out the workload by changing the placement of the courses, "Bioprocess Technology and "Hydrometallurgy". In addition, a compulsory course "Orientation to M.Sc. Studies" will be included in all Master's degree programmes beginning from 2017/18. One aim of the additional course is to give better instructions for students to plan their studies, especially the minor studies, distributing the workload evenly to all semesters and periods. The peers see that the curriculum has been re-design and peaks in the workload are now avoided. As a consequence they abstain from issuing a requirement concerning the workload distribution.

Taking the statement of LUT into account the peers assess criterion 2 to be mostly fulfilled.

3. Exams: System, concept and organisation

Criterion 3 Exams: System, concept and organisation

Evidence:

- University regulations on education and the completion of studies, approved on 22 June 2016
- Sample exams and final theses
- Self Assessment Report
- Module descriptions

Preliminary assessment and analysis of the peers:

At LUT various methods of examination are used. This includes written examinations such as essays, case studies and calculation problems. In addition, oral exams, laboratory work reports, learning assignments, group work, project work, literature reviews and seminars are also used depending on the competences that should be imparted and evaluated. The examination methods used in the different modules are reported in the study guide of each degree programme. Examination and teaching periods are annually announced by the vice rector of education and published on the UNI portal of LUT and the academic calendar. There are altogether eight examination weeks during the academic year, plus an additional examination week for re-sits in summer.

In addition to the traditional examination methods, a new electronic exam tool is available and a new electronic exam hall provides the possibility for LUT students to take exams all year around. This possibility is so far used only by a few teachers in their courses.

An independent research project, which is carried out as Bachelor's Thesis and Seminar (10 ECTS credits) or Master's Thesis and Seminar (30 ECTS credits), forms a crucial part of every programme.

The peers discuss with the programme coordinators how the students decide about the topic of their final thesis and if there any mechanisms for limiting the amount of time spent on the Master's thesis. They learn that currently approximately 90 % of students complete their Master's thesis within the expected time frame (six months). Approximately 50% of the Master's theses are done in cooperation with industrial partners, although the experiments are mostly done at the university. If a thesis is done in industry, there is always a supervisor at the company who is also involved in the grading of the thesis. Bachelor's theses are usually done at the university without direct involvement of industrial partners.

During the discussion with the peers the students point out that they appreciate to have the opportunity to prepare the Master's thesis in co-operation with an industrial partner. But it depends mostly on the initiative of the students to find a suitable topic. It is also common to contact the company, where the student has done a summer job, and ask about the possibility of doing the final thesis. The amount of time intended for the Master's thesis is six months, but in addition to the practical the thesis must be written and there is usually some literature research at the beginning. As a result the students take an average of 6 to 8 months for completing the master thesis. The Bachelor's thesis should take three months to write and must be finished within a year after the topic has been accepted. This new regulation was established in order to avoid that students submit their Bachelor's thesis after two or even more years.

The peers are impressed by the new electronic exam tool; it allows the students to take exams all around the year. There is a particular exam hall for doing the electronic exams, the teacher uploads the exam to the system and the student can freely choose the time when he wants to take it. Currently, the use of Exam in the Bachelor's and Master's programmes in Chemical Engineering is still modest and limited to only a few classes. Since the students and the teachers are satisfied with this new tool, the School of Engineering intends to increase the use of the electronic exam.

Each exam is offered three times during the academic year and can be taken three times; the first exam is scheduled for the examination period following the teaching period dur-

ing which the course is taught. If a student does not pass the exam after the third try, he may apply for an additional retake with the teacher responsible for the course.

Guidelines and procedures for fostering accessible education at LUT are in place to support the performance of students with learning disabilities and special needs.

During the discussion with the peers the students express their satisfaction with the organization and amount of the exams. There are not only written exams but a lot of group work (4 to 5 Students per group) and projects. In the course of the group projects, the students also acquire soft skills (e.g. presentation and communication skills); problem based learning and case studies are also an essential part of the classes.

The peers confirm that there is a form of assessment for each course and that all students are well informed about the form of assessment and the details of what is required to pass the module. The rules for re-sits, disability compensation, illness and other circumstances are anchored in the University regulations on education and the completion of studies and therefore transparent to all stakeholders.

The peers inspect a sample of examination papers and final theses from all four degree programmes under review and are satisfied with the general quality of the samples.

The peers come to the conclusion the ASIIN criteria regarding the examinations system, concept, and organisation are fulfilled.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 3:

The peers assess criterion 3 to be fulfilled.

4. Resources

Criterion 4.1 Staff

Evidence:

- Self Assessment Report
- Staff handbook

Preliminary assessment and analysis of the peers:
According to the Self Assessment Report, the academic staff consists of professors, assistant professors, post-doctoral researchers and PhD-students. In addition, there are several visiting professors and researchers working at the School of Engineering.

The composition of teaching and research personnel at LUT is based on a tenure track system. The members of the teaching staff are either employed in a tenure track position or a non-tenure track position. The aim of the tenure track positions is to advance to the level of full professor based on post-doctoral achievements and qualifications. Non-tenure track positions are either research or teaching oriented, based on the needs of the School of Engineering. The peers enquire if the academic staff members have permanent contracts and how high their teaching load is. They find out that the professors and assistant professors hold permanent positions, whereas the post-doctoral fellows and PhD-students are employed on four year contracts. The permanent staff members have all different contracts with respect to the teaching load, time for research and administrative tasks. Some professors almost only give classes, especially in the basic chemistry courses, while other professors or assistant professors spend more time on their research activities or are involved in the administration of the School of Engineering. Most members of the academic staff have both teaching and research activities although the focus of duties varies significantly.

LUT puts a strong emphasis on research activities and focuses on the different aspects of a circular economy including resource efficient production and sustainable energy generation. The research activities typically include working on research projects, reporting and publishing research results and supervising final theses.

The auditors notice that the composition and qualification of the teaching staff is suitable to sustain the Bachelor's degree programme as well as the Master's degree programmes. They also confirm that enough resources are available for administrative tasks and supervision and guidance of the students.

The auditors are very impressed by the excellent and open atmosphere among the students and the staff members. Especially, the programme coordinators are dedicated to the degree programmes and to the students and are striving for improving the quality of the programmes.

Criterion 4.2 Staff development

Evidence:

- Self Assessment Report

- Staff handbook

Preliminary assessment and analysis of the peers:
LUT provides several opportunities for its staff members to improve their teaching competences and to develop their didactic abilities. For example, LUT organises a special training in pedagogy; according to the Self Assessment Report, 17 staff members of the Department of Chemical Engineering have already participated in the training. In addition, LUT offers a variety of smaller training courses in order to support the professional development and expertise of the teaching staff. Finally, staff members in supervisory positions are entitled to participate in management training programme that is centrally organised by LUT (Leadership Excellence Programme).

During the discussion with the peers, the teachers express their overall satisfaction with the support mechanisms and mention that research budgets allow for going abroad and visiting other research groups, LUT also offers classes for improving the teaching skills and English proficiency.

In summary, the auditors confirm that LUT offers sufficient support mechanisms and opportunities for members of the teaching staff who wish to further develop their professional and teaching skills.

Criterion 4.3 Funds and equipment

Evidence:

- Self Assessment Report
- Onsite visit of the laboratories

Preliminary assessment and analysis of the peers:
During the audit the peer group also visits the laboratories in order to assess the quality of infrastructure and technical equipment. They notice that there are no bottlenecks due to missing or out of date equipment or a lacking infrastructure. The technical equipment is up to date and available in sufficient numbers.

In the LUT library the students have access to electronic scientific and educational resources and to the electronic library system, including current publications that are needed for study and research.

Most of the laboratories at the Department of Chemical Engineering are utilised both for research purposes and for teaching classes. In addition, there are a few laboratories that are only used for teaching, for example the laboratory of organic and inorganic chemistry.

The peers notice that the breadth of the hands on experiments done in the laboratories is focused on mechanical separation processes whereas other important techniques like distillery and thermal processes are only discussed theoretically in the classes, so the range of practical work is quite limited. The laboratory work is often related to the research areas of the university such as mechanical separation and purification technologies. Moreover, thermo processing and distillation techniques can't be done practically in the laboratories by the Bachelor's students because the necessary technical equipment is missing. Since the Bachelor's students should see in practice what is really happening in these areas of chemical engineering and not only learn the basic theoretical background, the peers judge it would be useful to equip the laboratories accordingly and to include corresponding experiments in the practical work.

The students express their general satisfaction with the available resources, the technical equipment, the laboratories, and the library. They have also remote access to the usual software and the opening hours of the library are now 24 hours 7 days per week.

The peers discuss with the programme coordinators about the amount of external funding and if those funds are required for sustaining the academic staff. They learn that on average 40% of the funding derives from external sources whereas 60% of the budget is provided by the Finnish government. The external funding is connected with the different research projects but is not essential for financing the teaching staff.

The auditors conclude that there are sufficient funds and equipment and that the infrastructure (laboratories, library, seminar rooms etc) complies with the requirements for sustaining the degree programmes apart from the above mentioned deficiencies.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 4:

The peers emphasise that from their point of view it would be useful to introduce laboratory experiments in thermal separation techniques and to update the laboratories and the equipment accordingly.

The peers assess criterion 4 to be mostly fulfilled.

5. Transparency and documentation

Criterion 5.1 Module descriptions

Evidence:

- Module descriptions
- Homepage of LUT: http://www.lut.fi/web/en/ (access: 04.04.2017)

Preliminary assessment and analysis of the peers:
The auditors confirm that the module descriptions are accessible to all students, the teachers, and all other stakeholders via the university`s homepage

In general, the module descriptions include all necessary information about the module`s objectives and content, its link to the programme objectives as well as prerequisites, workload, teaching methodology, exam requirements, literature and teaching staff. There are just some minor mistakes and inconsistencies. For example, one ECTS credit is awarded for 26 hours of students` workload, but the information in several modules descriptions does not fit this relation. In addition, in some module descriptions, e.g. “Biorefineries” the workload is not mentioned at all. Furthermore, the module descriptions should specify what kind of exam (e.g. written exam, presentation, essay etc.) must be taken and the criteria for pass and fail should also be. Moreover, the peers notice that some module descriptions are incomplete and do not contain the necessary information about the aims and the content of the module (e.g. modules “Biological Waste Water Treatment” and “Advanced Process Design”). Finally, the peers point out that not all module descriptions include literature references (key point: course material). Therefore, the peers expect that the module descriptions are revised and edited.

Criterion 5.2 Diploma and Diploma Supplement

Evidence:

- Self Assessment Report
- Exemplary Diploma Supplements
- Exemplary Transcripts of Records

Preliminary assessment and analysis of the peers:
All students receive a Diploma Supplement in English upon the graduation from LUT. It is handed out automatically and free of charge along with the degree certificate and a transcript of records in English.

LUT's Diploma Supplement follows the model developed by the European Commission, Council of Europe and UNESCO. It includes the necessary information about the university, the level of studies, the individual result, and the status of the awarded degree in the

national education system. It also gives information on the professional status of the qualification and contains a description of the Finnish education system. But the peers notice that the Diploma Supplements do not contain any information about the overall learning outcomes of the respective degree programme. In addition, the peer group points out that the Diploma Supplement should also include statistical data regarding the final grade and information about its composition according to the ECTS users' guide. This allows the reader to classify the individual result. Such a classification is missing in the submitted Diploma Supplements. As a consequence, the peers ask LUT to include this information in the Diploma Supplements.

Criterion 5.3 Relevant rules

Evidence:

- Self Assessment Report
- Homepage of LUT: http://www.lut.fi/web/en/ (access: 04.04.2017)
- All relevant regulations

Preliminary assessment and analysis of the peers:
The auditors confirm that the rights and duties of both LUT and the students are clearly defined and binding. All relevant course-related information is available in the language of the degree programme and accessible for the students and the teaching staff via the electronic UNI portal. They point out that they could not find the necessary information about the Bachelor's degree programme Chemical Engineering and the Master's degree programme Process Chemistry on the university`s homepage. They ask the programme coordinators to provide access to all relevant documents for all stakeholders. This could for example be achieved by publishing them on the university`s homepage.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 5:

The peers thank LUT for updating the description of the modules "Biorefineries", "Biological Waste Water Treatment", and "Advanced Process Design". Since the peers have noticed other deficits in the module descriptions (e.g. conversion of workload in ECTS, information about the form of exams, the criteria for pass and fail, literature hints) they would like to see all the module descriptions of the degree programmes under review. Thus, they retain the corresponding requirement.

LUT will update the Diploma Supplement and the peers expect to receive a sample of the new version for each degree programme. Until then they retain the corresponding requirement.

Taking the statement of LUT into account the peers assess criterion 5 to be mostly fulfilled.

6. Quality management: quality assessment and development

Criterion 6 Quality management: quality assessment and development

Evidence:

- LUT Quality Manual
- Self Assessment Report
- Performance Indicators

Preliminary assessment and analysis of the peers:
During the audit the peers gain the impression that the quality management system is one of the strong points at LUT. There is a continuous process implemented to improve the quality of the degree programmes and it is carried out through various mechanisms, such as the assessment of the learning processes by lecturers and regular course evaluations by the students. The evaluation of the degree programmes is also conducted by monitoring various performance indicators, such as students' satisfaction, employability, earned ECTS credit points and drop-out rates.

Students provide feedback through questionnaires that are filled out online every semester for each course. The course evaluation aims to continuously improve the degree programmes and to create a supportive and effective learning environment for students. In addition, also graduating students and alumni are asked to fill out online questionnaires concerning their academic experience in the degree programmes.

The peers ask about the return rate of the course evaluations and learn that it is rather low, but in addition, once in each period all classes are discussed in a workshop with the students, teachers, and programme coordinators. The results of the course evaluations are presented and feedback is given to the students about the consequences and the

planned changes. The students especially appreciate the open atmosphere during these workshops.

While meeting with the students, the peers learn that the students are involved in the further development of the degree programmes, e.g. the representatives of the students´ union meet regularly with the programme coordinators and discuss about students' problems and possible changes in the degree programmes.

The auditors gain the impression that the feedback is taken into account by the programme coordinators and changes are made instantly. They confirm that the School of Engineering regularly monitors and reviews the degree programmes and the modules to ensure that they achieve the objectives set for them and respond to the needs of the students.

External quality assessment of the degree programmes is provided by the review of the LUT quality management system by the Finnish Education Evaluation Council.

During the discussion with the representatives of the industrial partners of LUT the peers ask if the university follows the demand of the labour market and how they find out about the employment of the graduates. The industrial partners explain that some of the companies have individual contact persons at LUT and have concluded frame agreements with LUT. In addition, there is an annual seminar where the representatives of the industrial partners talk about new developments with the programme coordinators. They also confirm that the employability of the graduates is high; the graduates of the Master's programmes have very good chances to find an adequate job. The programme coordinators add that according to the national Finnish statistical office, 92% to 96 % of the LUT graduates are employed.

LUT has a department for alumni activities; it organises several events every year, publishes a newsletter, and conducts every second year an alumni survey 5 years after the graduation, the return rate is between 30% and 40%. In addition, there is an advisory board at LUT with experts from the industry; some of them are also graduates of LUT. Moreover, the programme coordinators get informal feedback via a facebook group of graduates of the chemical engineering programmes.

The representatives of the industrial partners suggest establishing a direct contact between the alumni and the current students, e.g. by organizing a seminar for graduates or students looking for an internship, a final thesis, or a summer job. In addition, they think it would be useful to give the members of the academic staff or employees from the industrial partners the opportunity to work for some time at the other institution in a kind of work exchange. In general, they recommend to get the "outside world" more involved

with LUT and to facilitate the conclusion of a frame agreement. The peers support this point of view.

A minor weak point, in the eyes of the peers, is the fact that neither the students nor the industrial partners were involved in the design and development of the new Master's degree programme Chemical Engineering for Water Treatment.

The peers can attest that policies and processes are in function at LUT that form a cycle for continuous improvement and contribute to the accountability of LUT. They especially appreciate the involvement of the students and the accessibility of the programme coordinators; this supports the development of quality culture in which all internal stakeholders assume responsibility for quality and engage in quality assurance at all levels of LUT.

In summary, the peer group confirms that the quality management system is suitable to identify weaknesses and to improve the degree programmes.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 6:

The peers assess criterion 6 to be fulfilled.

D Additional Documents

Before preparing their final assessment, the panel ask that the following missing or unclear information be provided together with the comment of the Higher Education Institution on the previous chapters of this report:

-

E Comment of the Higher Education Institution (19.05.2017)

The institution provided a detailed statement as well as the following additional documents :

- ATTACHMENT 1: REVISED LEARNING OUTCOMES
- ATTACHMENT 2: REVISED STUDY PLAN MA PROCESS CHEMISTRY

F Summary: Peer recommendations (07.06.2017)

Taking into account the additional information and the comments given by LUT the peers summarise their analysis and final assessment for the award of the seals as follows:

Degree Programme	ASIIN-seal	Subject-specific label	Maximum duration of accreditation
Ba Chemical Engineering	With requirements for one year	EUR-ACE®	30.09.2023
Ma Process Chemistry	With requirements for one year	EUR-ACE®	30.09.2023
Ma Chemical and Process Engineering	With requirements for one year	EUR-ACE®	30.09.2022
Ma Chemical Engineering for Water Treatment	With requirements for one year	EUR-ACE®	30.09.2022

Requirements

For all degree programmes

A 1. (ASIIN 5.2) Ensure that the Diploma Supplement contains detailed information about the educational objectives, and intended learning outcomes as well as statistical data according to the ECTS-Users' guide in addition to the final grade.

A 2. (ASIIN 5.1) Re-write the module descriptions so as to update the information about the form of exams, the criteria for pass and fail, resolve inconstancies with respect to the workload and ECTS credits and add missing or incomplete information about the aims and the content.

A 3. (ASIIN 5.3) Provide access to all relevant documents for all stakeholders.

For the Bachelor's degree programme Chemical Engineering

A 4. (ASIIN 1.1) Re-write the learning outcomes in order to make obvious that the degree programme also provides the qualification for starting a professional career.

A 5. (ASIIN 1.3) Strengthen the work-related competences of the students and make sure that they are able to take up a suitable employment after graduation.

A 6. (ASIIN 2.2) Analyze the available statistical data in more detail in order to find out the reasons for the long average time of studies and the low number of credits acquired in average per year.

Recommendations

For the Bachelor's degree programme Chemical Engineering

E 1. (ASIIN 1.3) It is recommended to extend the length of the compulsory internship and to demand a connection with the field of studies.

E 2. (ASIIN 1.3, 4.3) It is recommended to introduce laboratory experiments in thermo-separation techniques and to update the laboratories and the equipment accordingly.

E 3. (ASIIN 1.3) It is recommended to offer a course in process controls and to make all students acquainted with the aspects of materials for process equipment.

E 4. (ASIIN 1.3) It is recommended to move classes in advanced mathematics to the Master's level.

G Comment of the Technical Committees (21.06.2017)

Technical Committee 01 - Mechanical Engineering/Process Engineering (21.06.2017)

Assessment and analysis for the award of the ASIIN seal:

The Technical Committee 01 intends to align the different procedures and suggests removing requirement 5, which deals with work related competences and the employability of Bachelor's graduates, and turning it into a recommendation. Consequently, recommendation 5 has been included. Apart from this, Technical Committee 01 fully supports the requirements and recommendations as suggested by the peers.

Assessment and analysis for the award of the EUR-ACE® Label:

The Technical Committee deems that the intended learning outcomes of the degree programmes do comply with the engineering specific part of Subject-Specific Criteria of the Technical Committee 01.

The Technical Committee 01 - Mechanical Engineering/Process Engineering recommends the award of the seals as follows:

Degree Programme	**ASIIN seal**	**Subject-specific Label**	**Maximum duration of accreditation**
Ba Chemical Engineering	With requirements for one year	EUR-ACE®	30.09.2023
Ma Process Chemistry	With requirements for one year	EUR-ACE®	30.09.2023
Ma Chemical and Process Engineering	With requirements for one year	EUR-ACE®	30.09.2022
Ma Chemical Engineering for Water Treatment	With requirements for one year	EUR-ACE®	30.09.2022

Additional Recommendation:

E 5. (ASIIN 1.3) It is recommended to strengthen the Bachelor as the first professional degree in line with the Bologna process. Consequently, it is recommended to prolong the duration and enhance the substantiality of the Bachelor's theses to improve the employability.

Technical Committee 09 - Chemistry (13.06.2017)

Assessment and analysis for the award of the ASIIN seal:

A special feature of the Finnish university system is the seamless transition from Bachelor's to Master's degree at universities. As a result, the Bachelor's degree at LUT only partly qualifies for entering the labour market and almost 100% of the Bachelor's graduates continue their studies without interruption within the framework of a Master's programme. Finland follows the Bologna process only to a limited extent. This has prompted the experts to issue a number of relevant requirements for Bachelor's degree programme Chemical Engineering. Originally, additional requirements and recommendations had been suggested by the peers, but LUT has already reacted and has eliminated some of the identified deficiencies. The Technical Committee shares this opinion and agrees with the requirements and recommendations as proposed by the peers without any changes.

The Technical Committee 09- Chemistry recommends the award of the seals as follows:

Degree Programme	**ASIIN seal**	**Subject-specific Label**	**Maximum duration of accreditation**
Ba Chemical Engineering	With requirements for one year	EUR-ACE®	30.09.2023
Ma Process Chemistry	With requirements for one year	EUR-ACE®	30.09.2023
Ma Chemical and Process Engineering	With requirements for one year	EUR-ACE®	30.09.2022
Ma Chemical Engineering for Water Treatment	With requirements for one year	EUR-ACE®	30.09.2022

H Decision of the Accreditation Commission (30.06.2017)

Assessment and analysis for the award of the subject-specific ASIIN seal:

The Accreditation Commission decides to delete the requirement concerning the work related competences of the Bachelor's students and to include this aspect in the recommendation E1. The Accreditation Commission also changes the wording of the requirement about the analysis of the statistical data in order to make clear that the development of a concept is necessary and what this concept should include.

Assessment and analysis for the award of the EUR-ACE® Label:

The Accreditation Commission decides that the learning outcomes and curricula contents of the degree programmes under review correspond with the Subject-Specific Criteria of the Technical Committee 01 – Mechanical Engineering/Process Engineering.

The Accreditation Commission for Degree Programmes decides to award the following seals:

Degree Programme	ASIIN seal	Subject-specific Label	Maximum duration of accreditation
Ba Chemical Engineering	With requirements for one year	EUR-ACE®	30.09.2023
Ma Process Chemistry	With requirements for one year	EUR-ACE®	30.09.2023
Ma Chemical and Process Engineering	With requirements for one year	EUR-ACE®	30.09.2022
Ma Chemical Engineering for Water Treatment	With requirements for one year	EUR-ACE®	30.09.2022

Requirements

For all degree programmes

A 1. (ASIIN 5.2) Ensure that the Diploma Supplement contains detailed information about the educational objectives, and intended learning outcomes as well as statistical data according to the ECTS-Users' guide in addition to the final grade.

A 2. (ASIIN 5.1) Re-write the module descriptions so as to update the information about the form of exams, the criteria for pass and fail, resolve inconstancies with respect to the workload and ECTS credits and add missing or incomplete information about the aims and the content.

A 3. (ASIIN 5.3) Provide access to all relevant documents for all stakeholders.

For the Bachelor's degree programme Chemical Engineering

A 4. (ASIIN 1.1) Re-write the learning outcomes in order to make obvious that the degree programme also provides the qualification for starting a professional career.

A 5. (ASIIN 2.2) Provide a concept for a systemic monitoring of the study progress and its intended use for the development of the degree programme. This should include meaningful cohort-wise statistical data concerning the graduation rate, the drop-out rate, the examination failure rate and the duration of study. Prove evidence that first steps of its implementation have been taken.

Recommendations

For the Bachelor's degree programme Chemical Engineering

E 1. (ASIIN 1.3) It is recommended to extend the length of the compulsory internship and to demand a connection with the field of studies in order to strengthen the Bachelor as the first professional degree in line with the Bologna process and to adapt the wording of the learning outcomes accordingly.

E 2. (ASIIN 1.3, 4.3) It is recommended to introduce laboratory experiments in thermo-separation techniques and to update the laboratories and the equipment accordingly.

E 3. (ASIIN 1.3) It is recommended to offer a course in process controls and to make all students acquainted with the aspects of materials for process equipment.

E 4. (ASIIN 1.3) It is recommended to move classes in advanced mathematics to the Master's level.

I Fulfilment of Requirements (29.06.2018)

Analysis of the peers and the Technical Committee (13.06.2018)

Requirements

For all degree programmes

A 1. (ASIIN 5.2) Ensure that the Diploma Supplement contains detailed information about the educational objectives, and intended learning outcomes as well as statistical data according to the ECTS-Users' guide in addition to the final grade.

Initial Treatment	
Peers	fulfilled Vote: unanimous Justification: The Diploma Supplement has been revised beginning from January 2018. The learning outcomes and statistical information on final grade distribution have been included.
TC 01	fulfilled Vote: unanimous Justification: The TC agrees with the peers and considers the requirement to be fulfilled.
TC 09	fulfilled Vote: unanimous Justification: The Technical Committee agrees with the opinion of the reviewers and considers all requirements as fulfilled.

A 2. (ASIIN 5.1) Re-write the module descriptions so as to update the information about the form of exams, the criteria for pass and fail, resolve inconstancies with respect to the workload and ECTS credits and add missing or incomplete information about the aims and the content.

Initial Treatment	
Peers	fulfilled Vote: unanimous Justification: The module descriptions have been updated and now include all necessary information.
TC 01	fulfilled Vote: unanimous Justification: The TC agrees with the peers and considers the re-

	quirement to be fulfilled.
TC 09	fulfilled Vote: unanimous Justification: The Technical Committee agrees with the opinion of the reviewers and considers all requirements as fulfilled.

A 3. (ASIIN 5.3) Provide access to all relevant documents for all stakeholders.

Initial Treatment	
Peers	fulfilled Vote: unanimous Justification: The information about the degree programmes is now available on LUT's website, UNI-portal and online Study Guide.
TC 01	fulfilled Vote: unanimous Justification: The TC agrees with the peers and considers the requirement to be fulfilled.
TC 09	fulfilled Vote: unanimous Justification: The Technical Committee agrees with the opinion of the reviewers and considers all requirements as fulfilled.

For the Bachelor's degree programme Chemical Engineering

A 4. (ASIIN 1.1) Re-write the learning outcomes in order to make obvious that the degree programme also provides the qualification for starting a professional career.

Initial Treatment	
Peers	fulfilled Vote: unanimous Justification: The learning outcomes of the BSc programme in Chemical Engineering have been revised.
TC 01	fulfilled Vote: unanimous Justification: The TC agrees with the peers and considers the requirement to be fulfilled.
TC 09	fulfilled Vote: unanimous Justification: The Technical Committee agrees with the opinion of the reviewers and considers all requirements as fulfilled.

A 5. (ASIIN 2.2) Provide a concept for a systemic monitoring of the study progress and its intended use for the development of the degree programme. This should include meaningful cohort-wise statistical data concerning the graduation rate, the drop-out rate, the examination failure rate and the duration of study. Prove evidence that first steps of its implementation have been taken.

Initial Treatment	
Peers	fulfilled Vote: unanimous Justification: LUT has provided a concept for a systemic monitoring of study progress. The statistics on the graduation rate, the dropout rate, the examination failure rate and the duration of study have been included in the Annual Plan for Education Statistics which is published on the LUT's intranet.
TC 01	fulfilled Vote: unanimous Justification: The TC agrees with the peers and considers the requirement to be fulfilled.
TC 09	fulfilled Vote: unanimous Justification: The Technical Committee agrees with the opinion of the reviewers and considers all requirements as fulfilled.

Decision of the Accreditation Commission (29.06.2018)

Degree programme	**ASIIN-label**	**Subject-specific label**	**Accreditation until max.**
Ba Chemical Engineering	All requirements fulfilled	EUR-ACE®	30.09.2023
Ma Process Chemistry	All requirements fulfilled	EUR-ACE®	30.09.2023
Ma Chemical Engineering and Water Treatment*	All requirements fulfilled	EUR-ACE®	30.09.2022

*The Accreditation Commission has taken into account that the degree programmes *Ma Chemical and Process Engineering* and *Ma Chemical Engineering for Water Treatment* have been joint to the degree programme *Ma Chemical Engineering and Water Treatment*.

Appendix: Programme Learning Outcomes and Curricula

According to the Self Assessment Report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Bachelor's degree programme Chemical Engineering:

"After the completion of the BSc programme in Chemical Engineering the student

- demonstrates sufficient scientific and technological knowledge to proceed to deepen their knowledge in specific fields of chemical engineering
- demonstrates good skills in project work, reporting, communication and languages, presentation and in creative problem solving
- demonstrates sufficient knowledge of the principles of experimental work and modelling in the field of chemical engineering
- demonstrates knowledge of the principles of process development and design."

The following **curriculum** is presented:

	1. period	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	
1. Academic year Compulsory courses in the BSc in Chemical Engineering	BJ01A1010 Yleinen kemia/General Chemistry	3	BJ01A0020 Työturvallisuus laboratoriossa/Safety in Chemistry Laboratory	1	BM20A5820 Integraalilaskenta ja sovellukset/Integral Calculus and Applications	3	BJ01A0010 Johdatus kemiantekniikan opiskeluun/Introduction to Studies of Chemical Technology	1	**Workload of studies in the first academic year**
	BM20A5800 Funktiot, lineaarialgebra ja vektorit/Functions, Linear Algebra and Vectors	3	BM20A5810 Differentiaalilaskenta ja sovellukset/Differential Calculus and Applications	4	BM30A2900 Aaltoliikeoppi/Wave Motion and Wave Phenomena	3	BJ01A5050 Biojalostamot/Biorefineries	2	
	BM30A2600 Mekaniikan perusteet/Basics of Mechanics	4	BM30A2700 Lämpöopin perusteet/Basics of Thermal Physics	3	FV13A0150 Svenska för teknologer/FV13A1200 Teknisk svenska/Swedish for students in technology	2	BM20A4301 Johdatus tekniseen laskentaan/Introduction to Technical Computation	4	
			BJ01A1021 Epäorgaanisen kemian perusteet/Basic Inorganic Chemistry	3	BJ01A1030 Epäorgaaniset analyysit/Inorganic Analysis	2	BM20A5830 Differentiaaliyhtälöiden peruskurssi/Basic Course on Differential Equations	3	
					BJ01A4010 Mekaaniset yksikköoperaatiot/Mechanical Unit Operations	3	BJ01A1040 Orgaanisen kemian perusteet/Organic Chemistry	4	
					BJ01A5010 Johdanto kemianteollisuuden prosesseihin/Introduction to Chemical Process Industries	3	BJ01A3010 Kemiallinen termodynamiikka/Chemical Thermodynamics	5	

Compulsory studies, sum	*1 period*	10	*2 period*	11	*3 period*	16	*4 period*	19	56
Elective / optional courses / exchange studies (ECTS)									0
All studies, sum	*1 period*	10	*2 period*	11	*3 period*	16	*4 period*	19	56

	1. period	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	
2. Academic year Compulsory courses in the BSc in Chemical Engineering	Compulsory foreign language studies	3	BM20A1401 Tilastomatematiikka 1/Statistics I	3	BH40A1400 Virtaustekniikka 1/Fluid Dynamics I	3	BM20A5840 Usean muuttujan funktiot ja sarjat/Functions of Several Variables and Series	3	**Workload of studies in the second academic year**
	BJ01A1050 Orgaanisen kemian laboratoriotyöt/Organic Syntheses	2	FV18A2800 Tekniikan puhe- ja kirjoitusviestintä/Finnish Spoken and Written Communication for Engineers	3	BM20A1501 Numeeriset menetelmät 1/Numerical Methods I	3	BH40A0101 Uusiutuva Energia/Renewable Energy	3	
	BJ01A4021 Aineensiirron perusteet/Fundamentals of Mass Transfer	4	BJ01A2010 Analyyttisen kemian perusteet/Basic Analytical Chemistry	2	BJ01A2020 Analyyttisen kemian laboratoriotyöt/Analytical Chemistry Laboratory Works	3	BJ01A2030 Kiinteiden materiaalien karakterisointi/Characterization of Solid Materials	3	
	BJ01A0060 Tekniikan kandidaatin tutkinnon	2	BJ01A3040 Kemiallinen dynamiik-	4			BJ01A5020 Prosessi- ja tehdassuunnittelu/Process	4	

	työharjoittelu/Work Internship in Bachelor's Degree		ka/Chemical Dynamics				and Plant Design		
			BJ01A4030 Yksikköoperaratioiden mitoitus/Design of Unit Operations	4			BJ01A5040 Prosessiturvallisuus/Process Safety	2	
							CS30A0952 Innovaatio- ja teknologiajohtamisen peruskurssi/Innovation and Technology Management: a Basic Course	6	
Compulsory studies, sum	*1 period*	11	*2 period*	16	*3 period*	9	*4 period*	21	57
Elective / optional courses / exchange studies (ECTS)									0
All studies, sum	*1 period*	11	*2 period*	16	*3 period*	9	*4 period*	21	57

3. Academic year Compulsory courses in the BSc in	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	**Workload of studies in the third academic**
	BJ01A4041 Kemiallinen reaktiotekniikka/Chemical Reaction Engineering	5	BH20A0300 Lämmönsiirron perusteet/Fundamentals of Heat Transfer	3	CS31A0210 Yritystalouden perusteet/The Basic Course	3	BJ01A1060 Biokemian perusteet/Basic Biochemistry	2	

Chemical Engineering					of Business Economics				**year**
			BJ01A3030 Fysikaalisen kemian laboratoriotyöt/Physical Chemistry Laboratory Course	3			BJ01A4060 Soveltavan kemian laboratoriotyöt/Applied Chemistry Laboratory Course	4	
			BJ01A4050 Yksikköprosessien laboratoriotyöt/Laboratory Course of Unit Processes	4			BJ01A0030 Kandidaatintyö ja seminaari/Bachelor's Thesis and Seminar	10	
			BJ01A5030 Prosessisimuloinnin perusteet/Introduction to Process Simulation	4					
Compulsory studies, sum	*1 period*	5	*2 period*	14	*3 period*	3	*4 period*	16	38
Elective / optional courses / exchange studies (ECTS)	Electives 9 ECTS	19			Minor studies 10 ECTS	10			29
	Minor studies 10 ECTS								
All studies, sum	*1 period*	24	*2 period*	14	*3 period*	13	*4 period*	16	67

According to the Self Assessment Report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Master's degree programme Process Chemistry:

"After the completion of the MSc programme in Process Chemistry the student:

- exhibits knowledge and understanding of the fundamentals of chemistry and physics, analytics and principal chemical engineering methods
- can manage at least on a personal level the most fundamental knowledge processes in engineering: acquisition, review and documentation/reporting
- is capable of defining a problem and solving it using appropriate methods learned during his/her studies
- is trained in engineering practice, including safety and environmental aspects, is aware of the characteristics of project work and uncertainties associated with engineering and exhibits creativity and courage to propose new technological solutions
- is a practitioner of continuous learning, understands the ethical and societal aspects of his/her work, possesses entrepreneurial qualities and shows initiative and is ready to work in a multicultural and/or team environment."

The following **curriculum** is presented:

1. Academic year Compulsory courses in the MSc in Process Chemistry (Prosessikemian DI-ohjelma)	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	**Workload of studies in the first academic year**
	BJ02A1010 Epäorgaaninen kemia ja sen teolliset sovellukset (Inorganic Chemistry and Industrial Applications)	3	BJ02A1040 Teknillinen polymeerikemia (Technical Polymer Chemistry)	4			BJ02A1030 Pinta- ja liuoskemia (Surface and Solution Chemistry)	5	
	BJ02A1020 Orgaaninen kemia ja teolliset synteesit (Industrial Organic Syntheses)	4					BJ02A1050 Biopolymeerit (Biopolymers)	5	
	BJ03A1050 Environmental and Process Analytics & Monitoring	5					BJ02A1071 Bioprosessitekniikan perusteet (Bioprocess Technology)	5	
							BJ02A3051 Hydrometallurgy	5	
Compulsory studies, sum	*1 period*	12	*2 period*	4	*3 period*	0	*4 period*	20	36
Elective / optional courses / exchange studies (ECTS) **Minor in Process Design (32 ECTS in this example)**			BJ02A3020 Chemical Separation Methods	17			BJ02A2051 Process Intensification	15	36
			BJ02A2010 Modelling of Unit Operations				BJ02A2020 Process Control		

			BJ02A2041 Advanced Process Design				BJ02A2061 Product Design		
All studies, sum		12	*2 period*	21	*3 period*	0	*4 period*	35	68

2. Academic year Compulsory courses in the MSc in Process Chemistry (Prosessikemian DI-ohjelma)	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	**Workload of studies in the second academic year**
			BJ02A4060 Biobased Platform Chemicals	5	BJ02A0020 Diplomityö ja seminaari (Master's Thesis and Seminar)		BJ02A0020 Diplomityö ja seminaari (Master's Thesis and Seminar)	30	
			BJ02A1080 Tutkimusprojekti (Research Project)	10					
Compulsory studies, sum	*1 period*	0	*2 period*	15	*3 period*	0	*4 period*	30	45
Elective / optional courses / exchange studies (ECTS)	Electives 7 ECTS	7							15
All studies, sum	*1 period*	7	*2 period*	15	*3 period*	0	*4 period*	30	52

According to the Self Assessment Report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Master's degree programme Chemical and Process Engineering:

"After the completion of the MSc programme in Chemical and Process Engineering the student:

- has solid theoretical background in core areas of chemical engineering
- has strong engineering analysis and problem solving skills
- has trained her/his engineering skills such as making approximations and decisions under uncertainty
- has the courage to propose innovations and new technical solutions
- possesses project work and communication skills needed in the modern working environment."

The following **curriculum** is presented:

1. Academic year Compulsory courses in the MSc in Chemical and Process Engineering	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	**Workload of studies in the first academic year**
	BJ02A4041 Processing of Biomaterials	5	BJ02A2010 Modelling of Unit Operations	6	BJ02A2030 Fluid Dynamics in Chemical Engineering	5	BJ02A2020 Process Control	5	
			BJ02A2041 Advanced Process Design	5			BJ02A2051 Process Intensification	5	
Compulsory studies, sum	*1 period*	5	*2 period*	11	*3 period*	5	*4 period*	10	31
Elective / optional courses / exchange studies (ECTS) **Minor in Separation Technology (26 ECTS in this example)**	BJ02A3010 Membrane Technology	8	BJ02A2030 Chemical Separation Methods	6	BJ02A3030 Solid-Liquid Separation	8	BJ02A3051 Hydrometallurgy	5	27
	Electives 3 ECTS				Electives 3 ECTS				
All studies, sum	*1 period*	13	*2 period*	17	*3 period*	13	*4 period*	15	58

2. Academic year Compulsory courses in the MSc in Chemical and Process Engineering	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	**Workload of studies in the second academic year**
	BJ02A2061 Product Design	5	BJ02A2070 Project on Process and Plant Design	10	BJ02A0040 Master's Thesis and Seminar		BJ02A0040 Master's Thesis and Seminar	30	
					BH50A1500 Bioenergy Technology Solutions	6			
Compulsory studies, sum	*1 period*	5	*2 period*	10	*3 period*	6	*4 period*	30	51
Elective / optional courses / exchange studies (ECTS)	BJ02A3040 Crystallization	8	Electives 3 ECTS	3					11
	Electives 3 ECTS								
All studies, sum	*1 period*	13	*2 period*	13	*3 period*	6	*4 period*	30	62

According to the Self Assessment Report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Master's degree programme Chemical Engineering for Water Treatment:

After the completion of the MSc programme in Chemical Engineering for Water Treatment the student:

- has comprehensive understanding of the BAT and future water treatment technologies, covering advanced oxidation and various separation methods
- is able to demonstrate the required knowledge in process and environmental analytics and monitoring
- has adopted the principles of sustainability in water treatment
- demonstrates critical understanding of relevant theories and techniques in water treatment
- has the required problem-solving skills, and the ability to independently use knowledge, equipment and tools for the design and development of practical water treatment applications.
- is able to work with others in task-oriented groups participating and interacting in the group in a productive manner.
- is able to logically think through a problem and solve it."

The following **curriculum** is presented:

	1. period	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	
1. Academic year Compulsory courses in MSc degree	BJ03A1010 Introduction to Advanced Water Treatment	5			BJ03A1040 Advanced Materials in Adsorption and Ion Exchange	5	BJ03A2010 Advanced Oxidation Processes & Electrochemical Methods in Water Treatment	5	**Workload of studies in the first academic year**
	BJ03A1050 Environmental and Process Analytics & Monitoring	5			BJ02A3030 Solid-Liquid Separation	5	BJ03A2030 Water Treatment in Mining	5	
	BJ03A3010 Membrane Technology	5					BJ03A2040 Research Project Course in Water Treatment	10	
Compulsory studies, sum	*1 period*	15	*2 period*	0	*3 period*	10	*4 period*	20	45
Elective / optional courses / exchange studies (ECTS) **Minor in Process Design (27 ECTS in this example)**			BJ02A2010 Modelling of Unit Operations	17			BJ02A2020 Process Control	10	27
			BJ02A2041 Advanced Process Design				BJ02A2051 Process Intensification		
			BJ02A3020 Chemical Separation Methods						
All studies, sum	*1 period*	15	*2 period*	17	*3 period*	10	*4 period*	30	72

2. Academic year Compulsory courses in MSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS	**Workload of studies in the second academic year**
	BJ03A1020 Biological Waste Water Treatment	5			BJ02A0040 Master's Thesis and Seminar		BJ02A0040 Master's Thesis and Seminar	30	
Compulsory studies, sum	*1 period*	5	*2 period*	0	*3 period*	0	*4 period*	30	35
Elective / optional courses / exchange studies (ECTS)	Electives 8 ECTS	8	Electives 5 ECTS	5					13
All studies, sum	*1 period*	13	*2 period*	5	*3 period*	0	*4 period*	30	48