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Self-Assessment Report for International Accreditation – Bachelor's and Master's degree programmes in Electrical Engineering

Editors: Hanna Niemelä, Satu Viljainen, Mikko Kuisma, Pertti Silventoinen, Jarmo Partanen, Annikka Nurkka

Lappeenrannan teknillinen yliopisto
Hallinnon julkaisuja 181

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Lappeenranta 2012

ISBN 978-952-265-255-3 (PDF)
ISSN 0782-3770
Lappeenranta 2012

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1 Formal Data

1.1 Name and contact details

Name of the Degree Programme (Finnish)	Sähkötekniikan koulutusohjelma - tekniikan kandidaatti - diplomi-insinööri
Name of the Degree Programme (English)	Degree Programme in Electrical Engineering - Bachelor of Science (Tech.) - Master of Science (Tech.)
Language of instruction	Finnish
Contact person	Professor Pertti Silventoinen pertti.silventoinen@lut.fi Mobile +358 40 774 9930 Fax + 358 5 621 6799
Web address	www.lut.fi

The site of execution of the Degree Programme in Electrical Engineering is the Department of Electrical Engineering at Lappeenranta University of Technology. The Department of Electrical Engineering belongs to the Institute of Energy Technology (LUT Energy) that operates under the administration of the Faculty of Technology. LUT Energy brings together the energy related education and research at Lappeenranta University of Technology. LUT Energy coordinates three degree programmes: Electrical Engineering, Energy Technology and Environmental Engineering. LUT Energy is the largest education and research organisation in the energy sector in Finland.

1.2 Classification within the more research-oriented profile

The Master's degree in Electrical Engineering is classified as "more research-oriented".

1.3 Classification as consecutive

The Master's degree in Electrical Engineering is consecutive to the Bachelor's degree in Electrical Engineering.

1.4 Degrees to be awarded

The degrees to be awarded in the Degree Programme in Electrical Engineering are Bachelor of Science (Tech) in Electrical Engineering and Master of Science (Tech) in Electrical Engineering. The Universities Act (558/2009) (Enclosure 6.1) and the Government Decree on University Degrees (794/2004) (Enclosure 6.2) grant the right to award these degrees to Lappeenranta University of Technology[1].

[1] As a result of the implementation of the Bologna process in the Finnish Universities, the present degree structures have been effective since 2005. The transition period (terminated 31 July 2010) to the new curricula has naturally had its effects on various statistical data, which has to be taken into account when interpreting these data.

1.5 Standard period of study

The extent of studies required for the Bachelor of Science degree is 180 ECTS credits, and 120 ECTS credits for the Master of Science degree. In the Degree Programme in Electrical Engineering, the Bachelor's degree programme can be completed within the period of three years, and the Master's degree programme in two years. The extent and the standard periods of study of the Degree Programme in Electrical Engineering are in accordance with the requirements of the Finnish law (Enclosure 6.2, Government Decree on University Degrees 794/2004).

1.6 Commencement of studies

The Degree Programme in Electrical Engineering can be commenced in every intake semester. The courses being offered are coordinated to ensure this. The primary tool is the coordinated scheduling of the courses. The obligatory courses included in the Bachelor's and Master's degree studies are lectured every year.

The academic year of the University starts on 1 August and ends on 31 July. The academic year is composed of two semesters; the autumn semester and the spring semester. Both semesters are divided into two periods that each last for seven weeks. The curriculum presents how the courses forming the Degree Programme in Electrical Engineering are divided between the study years, and they are scheduled accordingly.

1.7 Fees/charges

Education leading to a university degree and the entrance examinations relating to student admission shall be free of charge for the student (Enclosure 6.1, Universities Act 558/2009).

The students of Lappeenranta University of Technology must register each academic year as attending or non-attending. Each student who wishes to take part in lectures, assignments, examinations or other forms of teaching must register as attending and pay the Student Union membership fee 103 €/a. This fee covers, for instance, the health care of the students.

2 Objectives and Demand – Reason for Establishing the Programme

2.1 Educational objectives and competency profile

2.1.1 Overall objectives of the applicant degree programme

In this report, a holistic approach is taken to the general educational objectives of the Degree Programme in Electrical Engineering; with minor exceptions, the objectives apply for both Bachelor's and Master's degrees. The objectives of the Degree Programme in Electrical Engineering are in accordance with the strategic goals of the University. The educational objectives of the Degree Programme reflect the mission of Lappeenranta University of Technology (Enclosure 7, LUT Strategy 2013, p. 4), according to which energy efficiency and the energy market are the university's strategic areas of expertise.

For both the Bachelor's and Master's degrees, the superordinate educational objectives and learning outcomes are described in detail in the Objectives Matrix Model 1 (Enclosure 4) and in the Study Guide (Enclosure 3, Module Handbook, p. 66), which is published on the university web pages.
http://www.lut.fi/fi/lut/studies/tools/studyguide/Sivut/Default.aspx
The educational objectives are accessible to the relevant interested parties, especially the teaching staff and students, but also any other parties interested in the educational content of the Degree Programme. The educational objectives of the Degree Programme are defined in the Study Guide as follows:

> The objective of the Degree Programme in Electrical Engineering is to train Bachelors and Masters of Science for the needs of industry, research institutions, businesses and public administration within the field of electrical engineering. A person who has taken the degree of Bachelor of Science in Electrical Engineering is able to

demonstrate the essentials of science and the fundamental laws in electrical engineering, apply his/her skills in work and follow the development in the field. The Master's Degree Programme in Electrical Engineering provides a holistic view of the modern electronic and power systems and their technological development.

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

According to his/her choice, a person who has taken the degree of Master of Science in Electrical Engineering is able to demonstrate in-depth knowledge in electrical drives technology, embedded systems, electronics or electricity market. A Master of Science in Electrical Engineering is able to apply the essential theories of electrical engineering to practical electrotechnical and electronics applications. A graduate from the Degree Programme is able to apply his/her knowledge in jobs in product development, research and marketing as well as in management of these. The Degree Programme also prepares a student for postgraduate and independent studies. 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 suitable studies in business in the degree. For students interested in foreign languages and international affairs, the university provides a large array of language studies as well as excellent opportunities for student exchange and training abroad.

The educational objectives are a result of continuous, years-long development work conducted by the teaching staff of the Degree Programme. The educational objectives are assessed and updated on a yearly basis. The objectives of the Degree Programme are oriented towards currently foreseeable specialist developments. These objectives are further described in detail under the major and minor subjects.

2.1.2 Description of the learning outcomes to be attained during the course of study (knowledge, skills and competences)

The educational objectives set for graduates of the B.Sc. and M.Sc. degree programmes are described in general in section 2.1.1 above (indented paragraphs). These general objectives are essentially supported by the LO descriptions described in sections 2.1.2.1–4 below for each major and minor subject (the very same information being available in the Study Guide, Enclosure 3, Module Handbook, pp. 67–68). Thus, the overall educational objectives and learning outcomes (and thereby the competency profiles) comprise three-level information about the Degree Programme: first, the educational objectives are defined at the degree level (p. 66; see 2.1.1 above) for both the Bachelor's and Master's degree; second, the objectives set for the degree studies are described (general studies, major and minor subjects categorised into obligatory and elective studies), and finally, the actual courses constituting these studies are described in terms of year and period, learning outcomes (LO), content, modes of study, evaluation, study materials and prerequisites (pp. 67–80).

The targeted learning outcomes are accessible to the relevant interest parties (students, staff) on the university web pages. The learning outcomes are established and can thus be referred to for instance in internal quality assurance.

The learning outcomes are in agreement with the targeted level of qualification. As the majors and minors essentially contribute also to the general LO of the degree programmes, the descriptions of the learning outcomes defined individually for each major and minor subject of the Bachelor's degree and the Master's degree are presented in sections 2.1.2.1–2.1.2.4 below (see also Objectives Matrix Model 2, Enclosure 4).

2.1.2.1 Major subjects for the Bachelor's degree in Electrical Engineering

Below, the LO descriptions of the major subjects for the Bachelor's degree in Electrical Engineering are given (Enclosure 3, Module Handbook, pp. 70–71). The major subjects are *Electrical Engineering and Electronics* and *Electrical Energy Engineering*.

1. Electrical Engineering and Electronics

After completing the major subject studies in Electrical Engineering and Electronics, the student is able to name and describe essential digital and analog electronics components and design and analyse simple analog and digital systems. Moreover, the student is able to identify and describe the essential instructions and regulations concerning safety in electrical installations and electromagnetic compatibility. The student is also able to describe the operation and control of typical electrical machines.

2. Electrical Energy Engineering

After completing the major subject studies in Electrical Energy Engineering, the student is able to name and describe modes of operation and cost accounting methods related to generation, transmission, distribution and use of energy. The student is able to describe the operation and control of typical electrical machines. Moreover, the student is able to identify and describe the essential instructions and regulations concerning safety in electrical installations and electromagnetic compatibility. In the elective studies, the student may complement his/her studies with studies for instance in energy technology and electronics.

2.1.2.2 Minor subjects for the Bachelor's degree in Electrical Engineering

Below, the LO descriptions of the minor subjects for the Bachelor's degree in Electrical Engineering are given (Enclosure 3, Module Handbook, p. 72). The minor subjects are *Control Engineering* and *Signal Processing and Electronics*.

1. Control Engineering and Signal Processing

In the minor subject of Control Engineering and Signal Processing, the student familiarises him/herself for instance with digital control, microprocessors and their programming. Upon completion of the minor subject, the student can design simple digital controllers and solve problems related to control engineering and signal processing by applying mathematical software applications. The student is able to describe the operation of microprocessors used in the embedded systems and program them in C language. The student can complement his/her studies for instance by elective studies in mechatronics, electronics and telecommunications.

2. Electronics

After completing the minor subject studies in electronics, the student is able to use the essential electronics measuring instruments and solve simple theoretical and practical problems related to prototype construction of analog and digital electronics. The student is able to describe the structure and operation of microprocessors and the essential design tools associated with them. The student can explain the propagation of radio waves and recognise the most relevant transmission paths and antenna types. In the elective studies, the student can concentrate for instance on optoelectronics or microelectronics.

2.1.2.3 Major subjects for the Master's degree in Electrical Engineering

Below, the LO descriptions of the major subjects for the Master's degree in Electrical Engineering are given (Enclosure 3, Module Handbook, p. 67–68). The major subjects are *Embedded Systems*, *Applied Electronics*, *Electrical Drives and Machines* and *Electricity Market and Power Systems*.

1. Embedded Systems

A Master of Science specialised in embedded systems is able to design and develop embedded systems and apply the principles of automation and communication systems and digital signal processing to work. Upon completion of the studies in embedded systems, the student will be able to work in various positions related to industrial and consumer electronics as well as design of automation and communication systems.

2. Applied Electronics

After the studies in industrial electronics the student will be able to work in design and research tasks related to analog electronics and analog signal processing. A Master of Science specialised in industrial electronics may find employment in various specialist, sales and design jobs.

3. Electrical Drives and Machines

Upon completion of the major studies in Electrical Drives and Machines, a graduate in electrical engineering will be able to work in the tasks of design and control of electromechanical and electromagnetic equipment. In addition to traditional industrial electrical drives, a M.Sc. specialised in electrical drives and motors can be engaged with power generation (e.g. wind power), mobile work machinery and electric vehicle systems. A M.Sc. may also operate within the context of modern electrical drives systems aiming to improve the energy efficiency of the systems and to reduce their environmental strain.

4. Electricity Market and Power Systems

Upon completion of the major studies in Electricity Market and Power Systems, the student will be able to demonstrate knowledge and skills in both technology and business: the major subject studies cover topics related to electricity transmission and distribution technology and business, the operation of wholesale and retail markets of electricity and the effects of emissions trading on the electricity market. A Master of Science specialised in Electricity Market and Power Systems may find employment in a wide variety of jobs: potential employers are for instance electricity distribution companies, energy companies, electrotechnical industry, information system suppliers, consulting agencies and energy-intensive industry in general.

2.1.2.4 Minor subjects for the Master's degree in Electrical Engineering

Below, the LO descriptions of the minor subjects for the Master's degree in Electrical Engineering are given (Enclosure 3, Module Handbook, p. 78–80). The minor subjects are *Power Electronics and Electrical Drives*, *Communications Electronics*, *Embedded Systems*, *Applied Electronics* and *Control Engineering*.

1. Power Electronics and Electrical Drives

Upon completion of the minor subject studies in power electronics and electrical drives, the student may find employment for instance in product development tasks in the domestic power electronics and electrical drives industry.

2. Communications Electronics

Upon completion of the minor subject studies in Communications Electronics, the student has acquired basic knowledge of digital data transfer and related data transfer methods, media and protocols. After completing the minor subject studies, the student will be able to apply digital data transfer methods for instance to embedded systems.

3. Embedded Systems

After completing the minor studies in Embedded Systems, the student can design and implement program-based electronic devices. In this minor subject, the student can choose courses in embedded systems, control engineering and digital signal processing. A student who has completed the minor subject studies in Embedded Systems is able to implement different systems with microprocessors or programmable logic circuits.

4. Applied Electronics

After completing the minor subject studies in Applied Electronics, the student can apply the most relevant electronics design tools and use basic measuring equipment in electronics product development and research work. The student will be able to use basic analog electronics components for instance in signal processing applications and apply modern analog electronics in the design of electronic devices and systems.

5. Control Engineering

In the minor subject studies in Control Engineering, the student focuses, according to his/her choice, on digital control design, nonlinear systems and their control and/or automation technology. The student can complement the studies with suitable courses in mathematics. After successfully completing the minor subject, depending on his/her specialisation, the student will be able to design digital controllers and implement them with a microprocessor and analyse nonlinear systems and design simple controllers for them. After the studies in automation technology, the student will be familiar with automation equipment and will be able to apply them in process control.

2.1.3 Objectives of individual modules

The learning outcomes (LO) are defined both for each major and minor subject and for individual courses in the Study Guide (Module Handbook), which is available on the university web pages. The descriptions of subjects and courses (modules) are written systematically and presented in a uniform manner for all subjects and courses. The wording of learning outcomes is consistent (verbs, other vocabulary used to describe skills, knowledge and competences acquired in the courses) and selected according to the prevailing LO terminology. Therefore, the targeted competences are clear to all students equally in all major and minor subjects (Enclosure 4, Objectives Matrices).

2.1.4 Professional focus, research focus, industrial placements, interdisciplinary cooperation, professional qualification of graduates

The competency profiles described in detail for each major and minor subject for the Master's degree correspond to the targeted employment opportunities defined for the Degree Programme in the Study Guide. The employment opportunities are defined as follows (p. 66):

> Upon completion of the M.Sc. studies in Electrical Engineering, the students will be able to demonstrate effective skills in problem solving in various situations; consequently, the graduates in Electrical Engineering have easily found employment. Alternative jobs and careers for Masters of Science in Electrical Engineering are for instance:
>
> · *design and product development: electrical design engineer, product development engineer, software engineer/specialist, electronics design engineer*
> · *production and operation: service engineer, supervisor of electrical works, automation engineer, power system planning engineer*
> · *management: project manager, managing director, production manager, country manager, service manager, branch manager*
> · *sales and marketing: marketing manager, technical sales person, sales manager, key account manager*
> · *research: researcher, research manager, senior research scientist*
> · *specialist tasks: system specialist, patent engineer, wind power specialist, development manager, methods specialist*

The courses in the Degree Programme involve laboratory and project work as well practical training in order to provide adequate connection to professional practice and to prepare students to commence work in existing or foreseeable professional fields. The courses in the degree structure are also closely linked to research conducted in the department and provide a path to post graduate studies. Moreover, a large majority of Bachelor's and Master's theses are completed in cooperation with industry in various projects either at the university or in companies, and thus provide a link to the professional field and a path to future employment in specialist tasks in these research areas.

The obligatory general studies in the Bachelor's degree include 2 ECTS credits of practical training. The obligatory general studies in the Master's degree include 2 ECTS credits of practical training. The Master's degree may include 10 credits of practical training at maximum. The number of credits exceeding this limit are categorised as elective studies in the degree.

2.1.5 Target enrolment/targeted student-staff ratio

The Board of the University decides the entry requirements and the number of new entrants accepted to the University's degree programmes. The University Rector makes the decision on the approval of new entrants to the degree programmes.

At minimum, the targeted number of Master's degree graduates is 40/a in the degree programme; for this number of students, it is economically feasible to maintain a unit of education within the university. Further, the objective at

the Department is that 8 to 10 students per professor graduate annually[2]. This guarantees that all the essential courses, both in the major and minor subject, can be provided continuously in the degree programme.

2.2 Demand

2.2.1 Target group

LUT Energy, which hosts the degree programmes in Electrical Engineering, Energy Technology and Environmental Engineering, has a coordinated communication and marketing strategy. Directed operation in communication and marketing issues has been a custom of the Department of Electrical Engineering for over a decade, and it has now been made a custom of LUT Energy as well.

The head of LUT Energy and the leaders of the different laboratories of LUT Energy form a steering group to provide the communication and marketing personnel high-level support with decision making power. Persons in charge of the communication and marketing activities are members of the steering group. The steering group meets once a month.

The communication plan of LUT Energy concerns issues such as in which media, how often and with what kind of a message LUT Energy wants to appear. The goal is to increase LUT Energy's recognition as a well-known expert in the field of research and education.

The marketing activities of LUT Energy are targeted to young people at the age of 14–19. For instance, LUT Energy has a national TV campaign during the spring application period to the degree programmes. In approaching its target group, LUT Energy receives support from the Communication Unit of Lappeenranta University of Technology. The Unit's main tasks are to maintain media contacts, coordinate the student visits to targeted high schools and fairs, and decide on the general face of the University.

LUT Energy also has direct contacts and cooperation with high schools and comprehensive schools in Eastern Finland. One form of cooperation is the courses organised on continuous basis for schoolboys and schoolgirls at university premises. Feedback is collected systematically through web inquiries to further develop the cooperation.

The Degree Programme has maintained a specific teaching laboratory in physics for this purpose for over a decade. The teaching laboratory was facilitated by ABB, which is one of the key industrial partners of the Department of Electrical Engineering. About 800 schoolchildren visit the laboratory each year. The pupils come from schools that are within the distance of approximately 100 km from the University. The travelling expenditures are covered by the Finnish Technology Industries, which is another long-term partner of the Department of Electrical Engineering.

The Degree Programme also provides a second-year upper secondary school students an opportunity to take part in a basic electronics course. The course is mainly carried out on the web. Face-to-face teaching is organised twice a year at the university premises. About 35–55 students from 7–11 different schools take the course each year. By passing the course, students obtain credits that are valid in university studies in Lappeenranta University of Technology.

2.2.2 Placement of graduates in the labour market

Statistics concerning the placement of graduates on the labour market are collected systematically by Lappeenranta University of Technology. Graduates from the Degree Programme in Electrical Engineering place well in the labour market; immediately after graduation approximately 60–80 % of the graduates have jobs, and after five years the figure is close to 100 %. As the bachelors graduating from the Degree Programme typically continue in the Master's degree programme and do not enter the labour market with the B.Sc. degree, there are no covering statistics available on the matter so far. The Bachelor's degree is also still rather unknown in the Finnish industry, which has its influence on the employment opportunities and demand for bachelors of science.

[2] There is also approx. one associate professor per each professor at the Department (Enclosure 1) contributing to student supervision and teaching. Furthermore, the principle at the Department is that "every teacher researches and every researcher teaches". Accordingly, at least 50 % of the doctoral students participate constantly in teaching activities.

Tables 1 and 2 illustrate employment rates and regional placement of graduates; the figures are based on graduate surveys. It is emphasised that there is significant annual variation in the numbers of respondents (NR), the percentages being thus only indicative.

Table 1. Employment rate (%)

Employment rate (%)	2009		2008		2007		2006		2005	
	NR	%	NR	%	NR	%	NR	%	NR	%
immediately after graduation	39	66.7	37	78.4	45	55.6	37	75.7	29	62.1
5 yrs after graduation, statistics available only for 2007 and 2008				88		100				

Table 2. Placement of graduates by geographic regions (%)

Geographic region	2009	2008	2007	2006	2005
South Karelia*	57.7	51.7	36.0	39.3	55.6
North Karelia*		3.4			
South Savo*		3.4	4.0	10.7	
Uusimaa*	19.2	27.6	36.0	21.4	16.7
Kymenlaakso*	3.8	3.4	4.0	7.1	
Päijät-Häme*		3.4			
Other	15.4	6.9	20.0	21.4	5.6

* The regions are all located in southern and eastern parts of Finland. LUT is sited in South Karelia, the other regions (except Päijät-Häme) are neighbour provinces.

Companies employing M.Sc. (Tech) graduating from the Degree Programme are found for instance in industrial electronics (ABB, Vacon, The Switch) and electric power systems (electricity distribution companies, energy companies).

2.2.3 Demand from industry

The fields of education of the Finnish universities are defined by the Ministry of Education and Culture. The Board of Lappeenranta University of Technology decides the number of new entrants, and the criteria of acceptance to each degree programme. The contents of the degree programmes are decided by those in charge of the programmes.

In the Degree Programme in Electrical Engineering, the content of the Degree Programme is determined on the basis of the general requirements concerning the education of electrical engineers, and the needs and expectations of the electrical industry. The industrial cooperation carried out in the research project provides a forum of information exchange about the needs and expectations of the industry regarding the education of electrical engineers.

The strongest way for the industry to signal its educational needs is to endow a professorship to a university. The Department of Electrical Engineering has an endowment professorship in Electricity Trading. The endowment has been made by the Finnish Electricity Association Sener for the period of 2006–2011. The Department of Electrical Engineering obtained the professorship through competitive selection. The electricity industry had identified an educational gap in Finland in the field of electricity markets and power systems, and the industry asked the Finnish technical universities how they would fill the acknowledged gap. The Department of Electrical Engineering at Lappeenranta University of Technology won the competitive bidding. The endowment professorship covers the salary of one full-time professor and one full-time assistant for the period of five years.

3 Educational Process

3.1 Entry and Admission Requirements

3.1.1 Entry requirements for Bachelor's degrees

Rector decides annually the selection process and basis of the selection criteria of the prospective students after hearing the opinion of the faculties. In practice student selection into the Bachelor's degree is mainly organised by a joint universities application system, DIA (joint application to Studies of Bachelor and Master of Science in Technology). This joint application system is common for seven technical universities in Finland. The joint application

system is coordinated by a joint application committee. This process enables an applicant to apply for five degree programmes in order of preference in one or in several technical universities using the same application form and examinations. The applicant may accept only one student place in degree education in a given academic year.

Prospective students applying in the Bachelor's degree are:

- *Applicants who have completed the Finnish matriculation examination or who have completed the Finnish matriculation examination and received a blue certificate.*
- *Applicants who have completed the EB, IB (European and International Baccalaureate) or Reifeprüfung degree (from die Deutsche Schule Helsinki).*
- *Applicants who will complete the EB or IB or Reifeprüfung degree either in Finland or abroad during the application year. These applicants must include their degree certificate or a certificate of participation in the respective examination from their school with their application form.*
- *Applicants who are not upper secondary school graduates but who have completed a polytechnic higher vocational degree, vocational polytechnic degree or at least a three-year vocational degree.*
- *Applicants from other Nordic countries who are eligible for application.*
- *Applicants who have not completed upper secondary education in Finland are eligible to apply for Bachelor's degree courses if they are eligible for to study at a university in their own country.*

The students can be selected in DIA by their success in the Finnish matriculation examination or by their success in the matriculation examination and the entrance examinations or by only the success in entrance examinations. The entrance examinations are organised by the joint application procedure. The entrance examination is based on the Finnish upper secondary 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 attained. This guarantees minimum knowledge level in science of all selected students.

To be selected by success in matriculation examination the prospective student must have at least grade C in physics or chemistry and passed advanced course in mathematics or he/she must have at least M in advanced course in mathematics. Up to 40 % of the applicants accepted into degree can be selected based on their success in the matriculation examination. DIA organises also this selection. The results are communicated to the applicants before the entrance examinations and students accepted based on their success in the matriculation examination are not allowed to participate in the entrance examinations.

3.1.2 General/specialised variant of the higher education entrance

Specialised variants of the higher education entrance in Bachelor's degree programmes at Lappeenranta University of Technology are defined in a specific Study Guide that is available on the university web pages. For instance, in the Degree Programme in Electrical Engineering, the following entrance criteria apply:

- *Success in specific contests in the fields of mathematics or natural sciences;*
- *Studies in the Open University (after performing 30 ECTS including 16/19 ECTS mathematics and 5 ECTS physics, average grade at least 2.0); and*
- *Completion of the specific forest industry line in upper secondary school.*

3.1.3 Industrial placements, work experience

Students applying in the Bachelor's degree are not supposed to have any former work experience or industrial placements; neither do they help in the applying process for the Bachelor's degree.

3.1.4 Foreign language skills, Finnish language skills

Applicants who have obtained their compulsory education in a language other than Finnish shall provide a certificate of their language proficiency in the Finnish language. Applicants whose mother tongue is Finnish are exempted from this requirement. Sufficient proof of language proficiency can be demonstrated by completing the National certificate of Language Proficiency test at level 4 or above (= intermediate level, 6 being the highest).
http://www.lut.fi/fi/lut/admissions/applying/masteroftechnology/graduate/Sivut/Default.aspx (in Finnish)

For the Bachelor's or Master's degree, a student has to demonstrate skills in Finnish and Swedish languages that are required of civil servants. In addition, a student must demonstrate skills in at least one foreign language that enables operating in an international context. A student who has received his or her basic education in some other language than Finnish or Swedish is not required to meet the first language criterion. A student can also be relieved of the first criterion by the Dean for some special reason.

3.1.5 Aptitude tests

The entrance examination contains mathematics, physics and chemistry as aptitude tests to engineering education.

3.1.6 Entry requirements for Master's degrees

All students accepted in the Bachelor's degree programme are also accepted in the Master's degree programme.

There are also several separate variants of entrance directly to the Master's degree programmes. Applicants should have a B.Sc. degree in the relevant field of study or in a closely related field. Also applicants with a Bachelor's degree from Universities of Applied Science in a related field from a Finnish University of Applied Science (Polytechnics) are eligible to apply. The degree must be completed by the end of the application period. The programme applied for makes the final decision if the applicant's previous degree is suitable.

Prospective students applying and selected in the Master's degree will prepare their personal study plans with the help of academic advisors. This personal study plan defines also the needed complementary studies for the student to be ready to take part in the Master's level studies. The Master's thesis project cannot be commenced (the topic for the thesis cannot be applied for) before completing the Bachelor's degree.

3.1.7 Transfers from/to the conventional system of qualification

Recognition and assessment of prior learning is in use. If a student conducts studies in another university or educational institute in Finland or abroad, he/she can request the head of the degree programme to credit the studies taken elsewhere.

A student can credit and replace study modules also by knowledge gained otherwise. Knowledge can be proved by an oral or written examination. Also portfolios are in use as a means to validate the prior gained knowledge.

3.2 Course of study

3.2.1 Curricular content

Individual modules are clearly classified within ASIIN's categories: all the courses of the Degree Programme in Electrical Engineering are listed consecutively starting from general studies to each major and minor subject in the Model Curricular Analysis (Enclosure 4).

When assessing and developing the educational objectives of the Degree Programme in Electrical Engineering, special emphasis has been placed on linking the study modules, including general studies and major and minor subject, into coherent qualification profiles. The teaching staff updates and develops the curriculum (e.g. based on student feedback and course evaluations) on a yearly basis[3].

The degree structure and curriculum support the attainment of learning outcomes and future employment by providing both the theoretical and practical knowledge and skills required of a Bachelor and Master of Science in Electrical Engineering. The attainment of the educational objectives is monitored by internal and external evaluations (Section 5).

[3] The degree programme has also been developed in the context of the national W5W project, which supported the implementation of the Bologna process in the Finnish Universities. A working group of nine staff members participated in the project.

3.2.2 Orientation – national / international

In the major and minor subjects in the Master's degree, the language of instruction is English in part of the elective courses (the B.Sc. courses are instructed chiefly in Finnish). The students of national and international Master's studies also have shared courses. The students of national Master's studies are encouraged to make use of the University's large number of cooperative international universities.

3.2.3 Didactic concept/programme type

The teaching methods applied in the Degree Programme in Electrical Engineering include lectures, classroom and laboratory exercises and assignments, project work and seminars. In the Degree Programme, practice-oriented, problem-based teaching methods are applied along with the scientific content in a wide variety of courses. The courses also involve group and project work, which train social competences of the students. Examples of such courses are *Power Exchange Game for Electricity Markets*, *Laboratory Course in Electrical Engineering*, *Laboratory Course in Electrical Power Engineering*, *Laboratory Course in Control Systems and Signal Processing*, *Digital/Communication Electronics Project*, *Electronics Laboratory Course*, *Applied Electronics Project* and *Power Electronics Project* course.

To support the educational activities, the University publishes Teacher's Quality Manual (Enclosure 8) that provides the teaching staff with guidance, for instance, on the following issues:

- *Teaching planning*
- *Defining learning outcomes of a study course*
- *Determining the content of a study course*
- *Deciding the appropriate methods to evaluate the achievement of the learning outcomes*
- *Selecting suitable methods of teaching*

The Teacher's Quality Manual (Enclosure 8) is designed to improve the quality of higher education and is available to all teaching staff at the University.

3.2.4 Structure (programme structure, subjects offered, compulsory/core subjects, semi-elective subjects, minors, specialisation, modularisation)

The structure of the Degree Programme in Electrical Engineering is defined in the Study Guide as follows (Enclosure 3, p. 66):

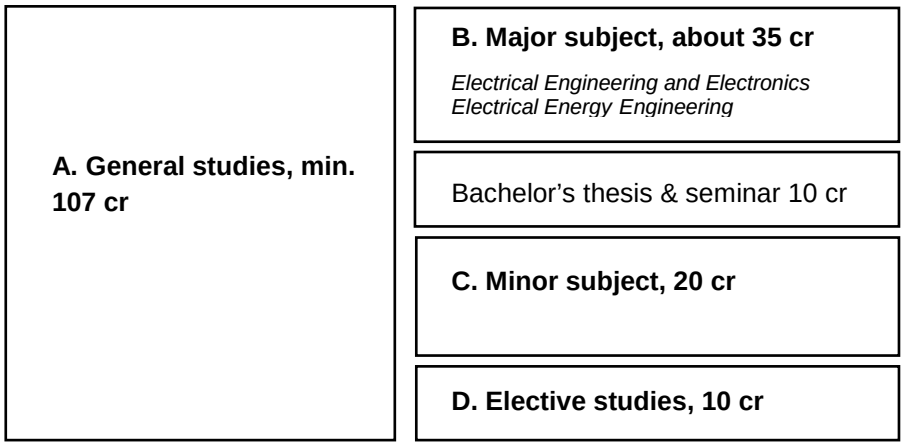
> The Degree Programme in Electrical Engineering comprises two cycles, and its standard duration is five years. The first cycle takes three years and leads to a Bachelor's degree. The second cycle leading to a Master's degree takes two years. After the first cycle of the Degree Programme, the student will be able to demonstrate mathematical and scientific skills required in the studies in electrical engineering, and to show general knowledge on technology and on the basics of electrical engineering. The student will extend and deepen these skills and knowledge in the major and minor subject studies of the Bachelor's degree. The major subjects in the Bachelor's degree are:
>
> 1. *Electrical Engineering and Electronics*
> 2. *Electrical Energy Engineering*
>
> The student chooses his/her major subject of the Bachelor's degree in the spring term of the second year of study. Regardless of the B.Sc. major subject chosen, the student may continue his/her studies to any major subject in the Master's degree. The minor subjects offered by the Degree Programme in Electrical Engineering to the students of the degree programme/its own students are *Control Engineering and Signal Processing* and *Electronics*. It is also possible to choose a minor subject from other degree programmes. Hence, the modules and the degree structure provide an adequate range of (semi-)elective studies and contribute to the flexibility of individual study profiles and transfer of credits (Enclosure 3, pp. 72–73, 80).

Upon completion of the Master's degree studies, the student will be able to demonstrate in-depth knowledge in his/her field of specialisation, that is, in the major subject. The student can also show that he/she has complemented this knowledge with minor subject studies according to his/her choice. The major subjects in the Master's degree are:

1. *Embedded Systems*
2. *Applied Electronics*
3. *Electrical Drives and Machines*
4. *Electricity Market and Power Systems*

The minor subjects offered by the Degree Programme in Electrical Engineering to the students of the degree programme/its own students are *Power Electronics and Electrical Drives*, *Digital Electronics*, *Embedded Systems*, *Applied Electronics* and *Control Engineering*.

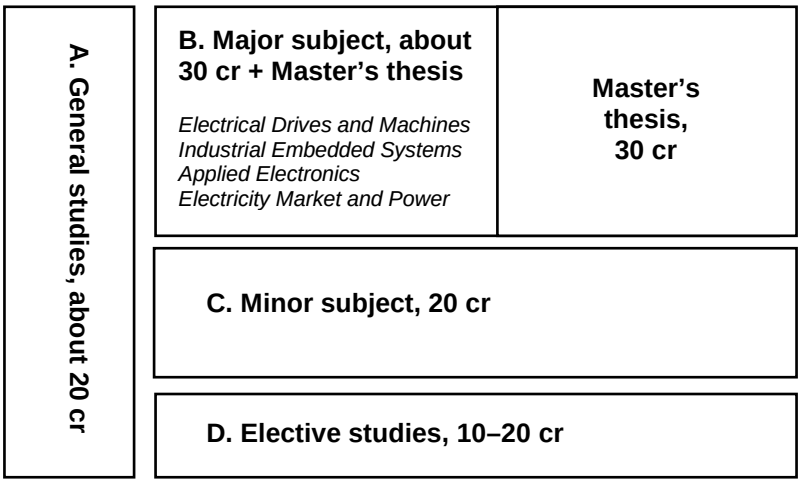
In the Degree Programme in Electrical Engineering, the structure of the Bachelor's studies is the following:



Bachelor's degree in Electrical Engineering, 180 ECTS cr

The Bachelor's studies start with general studies. After completing the general studies, the student has acquired skills required in the major and minor subject studies: the general studies include for instance mathematics, physics, language and communication studies, studies in electrical engineering and practical training. The student chooses a major and minor subject, in which he/she develops his/her professional competences in electrical engineering. In addition to these, the Bachelor's degree comprises a Bachelor's thesis and a seminar (10 cr) and elective studies.

After completion of the Bachelor's studies, the student continues his/her studies in the Master's degree programme. In the Degree Programme, the structure of the Master's studies is the following:



Master's degree in Electrical Engineering, 120 ECTS cr

The Master's degree programme consists of general studies preparing for a professional career, including for instance mathematics, language and communication skills and practical professional training. In the major subject studies, the student acquires in-depth, detailed knowledge on electrical engineering and writes a Master's thesis (30 ECTS cr.)

The programme structure, the modules of the degrees and module sizes (duration and number of ECTS credits) are described in detail in the Module Handbook (Enclosure 3, pp. 66–117).

The maximum duration of courses (modules) is two semesters, and they are worth 1–10 ECTS credits, typically from 2 to 6 credits (Bachelor's thesis 10 credits, Master's thesis 30 credits).

3.2.5 Workload

Courses that constitute the Degree Programme in Electrical Engineering are quantified according to the work load required. The basic unit is an ECTS credit. One ECTS credit equals 26 hours workload, including face-to-face teaching hours, individual studying, as well as preparation for and taking part in the examinations.

The Degree Programme is composed so that by following the Study Guide (Module Handbook), the degrees can be completed within the standard period of study (i.e., it is possible to take 60 credits per year on average), and the maximum of 75 credits is not exceeded in any year (see Enclosure 4, Model Curricular Analysis).

The workloads for the Bachelor's and Master's Degrees are presented in detail in the tables below. Each semester consists of two periods, the whole academic year comprising four periods.

The LUT Teacher's Quality Manual provides guidance in the dimensioning of studies and on issues concerning the content analysis and workload and of the courses (see pp. 14–17 in Enclosure 8, Teacher's Quality Manual).

Workload per the year of study and periods, Bachelor's degree

		Major subject of Electrical Engineering & Electronics					Major subject of Electrical Energy Engineering				
		Total	1. period	2. period	3. period	4. period	Total	1. period	2. period	3. period	4. period
1. year	General & Major & Elective		15,75	16,25	17,25	18,75		13,25	15,75	17,25	18,75
	Minor										
Total		68	15,75	16,25	17,25	18,75	65	13,25	15,75	17,25	18,75
2. year	General & Major & Elective		14,5	8,5	10,5	9,5		12	8	16	16
	Minor		2,5	2,5	2,5	2,5		2,5	2,5	2,5	2,5
Total		53	17	11	13	12	62	14,5	10,5	18,5	18,5
3. year	General & Major & Elective		14	13	10	12		13,5	11,5	9,5	9,5
	Minor		2,5	2,5	2,5	2,5		2,5	2,5	2,5	2,5
Total		59	16,5	15,5	12,5	14,5	54	16	14	12	12
		180					181				

Workload per the year of study and periods, Master's degree

		Major subject of Electrical drives & Machines					Major subject of Embedded systems					Major subject of Applied Electronics				
		Total	1. period	2. period	3. period	4. period	Total	1. period	2. period	3. period	4. period	Total	1. period	2. period	3. period	4. period
1. year	General & Major & Elective		22	12	12	12		12,5	10,5	16	16		15	13	15	15
	Minor		2,5	2,5	2,5	2,5		2,5	2,5	2,5	2,5		2,5	2,5	2,5	2,5
Total		68	24,5	14,5	14,5	14,5	65	15	13	18,5	18,5	68	17,5	15,5	17,5	17,5
2. year	General & Major & Elective		7,5	11,5	15,5	7,5		10	10	12,5	12,5		9	9	12	12
	Minor		2,5	2,5	2,5	2,5		2,5	2,5	2,5	2,5		2,5	2,5	2,5	2,5
Total		52	10	14	18	10	55	12,5	12,5	15	15	52	11,5	11,5	14,5	14,5
		120					120					120				

		Major subject of Electricity markets and power systems/Electricity trading					Major subject of Electricity markets and power systems/ Electricity distribution networks				
		Total	1. period	2. period	3. period	4. period	Total	1. period	2. period	3. period	4. period
1. year	General & Major & Elective		14	19,5	17	11,5		14	16	17	13
	Minor		0	0	0	0		2,5	2,5	2,5	2,5
Total		62	14	19,5	17	11,5	70	16,5	18,5	19,5	15,5
2. year	General & Major & Elective		9,5	9,5	7,5	11,5		7,5	7,5	12,5	12,5
	Minor		5	5	0	10		2,5	2,5	2,5	2,5
Total		58	14,5	14,5	7,5	21,5	50	10	10	15	15
		120					120				

3.2.6 Credit point system

The average input of 1600 working hours needed for studies of one academic year correspond to 60 ECTS credits (Enclosure 6.2, Government Decree on University Degrees 794/2004).

Obligatory industrial training of 2 and 2 ECTS credits is required for the Bachelor's and Master's degrees, respectively. For training, one ECTS credit equals two weeks' working as an employee. The employment contract has to be at least for 15 days (working periods shorter than this cannot be included in the training).

Studies carried out in other universities or education institutions can be included in the degree. The decision of the acceptance is made by the head of the degree programme.

More detailed description of the credit point system and inclusion of studies in other institutions is presented in the Regulations on Education and the Completion of Studies (Enclosure 5) of the University.

3.2.7 Examinations

Examinations are arranged according to the curriculum. Examinations outside the schedule can also be arranged. Examinations are mostly written examinations, the standard duration of which is three hours[4]. Written examinations typically include essays, problem-solving or case-based questions and calculation problems. Oral examinations and other types of evaluations such as reports and demonstrations are also possible (advice on alternative examination types available for teachers in the Teacher's Quality Manual, p. 25, Enclosure 8).

Courses are usually evaluated on the scale excellent (5), very good (4), good (3), very satisfactory (2), satisfactory (1) and failed (0). Sometimes a pass–fail grading is used. The evaluation principles (examination, assignment etc.) are given in the course descriptions in the Study Guide. The maximum score for each course is 100 points, and 50 points is required to pass the course. The accrual of the total score may include, for instance, examination, exercises, home assignments and seminars. The assessment criteria of each course are described in the Study Guide (Enclosure 3).

Three examinations are arranged in each course, of which a student can participate in two examinations. The first examination is scheduled for the examination period following the teaching period during which the course is taught. There are altogether seven examination weeks during the study year.

Grades obtained in courses are listed in the WebOodi data system that students to use to enrol to courses and examinations. Students can view their grades and the weighted average of their studies at any time. Grades included in the degree, and their weighted average, are listed in the report that complements the diploma.

A final thesis is required to complete both the Bachelor's and Master's degree programmes. The theses are independent work of students, and their topics and contents are discussed with supervising professors before starting the work. The examiners are required to evaluate the theses, and both of them have to be professors. The theses are graded on the scale of 1–5.

Bachelor's theses are presented before a colloquium consisting of other Bachelor-level students and teaching personnel to assess whether the student's achievements are based on his/her own work. At the Bachelor's and Master's levels, a 'maturity test' is used to assess whether the student's achievements are actually his/her own. The topic of the test is determined by the supervising professor of the student, and it relates closely to the topic of the student's thesis. The test is evaluated by the supervising professor. At the Bachelor level, a language teacher also evaluates the test to assess the student's language proficiency.

3.2.8 Degree

To receive the Degree of Bachelor of Science from Lappeenranta University of Technology, at least 90 ECTS credits including the Bachelor thesis, have to be passed in this university (total degree 180 ECTS credits). For the degree of Master of Science in Technology, the minimum is 70 ECTS credits including the Master thesis.

[4] Unless otherwise mentioned, the term 'examination' in the Module Handbook refers to a written examination.

The head of the degree programme makes the decision of the courses included in the degree of an individual student. Courses that are included in the Bachelor's degree cannot be included in the Master's degree.

The detailed regulations of the degree and examinations are given in Regulations on Education and the Completion of Studies (Enclosure 5). The Regulations are binding on the whole University. They were approved by the Rector on 16 July 2010 and entered into force on 1 August 2010.

3.2.9 Diploma Supplement

Diploma supplement is attached to the degree certificate (Bachelor and Master; Enclosure 13). It includes information about the University, modules included in the degree, as well as the grades of the modules and the structure of the degree (Enclosure 5, Regulations on Education and the Completion of Studies, § 22).

4 Resources

4.1 Institution and Context

4.1.1 Description of the institution

University education is governed by the Universities Act (558/2009) (Enclosure 6.1) and the Government on University Degrees 794/2004 (Enclosure 6.2). The roles and responsibilities of the management of education are defined in the Administrative Regulations of the University. The educational objectives are agreed upon annually in the negotiations between the University and the Ministry of Education and Culture. The achievement of objectives affects the financing granted to the University by the Ministry. The financing decisions are made on an annual basis.

The University Board decides the strategic long-term goals of the university teaching and education, and the degree programs provided by the University. The Board also decides the entry requirements and the number of new entrants accepted to the University's degree programmes. The University Rector makes the decision on the approval of new entrants to the degree programmes. The Rector also appoints, when necessary, the board of examiners to consider the remedial requests concerning the study attainments.

The University applies the Regulations on Education and the Completion of Studies approved by the Rector. The Regulations define the basic ways of action concerning the teaching and studying at the University, and the degree programmes provided by the University. The Regulations are published on the University's web pages.

The University has a Vice Rector responsible for education. In addition, each degree programme has an appointed head. The Vice Rector organises a meeting between the heads of the degree programmes once in every two months to discuss the leading, evaluating and developing principles of the degree programmes. The memos of the meetings are published on the University intranet. The Vice Rector also leads the University's supervisory and development group for teaching appointed by the Rector. The objective of the group is to promote the internal cooperation within the University in developing the teaching customs.

The student representation in the University's administrative bodies is determined by the Universities Act and the Administrative regulations of the University. In accordance with the statutory representation in the administrative bodies, the students also have a representation in the University's supervisory and development group for teaching. In addition, the students participate in the development of teaching through the course evaluation carried out annually in each University study course, and through the teaching feedback inquiry organised by the Students' Union.

4.1.2 Committees responsible for teaching in the degree programme

The university has three faculties: the Faculty of Technology, the Faculty of Technology Management, and the School of Business. The Department of Electrical Engineering, as part of the Institute of Energy Technology (LUT Energy), belongs to the Faculty of Technology (Enclosures 5 and 9).

The head of the faculty is the dean, and the highest decision-making body in the faculty is the faculty council. The dean acts as the chair of the faculty council. The dean manages the faculty and is responsible for the results of its instruction, research and societal influence. The faculty council makes decisions regarding the curricula. A curriculum presents the aims and organisation of the education, and the course descriptions and learning outcomes of courses in the degree.

The Faculty of Technology has a development group for teaching appointed by the Dean of the Faculty. The group is responsible for developing the quality of teaching and the contents of the degree programmes within the Faculty. The group has representation from each degree programme provided by the Faculty. The group also has three student representatives that are appointed on the basis of the recommendations of the Students' Union.

The Faculty Council is responsible for supervising the quality of teaching. The Council also decides the study plans and the degree requirements. In addition, the Council makes the proposal to the Rector concerning the entry requirements and the number of new entrants accepted to the degree programmes.

The quantitative and qualitative goals of the Faculty's actions are agreed upon on a yearly basis in the negotiations between the Faculty and the University. The University takes into account the results of the Faculty's operation in previous years and the Faculty's development needs in allocating the money received from the Ministry of Education and Culture.

The Faculty is responsible for the equipment needed in teaching and research. The Dean of the Faculty is responsible for the resources needed in teaching. The Dean also appoints the heads of the Faculty's degree programmes. In addition, the Dean accepts the theses of the graduate students.

The heads of the Faculty's degree programmes are responsible for producing, evaluating and developing the degree programmes. The heads of the degree programmes accept the topics of the theses of graduate students. Each degree programme of the Faculty also has an advisory group to support the work of the head of the programme.

The contents of the major subjects of the degree programmes are decided by the professors responsible for carrying out the research in the corresponding fields of science. The major subjects are congruent with the focus areas of the research. The professors are also responsible for organising teaching in their own remits. In addition, the professors make the propositions to the heads of the degree programmes regarding the topics of the theses of their own students.

Teachers in charge of the study courses are responsible for executing, evaluating and developing their own teaching. The University has published LUT Teacher's Quality Manual to support the teaching activity. This handbook contains information about the planning and implementation of study courses. It also gives instructions for defining the learning outcomes of the study courses, and for evaluating whether the learning outcomes have been achieved. In addition, the handbook provides the teachers with tools to measure of workloads of courses. The handbook is published as a printed version and in electronic format on the University's intranet.

Course evaluations are carried out in each course on a yearly basis. The evaluations are carried out as web inquiries. Standard questions for all inquiries concern the appropriateness of teaching and the general impression about the study course. In addition, teachers are able to add their own questions to the inquiries as they wish. Course-specific evaluations are given to the teachers responsible for the courses. The results are also delivered to the heads of the degree programmes and the vice rector responsible for teaching once in a semester. If an individual study course receives a low average score (less than 2.5 in a scale 1–5, with 5 being the highest score), the Vice Rector intervenes. Course evaluations are also discussed in the result and development negotiations between the University and the Faculty.

4.1.3 Research facilities and main areas of research

The Degree Programme in Electrical Engineering strongly relies on the research carried out in the Department of Electrical Engineering. The main areas of research of the Department are electrical drives and machines, and the electricity market. The Department performed well in the international evaluation carried out by the Academy on Finland in 2006 focusing on the energy research in Finland. The Department was seen as one of the stronger units in Finland in the field of electrical power engineering, and it was concluded to compare well to similar units elsewhere

in Europe (Academy of Finland 2006, Enclosure 12). Within LUT Energy, there are about 180 persons working full time. The Department of Electrical Engineering employs about 80 persons.

The research laboratories under the administration of the Department of Electrical Engineering are responsible for organising the teaching in the Degree Programme in Electrical Engineering. The research laboratories' main areas of research are electrical drives and machines, embedded systems, applied electronics, and the electricity market and power systems. Each laboratory is responsible for one major subject in the Degree Programme, and the teaching is based on the research done in the laboratories.

The laboratories are also responsible for maintaining both the teaching laboratory facilities and the research laboratory facilities. The Department of Electrical Engineering received a total funding of 2.3 million euros in years 2000–2003 to equip the teaching and research laboratories. The money came from the EU, private companies and the University. The University's share was the work done by the staff of the Department for the laboratory equipping project. In 2004–2010, the annual spending to maintain and develop the teaching and research laboratories has been about 100 000 euros. The funding has come from the University, private companies and the EU.

The research laboratories producing the Degree Programme in Electrical Engineering work in close cooperation with the electricity industry. The industrial partners play an important role in signalling the needs of society regarding the electrical engineering education, enabling the continuous evaluation of the content of the provided Degree Programme in Electrical Engineering. In addition, the industry has played a notable role in facilitating the high-class teaching and research laboratories used for empirical educational and research purposes. Industrial cooperation also enables students to connect with their potential future employers in real-life projects during their studies.

Examples of current research projects that are relevant also from the perspective of the degree programmes:

Electrical drives and machines

1. Motion Control Research
    - utilization of accurate vector control converters in motion and position control applications
    - data transfer technologies (ABB)
2. Research of ultimate torque electrical machines for distributed generation, especially wind power
3. Development of a method to double the torque per volume compared to traditional machines (Academy of Finland)
4. Research and development of present day wind power generators
    - The target is to produce the highest efficiency machines but still at an acceptable cost (The Switch)
5. Research and development of traction systems for heavy mobile working machines
    - Special focus: work cycle dependent dimensioning of modern drive components (EFFIMA)
6. Future combustion engine power plant research
7. Utilization of modern machine and converter technology in ship power distribution systems
    - Special focus: DC delivery
8. Development of high voltage insulation system for natural gas high speed, high power compressor motors (STATOIL)
9. Electrical energy recovery and reuse in work machines, ENTALT.

Applied electronics

10. Energy Efficient Power Electronics in Fuel Cell Applications

Electricity market and power systems

11. Smart Grids
    - Power electronics in electricity distribution
    - Plug-in hybrid and electric vehicles
    - Network business models
    - Methods for strategic planning of smart grids

Embedded systems

12. Frequency-converter-based life cycle cost optimization for fan and pump systems
13. Power line communication in industrial and smart grid applications

4.1.4 Related degree programmes and degrees

The Degree Programme in Electrical Engineering is carried out in the Institute of Energy Technology (LUT Energy) in the Faculty of Technology at Lappeenranta University of Technology. LUT Energy provides three different degree programmes: Electrical Engineering, Energy Technology and Environmental Technology.

The Department of Electrical Engineering educates annually about 30 international students in its international Master's programme. The students come from the cooperation universities in Russia and China and also from other countries, and they are selected based on the success of their former studies, interviews and language test.

Students of the Degree Programme in Electrical Engineering can attend the post-graduate courses offered by the Finnish Graduate School in Electrical Energy Engineering at the end of their studies. The Department of Electrical Engineering in charge of the Degree Programme in Electrical Engineering is the national coordinator of the Graduate School. The ECT credits obtained in the post-graduate courses can be included either in the Master's degree or the doctoral degree.

4.1.5 Areas of specialisation in teaching

The main areas of specialisation in teaching are congruent with the main areas of research. According to the University's educational planning principle, teaching is based on research.

4.2 Partnerships – Cooperation Related to the Degree Programme

4.2.1 Cooperation within the institution

The degree programmes of LUT Energy carry out close cooperation in planning and implementing of the programmes. For instance, the Degree Programme in Electrical Engineering uses the same student administration services as the other two degree programmes of LUT Energy (Energy Technology and Environmental Technology).

LUT Energy's main areas of research are energy efficiency and the energy markets. These also form one of the four strategic focus areas of the University.

The Degree Programme in Electrical Engineering also widely utilises the study courses offered by the other degree programmes of the University. Examples of such courses are the courses of mathematics and natural sciences, and the business and language courses.

Internal cooperation within the University is promoted by the supervisory and development group for teaching lead by the Vice Rector in charge of education.

4.2.2 External cooperation

Student exchange is arranged by LUT International Services, which supports university's internationalisation by developing and maintaining cooperation relationships and agreements with international universities and networks. LUT has an extensive partner network all around the world. The network of over 150 higher education and research institutions forms an excellent basis for collaboration in mobility of students, teachers and researchers, as well as joint education and research projects.

Examples of cooperation with international universities are the Department's double degree agreements with a network of Russian (St. Petersburg and Moscow) and Chinese (Chongqing) technical universities. About 25 students from Russia and China participate annually in the student mobility.

Moreover, the Department of Electrical Engineering is the coordinator of the national Graduate School in Electrical Energy Engineering. The coordinator is nominated by the Ministry of Education in Finland, on the basis of the proposition of the Academy of Finland. All universities in Finland that give higher education in electrical engineering

are represented in the Graduate School in Electrical Energy Engineering. The Department of Electrical Engineering has held the coordinator's position since 1995.

Research cooperation with other universities and institutions in Finland and abroad
The Department is participating in various research projects coordinated by The CLEEN Ltd (Finnish Energy and Environment Competence Cluster) http://www.cleen.fi/home/; Cleen is an energy and environment strategic centre for science, technology and innovation is based on the common vision and strategic research agenda defined by the centre's owners, i.e., companies and research institutes. Further, the Department is an active stakeholder in various national research consortiums and collaborates with other Finnish universities (e.g. Tampere University of Technology).

The Department of Electrical Engineering is a member in Energy Hills, the largest European energy cluster http://www.energyhills.eu/index.php?english. Energy Hills combines the energy-related expertise, research and development skills of leading European universities, major research institutions and private sector companies from the energy sector. This competence is completed by members from the public sector, financial institutions and regions.

LUT is also one of the Competence Centres in the ECPE Network (European Center for Power Electronics), established in 2003 by power electronics industries to promote research, education and technology transfer in the field. The main objective of ECPE European Center for Power Electronics e.V. is the promotion of research, innovation, education, publicity and technology transfer in the area of power electronics in Europe. http://www.ecpe.org/network/competence_e.php

The Department is involved in collaborative activities with the key stakeholders in the energy market (Energy Market Authority, energy companies, power system operators) both nationally and internationally, especially in the Scandinavian context. International collaborative partners of the Department include for instance SINTEF research organisation and the Norwegian University of Science and Technology (NTNU) in Norway.

Cooperation with other interest groups
The Carelian Drives and Motor Centre (CDMC), established in 1998 in co-operation with ABB, is a centre of expertise operating in connection with the Department of Electrical Engineering. The CDMC's key objectives and operations focus on research and development of electrical machines and drives. The centre operates in the premises of the Laboratory of Electrical Drives Technology. The CDMC generates, develops and executes research operations and transfers the results of these projects to the product development and productisation processes of ABB. Annually, the centre's research programs produce several master's theses and doctoral dissertations. In the CDMC, some ten researchers are constantly completing their Master's theses and dissertations.

In addition, there is long-term industrial cooperation for instance with the companies Vacon, The Switch and Wärtsilä related to technology promoting energy efficiency; these projects employ 5 to 10 persons each and last typically from three to five years.

4.3 Participating Staff

4.3.1 Composition

The composition of teaching and research personnel in LUT is based on a new four-step system: Doctoral Student, Post Doctoral Researcher, Associate Professor and Professor. This four-step system supports structured and consistent education and development activities. The employment contracts of the personnel range from 1 year contracts (doctoral student) to permanent positions (associate professors, professors).

Table 3. Staff Contributing to the Degree Programme (2010)

Position type	Permanent positions	Total number of positions
Professors*	4	6
Associate Professors*	6	9
Post-doctoral researchers*	1	10
Doctoral Students*		51
Total academic staff	11	76
Other (secretaries, student advisers)	3	

*Personnel with teaching responsibility; at least 50 % of the doctoral students participate constantly in teaching activities.

4.3.2 Supervision

Teachers are responsible for the modules they teach as well as supervision concerning contents of their own subjects. Persons in charge of the modules are required to have a doctorate. Teachers are available at the university mainly during office hours, but students may have guidance and individual supervision also out of these hours by fixing the time with the teacher.

General supervision concerning studies at the university and about the degree programme is given by the Head of Study Affairs of the Faculty and by the study coordinator of the degree programme. In addition, study counseling is provided by the student adviser of the degree programme. There are also tutors at two levels: student tutors helping new first-year students in practical matters and teacher tutors helping students with their personal study plans.

4.3.3 Relevant professional development measures/opportunities

Lappeenranta University of Technology aims to create a good working environment for its staff, and to support their professional development and well-being at work.

The University has a human resources committee through which the university personnel have representation in decision-making concerning the development of the working environment and conditions. The Committee also annually revises the measures for professional development and maintaining professional expertise that determine the focus areas of personnel training at the university. The chair of the Committee is the Vice Rector in charge of education. The names of other members and the Committee memoranda are available on the University intranet.

The University organises training in university pedagogy, which aims to strengthen the practical teaching competences of the teaching personnel. The extent of the course is 25 ECTS credits total. At the moment, 15 staff members of Electrical Engineering have participated in the training, 10 having completed the whole 25 credits. The costs of staff training organised by the university are covered by general personnel training appropriations. Each unit offers its staff members the opportunity to take part in staff training outside the university in order to support their professional development and expertise. The professors are also obliged to participate in management training organised by the University (provided by JTO School of Management).

The university also supports the professional development of its personnel by allowing them to take two lessons (2 x 45 minutes) per week for independent study if the employee's supervisor and head of the unit consider that the studies serve the purposes of the working community.

University staff members conduct annual performance and development discussions with their immediate supervisor. The parties of the discussion examine results obtained, set goals for the near future also concerning the professional development and personnel training needed. Instructions for performance and development discussions are available on the University intranet.

4.4 Financial and Physical Resources

The annual income of the Department of Electrical Engineering in charge of the Degree Programme in Electrical Engineering is around 6 million euros. Over half of this money comes from sources other than the university budget (e.g. 3.4 million in 2010). These sources include the Academy of Finland, the Finnish Funding Agency for Technology and Innovation, the European Union and private companies. Most of the outside financing comes from industrial cooperation.

4.4.1 Human resources

At the Department, the staff participating in teaching activities includes professors, associate professors, post doctoral researchers and doctoral students. Professors and associate professors, who are normally in charge of the course modules and the major subjects, are mostly paid from public budget funds. This guarantees a solid founding and the continuity of the degree programme. Part of the funding for post doctoral researchers comes from external funding (there are significant individual variations, the external funding varying from 0 to 100 %, being e.g. 30% of the person's total labour cost). The funding for doctoral students comes chiefly from research projects and from the Graduate School in Electrical Energy Engineering.

4.4.2 Physical resources, annual and past investments

Basic teaching and teaching materials, excursions, maintenance of the teaching equipment, rents and charges of the study affairs and the university administration are financed from the budget money. (A detailed description of the laboratories and equipment is found in Section 4.5.3.1.)

Table 4. Financial resources of the programme.

Year	Course Funds, €					Investments in major equipment
	Staff funds total[5]	Rents of offices and laboratories	Computers and equipment	Charge of study affairs services	Charge of university administration	
2007[1]	3 343 309	800 880	136 629			179 000
2008[2]	3 262 052	715 400	65 423			26 563
2009[3]	3 115 012	740 400	114 627	62 500	46 500	35 756
2010[4]	3 287 800	692 400	76 990	72 000	54 500	177 000

[1] 2007–2009 actual, realised figures
[2] The decrease in staff funds is explained by the separation of Electronics Design Centre from the Department of Electrical Engineering in the early 2008.
[3] In 2009, the University adopted a new internal invoicing system; before that there are no figures available for charges of study affairs services and university administration.
[4] Figures for 2010 from the budget
[5] Including indirect employee costs

4.4.3 Premises

The University has 45 lecture halls, 12 classrooms for language studies, and 21 micro computer classrooms and work premises.

The university library provides services for university students and staff, and for outside customers. In the library area, there is also a study and work place with guidance for students - the Origo. Origo has about 100 posts, several group work premises, and two computer classrooms. The computer classrooms are available for independent studies whenever they are not reserved for teaching purposes. Origo also has a reading room that is open 24/7.

In the University premises, there are two restaurants and two cafes available for students, staff and other people. Eight rooms have been reserved for students' guilds. The University premises also host two chapels, and the two

gyms support the students' physical activities. At the University campus, there is also a student health centre. The Student Union House has facilities for hobbies and meetings that are available to all students.

4.5 Support for Teaching and Study

4.5.1 Computer facilities

4.5.1.1 Computer equipment

University offers for personnel Windows computers for normal use, or a similar computer with more memory and enhanced display adapter for those who use CAD software. The screens are mainly LCD screens. Both color and b/w printers and some scanners are available to the personnel.

Students can use the computers that are in common use in the library area (i.e. in Origo), or in the computer classrooms. The computers are mainly Windows computers, but in the library area there are a few Linux computers. There are printers and scanners also available for students.

4.5.1.2 Student supervision

The supervision is mostly carried out with centralised electronic means. Origo's supporting team also supervises the students. Part of the supporting staff is students. They have direct access to the support team in the University's Information Services and Technology (IS&T) Unit. The IS&T staff qualify as B.Sc. or M.Sc. in their field.

4.5.1.3 Student access

Students have access to computers in Origo's computer classrooms and other computer classrooms. There are 75 computers in Origo's computer classrooms, and they are available during the library opening hours. The total number of other computer classrooms is 13 and there are altogether 239 computers. These are available for students whenever they are not reserved for teaching. Four of the computer classrooms are equipped for CAD use and have a total of 52 computers for heavy use. One classroom with 20 computers has a Linux setup. In addition there are seven group work rooms that have one or two computers each. In the thesis writing room there are five seats each optimised for research and writing. On passageways there are some computers that can be used only for web browsing.

Centralised services, such as the learning environments can be accessed also outside of the campus. The university offers WLAN services to enable the use of students' own computers at the campus.

4.5.1.4 Description of tasks performed by the students

Students search and use publications that are available in the library or on the databases (www.lut.fi/en/library). They enrol on the modules they are going to take (https://weboodi.lut.fi/oodi --> in English), they get the course information, learning material and assignments of the modules they have enrolled in (noppa.lut.fi --> in English) and they participate in the web-based modules on the University BlackBoard learning space. They write reports, essays and theses. They use software specific to studies to solve the problems and tasks that belong to their studies. Also email and net browsing are part of their daily tasks.

4.5.1.5 Restrictions/hindrances

There are no computers suitable for blind people. Computers should be used only for studying purposes.

4.5.2 Library/Literature/Media Facilities

4.5.2.1 Inventory

LUT Library collections consist of approx. 100.000 printed monographs, 67.000 printed journals, 18.000 electronic books, and 11.200 e-journals.

4.5.2.2 Other media

The number of printed maps is 9, documents in microfiche form approx. 1.100, and audio recordings 550.

4.5.2.3 Procurement

The annual procurement of printed monographs is approx. 4.200 and the number of subscribed printed journals is 600 volumes per year.

The Library provides its customers with library and information services both on-site and online. Information literacy education for the entire University is also arranged and given by the Library personnel. The Librarians act as experts in publishing of the LUT series. The Library personnel also manage the use the customer and office space of the Library. The Library is an Independent Institute within the University.

4.5.2.4 Student access

There are about 266.000 yearly visits to the Library. The Library is open to LUT staff, students, and general public during terms on workdays: Mon-Thu 8:30–18:00 and Fri 8:30–15:30. In summer and during the holiday season the Library closes at 15:30 on each workday.

There are no restrictions to the number of loans.

The customers access the Library catalog Wilma 397.000 times per year. The Wilma database includes information about both printed and electronic books as well as the storage information of printed journals. Electronic books can be accessed via a link to the Library catalog.

There are over 20 database vendors with more than 100 databases available for the Library customers. Most database hosts allow IP access to their information sources. Students and staff also have remote access to e-journals and electronic books.

4.5.2.5 Staff qualifications

The number of Library staff is 17, eight of whom have Master’s degrees in science. Five staff members have professional library qualifications, which equal to Bachelor’s degrees. One of the staff members is an IT specialist.

4.5.2.6 Workplaces for students

The number of seats for reading in the Library is 170. There are 95 computer workstations available for the customers. The Library also offers six group work rooms with a total of 44 seats for group work.

4.5.2.7 Restrictions/hindrances

The Library is closed during weekends. Electronic material is available remotely for LUT staff and students only.

4.5.3 Laboratory facilities/equipment

4.5.3.1 Equipment and technical level

Below, the laboratory facilities in the Department of Electrical Engineering are described in brief.

Laboratory of Applied Electronics
In the Laboratory of Applied Electronics there is a 90.9 m^2 ESD protected room, designed for electronics education. Electronics laboratory course and several other courses in electronics use the laboratory facilities. There are eight equally equipped working cells in the laboratory. In every desk there is a computer with electronics design and simulation tools and data transfer systems for the measurement instruments. Oscilloscopes, signal generators, power supplies and multimeters can be found in all working cells. Some instruments such as frequency counters, spectrum analyzers and impedance analyzers are shared by the whole laboratory.

Laboratory of Electricity Market and Power Systems
In the Laboratory of Electricity Market and Power Systems, there are protection relays for teaching relay protection in electricity distribution networks. The equipment includes feeder terminals, a motor protection terminal, three-phase definite time-lag overcurrent and overvoltage relays, DC auxiliary voltage protection, differential protection and feeder protection terminals.
There is software for teaching of planning and management of electricity distribution systems; the software included in the relay panel comprise SCADA 8.4.3 SP2 supervisory control and data acquisition system and Opera 3.3 distribution management system.
In the laboratory, there are computers for student use. There are MicroScada Pro DMS 600 Workstations with Opera 4.1 SP1 distribution management system, Integra 4.1 SP1 network information system and Profila line profile design system. There are altogether seven PCs in the laboratory for students for guided and independent use.

Laboratory of Electrical Drives Technology
The Laboratory of Electrical Drives Technology has several laboratories for education and research purposes. The range is from basics of electrical engineering to MW size of power. The basic laboratory course in electrical engineering is taught in a modern laboratory room solely for the purpose, including 10 laboratory works with approx. 1 kW motors, transformers, passive components, oscilloscopes, power meters and computers for measurement analysis.
The laboratory was built and originally equipped in an EU project around the year 2000. The more advanced laboratory course in electrical power engineering is taught in a laboratory with approx. 10 kW power supplies for motors and frequency converters, where also advanced measurement equipment is used, similar to industry. The laboratory is in close connection with two more laboratories with 100 kW–1 MW range of power supplies for the electric drive applications. These laboratories were built around 1990 and 2000, and are constantly updated within current research projects. The laboratory environment is similar to industrial facilities. Within the laboratory facilities there is also an ABB laboratory of physics, where 700 students/year of under university level are taught about the practice and theory of electromagnetism and electronics.

Laboratory of Control Engineering and Digital Systems
The Laboratory of Control Engineering and Digital Systems has two education laboratories. The first one is for teaching and exercises related to control engineering and industrial automation. In the laboratory, there are several control engineering works, in which control algorithms are developed and tested for a unit process, such as a helicopter, inverse pendulum, etc. In addition, there are industrial automation exercise works. In these, the automation equipment includes a PC-based control room application, field buses, and a controlled unit process. The other education laboratory is dedicated for teaching and exercises of embedded systems and signal processing courses. In each student location there are embedded micro controller boards, a PC for software development, an oscilloscope for testing and a general purpose function generator for generating stimulus.

All the laboratories of the Department were originally equipped in an EU project in the early 2000s. During the past few years some of the measurement instruments and all computers have been updated or replaced by more modern devices in all laboratories.

4.5.3.2 Student supervision

Students perform the laboratory works in electrical engineering under supervision of trained personnel. Supervisors can be other students that are employed by the Department of Electrical Engineering. At the start of their first laboratory course, the students complete an orientation that focuses especially on safe working practices in a laboratory environment. Prior to the first laboratory work, the students are required to sign a form stating that they have received guidance on work safety, and that they have familiarised themselves with first aid instructions.

Before each laboratory work, the students write a preliminary report about the topic of the work. At the laboratory, the supervisor always checks the connections made by the students.

4.5.3.3 Student access

Students have access to laboratory facilities only in the company of supervisors.

4.5.3.4 Restrictions/hindrances

For the electrical safety reasons undergraduate students are not allowed to work alone in any laboratory.

4.5.4 Academic guidance for prospective and existing students

The University has contacts with study advisors and teaching staff in Finnish high schools and polytechnics. Printed material is posted to these educational institutions each autumn. The teachers and study advisors are provided an opportunity to bring groups of students to the University to visit the physical premises (laboratories, library etc) and have a guided tour on the campus. All high schools in the surrounding regions (about 200 km range) are invited to an open house event in every November.

The University's own degree students visit high schools and education events at garrisons during each academic year. The goal of the visits is to provide information on the study opportunities and student life. More than one hundred visits are made by the students each academic year. The University also takes part in the most important national fairs targeted at young people seeking higher education opportunities.

Academic Guidance Methods for Existing Students

The university offers academic guidance actions that together cover the entire span of studies and efficiently support studies and learning. With this guidance, students are able to complete their studies by following an appropriate study plan that they have prepared themselves and to graduate within the desired time.

The roles and duties of study guidance personnel and units are listed in the table below.

Table 5. Academic Guidance Methods

Peer tutor	Introduces new students to the university, studies and the student community, and helps them with practical arrangements at the start of studies. A peer tutor introduces new students to the university facilities, study guidance staff and other students. A peer tutor makes sure that students know the most important practices related to studies: registration for courses, attending lectures, taking examinations, preparing a course schedule, social aspects.
Tutoring coordinator	Coordinates and develops the university's peer tutoring together with faculties, Student Services and the student union.
Student adviser	Student advisers are LUT students who work part-time while they study. They provide information and guidance in studies, see to the choice of tutors and arrange their training together with the study coordinator and take part in arranging briefings for students.
Study counselling psychologist	Counsels students in problems related to studies and learning and provides expertise in issues involving learning and guidance, supporting other study guidance personnel.
Study coordinator	Coordinates study guidance for students. The duties include study and degree guidance for students, from applicants to postgraduate and partly even mature students. The study coordinator helps students in preparing their individual study plan (including the recognition of prior learning and studies outside LUT, e.g. through the flexible right to study) and provides

	guidance in administrative issues related to graduation. The Language Centre study coordinator offers study guidance with regard to language and communication studies, and handles credit transfer applications for language and communication studies completed at other universities and higher education institutions.
Head of degree programme	Is in charge of evaluating and developing study guidance.
Head of study affairs	Is responsible for organising study guidance in the faculty. Is responsible for administration of studies and partly also for study guidance related to administrative affairs.
Teacher/tutor	Helps students prepare their individual study plan and follow its progress. Teacher/tutors provide guidance in the selection of major and minor subjects from the viewpoint of career guidance. They are study guidance personnel appointed for a department or degree programme. Students may turn to them with any issues involving studies.
Teachers	Are responsible for study guidance related to the completion of the courses/modules they are responsible for.
Introductory course/module	Introductory courses are arranged in all degree programmes to help students get started with their academic studies. Introductory courses usually also guide in preparing an individual study plan.
Professors	Provide guidance in the selection of a research topic, and in preparing final theses for undergraduate and postgraduate studies.
International Services	Offers general study guidance to international students at the university and coordinates the activity of international tutors. International Services also assists Finnish students in matters related to studies abroad.
Career Services	Guides students in career planning and searching for employment.
Language Centre	Offers study guidance related to language, communication and culture studies.
Library	Provides guidance in information retrieval and Instruction in information literacy.
Origo helpdesk	Supports services for the use of information and communication technology in studies.

5 Attainment of Objectives

5.1 Data and statistics

Finland has ratified the Council of Europe and UNESCO Convention on the Recognition of Qualifications concerning Higher Education in the European Region (Bologna Process) in 2005. Before 2005, the Finnish system had no Bachelor's degree in universities of technology, and the students completed directly the M.Sc. degree. The transition period of two parallel university degrees ended in August 2008 in the most fields of education. The students who had started to study in a university before autumn 2005 had a right to continue studies in the Master's degree programs without a B.Sc degree according to the old syllabus until July 2010. Since the Finnish system is new, there is no reliable data available for the time being to separately evaluate the B.Sc. and M.Sc. degrees (median times of study for B.Sc. and M.Sc. together are listed in Table 6).

At present, the degree programmes are designed and composed so that completion of degrees is guaranteed within the standard periods of study (3 + 2 years). Further, the structure and scheduling of the degree is designed so that the student is able to proceed in the studies without problems or delays. The student feedback supports this information, showing that the degree programmes receive excellent grades, the best in majority of categories at the University (see Table 7 below). Among the University units, Electrical Engineering has received top results in every category.

Table 6. Time of study

	2009	**2008**	**2007**	**2006**	**2005**
Time of study, median, B.Sc + M.Sc	4 yrs, 7 mos	4 yrs, 4 mos	4 yrs, 7 mos	5 yrs, 3 mos	5 yrs, 4 mos
M.Sc. Degrees	54	58	55	38	32

Table 7. Student satisfaction with the degree programmes in 2009 (graduate survey): content of the degree programme, specialist and social competences acquired in the course of the degree programme and satisfaction with the thesis supervision and the study atmosphere (on a scale 1–5).

	Säte	Kati	Kete	Kote	Ente	Ymte	Tite	Tuta	Mafy	All
content of degree	**4,135**	4,01	3,638	3,705	3,571	3,683	3,625	3,847	3,958	3,83
specialist competences	**3,854**	3,72	3,667	3,737	3,619	3,35	3,624	3,745	3,583	3,701
social competences	**3,642**	3,526	3,439	3,411	3,312	3,229	3,418	3,586	3,375	3,488
thesis supervision	**4**	3,824	3,986	3,904	3,69	3,733	3,792	3,778	4,083	3,845
study atmosphere	**4,01**	3,903	3,379	3,618	3,683	3,691	3,562	3,819	3,792	3,755

Säte: Electrical Engineering, Kati: School of Business, Kete: Chemical Technology, Kote: Metal Technology,
Ente: Energy Technology, Ymte: Environmental Engineering, Tite: Information Technology, Tuta: Industrial Management, Mafy: Technomathematics and Technical Physics

5.2 External evaluation outcomes

International evaluation carried out by the Academy of Finland
The international evaluation (2006) focused on the energy research in Finland. The Department was seen as one of the stronger units in Finland in the field of electrical power engineering, and it was concluded to compare well to similar units elsewhere in Europe (Enclosure 12).

The audit of the Finnish Higher Education Evaluation Council 2009
The objective of the FINHEEC audit is to ensure that the higher education institution has a quality assurance (QA) system that supports continuous development of activity. The audit also ensures that a higher education institution operates in accordance with its objectives and the activity is internationally reliable. LUT was audited in 2009 (valid until 5 March 2015; abstract of the audit in Enclosure 11).

Questionnaire surveys for the external supervisors of the Master's theses
Supervisors of the Master of Science theses are asked to fill in a survey related to the theses written. At the moment (June 2010), the first surveys have been sent to the supervisors; According to the statistics available, the employers/supervisors' satisfaction with the outcomes of the thesis project in Electrical Engineering are good (mean 8.4 on the scale 4–10).

Follow-up of the progression of studies
LUT has followed up the progress of studies and the accumulation of credits every year since 2005. This follow-up has been made in a nationwide project, which has shown that the study process in LUT is among the most effective processes in Technical Universities and Faculties in Finland. The project report is available in Finnish at http://lib.tkk.fi/Raportit/2009/isbn9789512297740.pdf).

5.3 Internal evaluation outcomes

The university grants quality bonuses for the development of education for one or two years at a time. The quality bonus is a reward for development measures taken and an incentive for the further development of education and teaching. The steering and development group for education makes the preparations for the application procedure and the decision to grant a quality bonus, and the rector appoints the recipients of the bonus (Enclosure 9, LUT Quality Manual, p. 38).

The vice-rector in charge of research evaluates the research and post-graduate education carried out by the faculties/departments, and gives feedback on it. The indicators are also used in the allocation of budget funds to the faculties. The Department of Electrical Engineering has been granted performance-based funding in the form of quality bonuses for teaching and bonuses for a centre of excellence in research as shown in the table below (LUT Quality Manual, pp. 21–25).

Table 8. Internal evaluation outcomes 2005–2010

Year	Quality bonus for teaching €	Bonus for a centre of excellence in research €
2005	20 000	40 000
2006	25 000	60 000
2007	25 000	60 000
2008		50 000
2009	35 000	50 000
2010	18 300	90 000
Total in 6 years	123 300	350 000

An internal audit was conducted (in compliance with the LUT Quality Manual) at the Department of Electrical Engineering as part of the evaluation of the Faculty of Technology in 2008. The results of the audit report support the research-oriented profile and the connections of the unit to the professional field.

5.4 Number of students commencing the degree programmes

The table below presents the students starting their studies both in the autumn and spring terms; the table includes students approved either in the year in question or before that.

Table 9. First-Year Enrolments, Electrical Engineering

Degree programme / Degree type	2009	2008	2007	2006	2005
Bachelor	32	23	25	27	32
Master	35	39	44	39	31
Total	67	62	69	66	63

5.5 Number of students per semester and the drop-out rates

As described above in section 5.1, in Finland the time to complete studies has been very flexible. The first students who have had a time limit for their studies have enrolled in 2005. This phenomenon can seen in the tables, as there are very many “N” year students, meaning students who have been studying longer than five years. At this moment the Bachelor’s degree takes theoretically three years, but students who have not completed their studies in six semesters, are called “Bachelor N students”. Only after graduating in the Bachelor’s degree the student is counted as a Master’s level student. This phenomenon makes the statistics look as if we had very many Bachelor students and not so many Master students. This is not true, since there is no formal rule that a student should graduate in the Bachelor’s degree before she/he could start Master’s degree studies. At the moment many students graduate in the Bachelor’s degree only shortly before graduating in the Master’s degree.

The Head of the Degree Programme receives data on the individual drop outs and drop out rates, and based on these data, either the student adviser or the study coordinator contacts all the drop outs at least once a year (the red and blue circles in Table 10 exemplify the development of the numbers of students).

In Table 10 students are divided by degree programmes and years of study.

Table 10. Students divided by the Degree Programme and Year of Study

Bachelor and Master students per year of study								
Year	**1**	**2**	**3**	**B.Sc. Yr N**	**4**	**5**	**M.Sc. yr N**	**Total**
2009/2010	32	22	**19**	47	35	29	107	291
2008/2009	20	**20**	28	24	58	28	112	290
2007/2008	**21**	33	**23**	23	70	19	114	303
2006/2007	33	**28**	48	6	76	56	98	345
2005/2006	**35**	50	57	3	69	50	76	340

Graduates

The table below shows how many Bachelors/Masters of Science have graduated from the Department of Electrical Engineering between 2005 and 2009.

Table 11. Graduates, Electrical Engineering

Graduates, Broken Down by Degree Programme					
Programme type:	**2009**	**2008**	**2007**	**2006**	**2005**
Bachelor	14	14	1	1	-
Master	54	58	55	38	32
Total:	68	72	56	39	32

Staff-student ratio

The table below presents the teaching staff ratios for the degrees organised by the Institute of Energy Technology (LUT Energy), which hosts the Department of Electrical Engineering. The teaching staff comprises professors, associate professors, post-doctoral researchers and doctoral students.

Table 12. Students per teacher per year

Year	**2009**	**2008**	**2007**	**2006**	**2005**
Student-staff ratio*	5.3	5.4	5.3	5.1**	5.8**

* The student-staff ratio is given for LUT Energy

** In 2005 and 2006, the staff of the Dept. of Technomathematics and Technical Physics was included in the staff of the Dept. of Electrical Engineering, whereas they are not counted in the figures for years 2007–2009.

6 Quality Assurance Measures

The University's quality management system covers the entire range of education provided by the university (undergraduate education, postgraduate education, continuing education and Open University education), research, societal and regional interaction and support services. The quality management system is described in the main quality manual and the subordinate quality manuals of faculties and other organisational units. The quality manuals include process descriptions and procedures for key processes. The university's quality management documents and other related material are available on the University intranet.

The University's main quality manual gives both internal and external stakeholders a comprehensive picture of the quality management of the university's different activities. The University has also published LUT Teachers´ Quality Manual to promote good teaching practices (Enclosure 8).

Quality manual for the Faculty of Technology

Quality goals of education given in the Faculty of Technology are the same as those given in the University's quality manual. These goals are:

- The education provided by Lappeenranta University is competitive and of a high standard, and yields results.
- There are versatile study opportunities.

- Students at the university obtain high-level academic know-how, including: how to utilise and apply their skills in both further studies and the world of work, how to forecast the changing needs of the labour market and react to them appropriately and how to operate in an international environment.
- The university's students and employers of LUT graduates are satisfied with the contents and implementation of the studies. The teaching staff is satisfied with the conditions provided by the University for teaching.

Education in the Faculty of Technology includes also the following principles:

- Education is based on the basic principles of natural sciences.
- Education meets the needs of industry.

6.1 Evaluation during the degree programmes

During their studies students can give feedback concerning the studies and conditions in the University on several occasions. At the beginning of the studies students are asked about the success of tutoring. The survey is carried out annually by the Student Affairs Office. The feedback is discussed with the peer tutors and personnel in charge of tutoring. The feedback is used to develop tutoring practices and training.

The Student Union surveys the state of well-being of students every other year. The results of the questionnaire are communicated to the university personnel.

All students prepare an individual study plan at the start of their studies. The study plans are evaluated and confirmed in accordance with faculty or department procedures. In the Degree Programme in Electrical Engineering, the head of the Degree Programme accepts the study plans.

The progress of studies and the accumulation of credits are monitored by the Student Affairs Office. The results are reported to the degree programmes, and the follow-up reports are available on the University intranet. The accumulation of credits is also examined annually to confirm students' eligibility for student financial aid from the Social Insurance Institution of Finland. Statistics on ECTS credits accumulated are compiled annually for each faculty, and the number of completed credits is one of the grounds for resource allocation to departments.

Student feedback of study courses is collected with an electronic web-based questionnaire according to a university-wide procedure. Teachers are responsible for collecting the student feedback, with the help of feedback system administrators. All course evaluations include questions on the expediency of the course, general impression of the course and open feedback. Additional questions are also possible.

6.2 Evaluation of the success of the degree programmes

Success of the degree programmes provided by Lappeenranta University of Technology is evaluated by assessing the competence of the graduates, quantitative results of the degree programmes, and the satisfaction in the education.

Competence of graduates
Skills and knowledge accumulated by students during the entire education process are demonstrated in a final thesis, which is prepared by all Bachelor's and Master's level students. Skills in the student's native language are demonstrated in a maturity test at the end of Bachelor´s degree studies.
Quantitative results of a degree programme
Information on the number of graduates, the times of degree completion, and the employment of the graduates are collected by LUT Student Services and compiled into annual statistics. The cost-efficiency of the education is also evaluated annually when the final accounts are drawn up.

The student mobility is monitored yearly by International Services. Student exchange statistics are compiled on the University intranet and published in the university's final accounts documents.

Satisfaction in the education
Satisfaction in the education obtained in the University among the graduates is surveyed at the time of graduation and five years after graduation. The feedback is broken down into individual degree programmes. Quality manager is responsible for this process together with Student Services. Career information and satisfaction with the education

is collected five years after graduation from the graduates with a Master's degree. The survey is conducted by LUT Career Services as a part of a national career follow-up.

Career information is collected five years after graduation from the graduates with a Master's degree. The survey is conducted by LUT Career Services as a part of a national career follow-up.

Satisfaction in the outcome of thesis projects and in the skills of the students is surveyed with a questionnaire is sent to the employers/supervisors of the graduates. The results are reported annually by the quality manager.

International and Career Services Unit collects feedback on student and support services from incoming exchange students at the end of their stay. LUT students leaving for student exchange write a report upon their return. The reports are published on the university web site. These follow-up practices are described in further detail in the Quality Manual of International and Career Services.

6.3 Further development of the degree programmes

The University is actively involved in a number of different national and international development projects for teaching. The Vice Rector in charge of education decides on development projects which LUT engages in and starts to promote. The Department of Electrical Engineering has been active, for instance, in the Virtual University project in which the Laboratory developed a web-based Basic Electronics course. The Department also participated in a project that focused on promoting the completion of Master's degree in five years (see footnote 3, section 3.2.1). The pilot project of the Department was to develop the supervision of individual study plans. Staff of the Department has also been active in developing the quality management system of education and feedback systems, and in writing the LUT Teacher's Quality Manual.

The University grants quality bonuses for the development of education for one year at a time. The quality bonus is a reward for development measures taken and an incentive for the further development of education and teaching. The steering and development group for education makes the preparations for the application procedure and the decision to grant a quality bonus, and the Rector decides the recipients of the bonus.

The pay system of the University provides an incentive for teachers to develop their teaching and pedagogical skills. The job classification of the teaching staff is based on scientific qualifications and their development, the development of teaching skills and the variety of teaching duties, and responsibility for one's field of science and its development.

The support services for education provide administrative services and technological support in using educational technology for teachers. The responsibility for these support services is shared by Student Services and Information Services and Technology, which operate within the context of University Services, and by faculty support services.

For teaching positions, the university recruits professionals with not only strong scientific expertise in the field in question, but with pedagogical skills as well. Applicants for teaching positions must submit a teaching portfolio or another report on their teaching qualifications. Instructions for compiling a teaching portfolio are available on the University intranet. In addition, the appointment of professors requires a trial lecture from the applicant. The faculty in question supplies the applicant with instructions regarding the trial lecture. Instructions are also available from the university registrar's office.

ENCLOSURES

1. Evidence of adequate teaching capacity (not included in this publication)
2. Staff Handbook (not included in this publication)
3. Module Handbook
4. Objectives Matrix Models, Model Curricular Analysis
5. University Regulations on Education and the Completion of Studies (not included in this publication)
6. Universities Act 558/2009, Government Decree on University Degrees 794/2004 (not included in this publication)
7. LUT Strategy 2013 (not included in this publication)
8. LUT Teacher's Quality Manual (not included in this publication)

9. LUT Quality Manual (not included in this publication)
10. Student Feedback Form (not included in this publication)
11. Audit of the Finnish Higher Education Evaluation Council, Abstract 2009, Audit Certificate HEEC (not included in this publication)
12. International evaluation by the Academy on Finland 2006 (not included in this publication)
13. Diploma Supplements (not included in this publication)