



Open your mind. LUT.
Lappeenranta University of Technology

STUDY GUIDE FOR DOCTORAL STUDIES

FACULTY OF TECHNOLOGY 2010–2012

Faculty of Technology
1 September 2011

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I General Information on Postgraduate Degrees at LUT

The instructions given in this study guide are based on the University Regulations on Education and the Completion of Studies (approved by the rector on 21 June 2011, references to sections in parenthesis) and on the Finnish version of the Study Guide for Doctoral Studies at the Faculty of Technology 2010-2012.

Lappeenranta University of Technology (LUT) is an international scientific community with more than 6500 students and experts. The university conducts scientific research and academic education and offers good possibilities for completing the postgraduate degrees of Licentiate of Science (Technology), Doctor of Science (Technology) and Doctor of Philosophy. This guide mainly deals with the completion of postgraduate degrees in technology, but may also be applied to the degree of Doctor of Philosophy.

All doctoral programmes at LUT are part of LUT Graduate School of Lappeenranta University of Technology. The doctoral programmes can be offered by LUT or they can be organised together with other universities nationally or internationally. Each attending doctoral student is a belongs to LUT Graduate School.

Doctoral studies at LUT are fixed-term (3.5 years/doctoral student) and are the first stage of the four-stage tenure track for researchers. The aim is to admit skilled, motivated students who have the aptitude for a career in research and other demanding expert tasks, who are committed to their postgraduate studies and research and who have sufficient skills in research.

The Centre of Computational Engineering and Integrated Design ([CEID](#)) operates under the Faculty of Technology. CEID works in the field of scientific computing and the modelling of industrial processes, which is one of LUT's three strategic areas of expertise. The head of CEID is Professor Jari Hämäläinen.

CEID develops and coordinates the use of computational methods in research and education, takes part in research programmes of the Academy of Finland and TEKES, and supervises joint research projects of laboratories. CEID coordinates the development of software and computer resources needed in computational engineering and integrated design, and organises postgraduate education and scientific seminars.

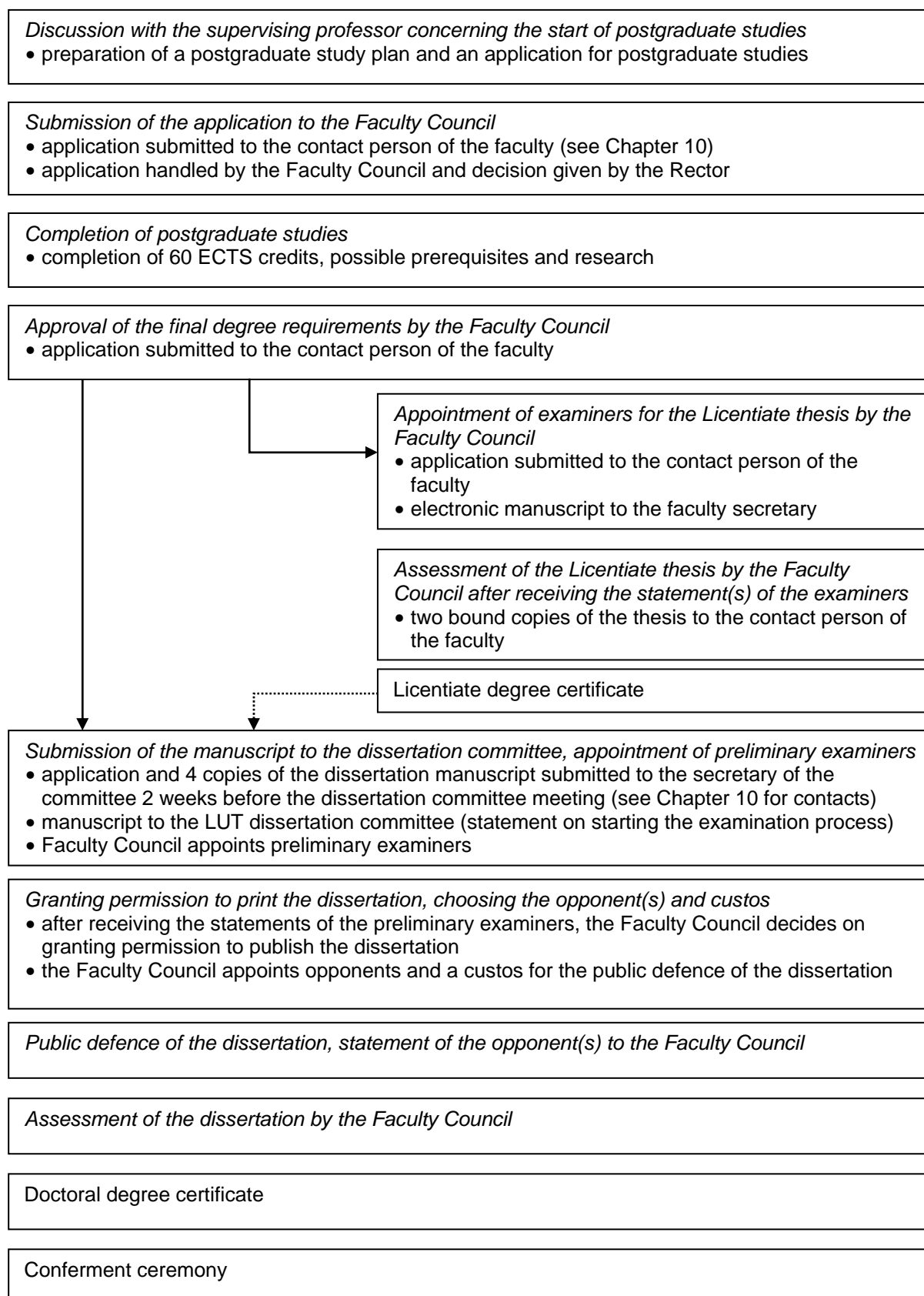
1. Eligibility to Complete Scientific Postgraduate Studies

The criteria for accepting an applicant into LUT:

- The applicant has completed a higher university or comparable degree in engineering, which the Faculty Council deems as providing a sufficient basis for further studies. The applicant is required to have completed advanced studies in the research field or otherwise obtained the required information.
- If the applicant has not completed the required Master's-level (advanced) courses, the Faculty Council decides on possible prerequisites for each case individually (section 45). This also applies to **applicants who have already obtained a doctoral or licentiate degree from another field of study**. In addition, the applicant must complete a sufficient amount of studies in his/her field of research (major subject).
- **An applicant who has completed a licentiate degree in the same field** is required only to complete a doctoral dissertation that is to be published in the field of research in question.
- An applicant with a higher university degree obtained abroad is required to submit information in English (e.g. a Diploma Supplement) on the extent and the level of the

degree(s) obtained when applying to LUT. The extent of the foreign degree(s) has to be equivalent to the Finnish Bachelor's and Master's degrees.

2. Course of Postgraduate Studies



3. Extent and Contents of Postgraduate Studies

The extent of scientific postgraduate studies in the field of technology is as follows:

Studies in the field of research (major subject)	35–40 ECTS cr
Studies supporting the field of research	20–25 ECTS cr
Total	60 ECTS cr

The doctoral degrees require approximately four years of full-time studies. The licentiate degree usually requires two years of full-time studies.

The postgraduate student completes his studies in the form of graduate school courses or other postgraduate courses, courses offered by LUT or some other university or by taking examinations on scientific literature in the field.

In the Faculty of Technology the examiner of the studies supporting the field of research is always someone other than the professor/docent of the student's field of research (major subject).

LUT recommends the course *LUTJ0000 Science, Research and the Researcher (5 ECTS cr)* to all doctoral students. *FV11A9350 English Clinic for Researchers and PhD Students (5 ECTS cr)* is an obligatory course for the doctoral students of Faculty of Technology. In addition, the faculty recommends the course *BM20A3401 Design of Experiments (4 ECTS cr)* to its students. All the above mentioned courses are intended to be included in the studies supporting the field of research.

The university-level courses which the postgraduate student has completed before starting his postgraduate studies can be accepted as part of the postgraduate studies on condition that courses in question have not been included in the previous degree (section 51). See also Chapter 6.

4. Supervisor and Major Subject

An applicant wishing to start postgraduate studies at LUT should first discuss the studies and their prerequisites with one of the professors or docents of the intended major subject.

The supervisor can be a tenured professor at LUT, a docent at LUT or an acting professor at LUT who holds a doctorate. If the supervisor changes, the choice of a new supervisor has to be approved by the Faculty Council. The supervisor is responsible for the degree requirements of the postgraduate studies.

The field of research (major subject) can be chosen from the table below.

ENERGY AND ENVIRONMENTAL TECHNOLOGY		
4650	Bioenergy Technology	Professor Tapio Ranta
4655	Sustainable Energy Systems	Professor Timo Hyppänen Professor Esa Vakkilainen
4666	Heat Transfer and Fluid Dynamics	Professor Jari Backman Professor Timo Hyppänen Professor Jaakko Larjola Docent Payman Jalali Docent Teemu Turunen-Saaresti

4670	Nuclear Engineering	Professor Riitta Kyrki-Rajamäki
4680	Environmental Technology	Professor Mika Horttanainen Professor Mika Sillanpää Professor Risto Soukka
4685	Environmental Management	Professor Lassi Linnanen

CHEMICAL TECHNOLOGY

5530	Organic Chemistry	Professor Mika Mänttari Professor Heli Sirén
5531	Inorganic Chemistry	Professor Heli Sirén
5533	Physical Chemistry	Docent Jaakko Partanen
5672	Paper Technology	Professor Kaj Backfolk
5673	Paper Chemistry	Professor Kaj Backfolk
5715	Industrial Chemistry	Professor Erkki Paatero Docent Tuomo Sainio
5730	Unit Operations of Chemical Engineering	Professor Antti Häkkinen Professor Marjatta Louhi-Kultanen
5760	Technical Polymer Chemistry	Professor Mika Mänttari Docent Arto Pihlajamäki
5766	Membrane Technology	Professor Mika Mänttari Docent Arto Pihlajamäki
5770	Environmental Engineering Unit Operations	Professor Marjatta Louhi-Kultanen
5772	Modelling in Environmental Technology	Professor Andrzej Kraslawski
5774	Modelling in Environmental Protection	Professor Andrzej Kraslawski
5796	Process Analytical Technology	Professor Marjatta Louhi-Kultanen Professor Heli Sirén Docent Satu-Pia Reinikainen
5797	Process Systems Engineering	Professor Andrzej Kraslawski
5799	Process and Product Development	Professor Ilkka Turunen

MECHANICAL ENGINEERING

2652	Production Engineering	Professor Henry Lindell Professor Juha Varis
2659	Metals Technology	Professor Jukka Martikainen
2663	Machine Design	Professor Aki Mikkola
2665	Engineering Mechanics	Professor Timo Björk
2667	Steel Structures	Professor Timo Björk
2669	Material Technology	Professor David Cameron Professor Jukka Martikainen
2759	Welding Technology	Professor Jukka Martikainen
2761	Mechatronics	Professor Heikki Handroos
2768	Mechanical Wood Processing	Professor Timo Kärki
2775	Laser Processing	Professor Veli Kujanpää Professor Antti Salminen

MATHEMATICS AND PHYSICS

1637	Applied Mathematics	Professor Matti Alatalo Professor Heikki Haario Professor Matti Heiliö Professor Jari Hämäläinen *) Docent Tuomo Kauranne Docent Katariina Pussi
8825	Technical Physics	Professor Erkki Lähderanta Professor Tuure Tuuva

Docent Erik Vartiainen		
ELECTRICAL ENGINEERING		
8810	Electronics	Professor Jero Ahola Professor Pertti Silventoinen
8835	Electricity Market	Professor Jarmo Partanen Professor Satu Viljainen
8840	Electric Motors and Drives	Professor Juha Pyrhönen
8850	Control Engineering	Professor Olli Pyrhönen
8860	Embedded Control Systems	Professor Jero Ahola Professor Olli Pyrhönen

*) May also be a supervisor in other major subjects, depending on the application field of the dissertation (CEID)

The field of research (major subject) for the degree of Doctor of Philosophy can be chosen from a field for which there is a professorship at LUT and which is offered by the Faculty of Technology.

5. Application Procedure

- The applicant submits an application form for postgraduate studies to the contact person of the faculty. Application forms in English can be requested from the contact person (see Chapter 10).
- There are no specified application periods. Applications are processed in Faculty Council meetings monthly.
- A study plan for postgraduate studies, certified copies of B.Sc. and M.Sc. degree certificates and authorised certified translations into English are required as attachments.

The applicant prepares the preliminary postgraduate study plan together with the supervisor. The implementation of the plan is monitored by the supervisor (section 50).

The preliminary study plan consists of:

1. **studies to be included in the degree**
 - the areas of study, e.g. crystallization, fatigue of metal structures
 - the basis of evaluation (an exam, a literature review, etc.)
 - the extent of each area of study in ECTS credits
 - a preliminary timetable for the completion of each area of study
2. **a brief outline of the research**, which
 - can be written in Finnish or English
 - includes a timetable for the completion of each task
 - should not be longer than one A4 sheet of paper
3. **a plan for internationalization**
 - preliminary schedule for an international stay
 - possible host university/institution
4. **a plan for publication**
 - preliminary schedule for publishing
 - possible subject areas
5. **a plan for financing**

[Please see an example of the preliminary study plan](#)

[Please see an example of the research plan \(background, objective, tasks\)](#)

The Faculty Council confirms the major subject, possible prerequisites, the preliminary postgraduate study plan and appoints the supervisor. The Faculty Council recommends the approval or the refusal of the application to the Rector.

The Rector makes the decision on granting the study right after receiving the recommendation from the Faculty Council.

In addition to the educational background of the applicant, also the availability of supervision and/or financial resources and the suitability of the expertise of supervisors available have an impact on the selection of postgraduate students.

6. Presenting Final Degree Requirements

The final degree requirements are to be approved by the Faculty Council before the manuscript of the dissertation is submitted for preliminary examination (section 50). The student prepares the final degree requirements together with the supervisor.

[Please see the form available for presenting the final degree requirements.](#)

6.1. General Instructions

When presenting the final degree requirements, the student has to specify **the basis of evaluation (oral/written exam, literature review, etc.), the place of completion, the examiner and the extent of each study attainment.** The extent of the study attainment is given in ECTS credits (only whole numbers).

The proposal for the final degree requirements has to be signed by the supervisor.

6.2. Postgraduate Courses

- **Studies included in the major subject must be postgraduate-level studies (section 51)**, e.g. courses offered by graduate schools or postgraduate courses offered by universities.
- Only exceptionally, and on the recommendation of the supervisor, can courses other than the ones specifically aimed at postgraduate students be accepted as a part of major studies.

6.3. Literature

One type of study attainment is to take examinations on scientific literature on the research area. In addition to specifying the examiner and the extent of the study attainment, the student also has to give details on the author, the title, the publication year, the number of pages studied from each book and on how the contents was examined.

Some departments have compiled recommendations on commonly used literature suitable for postgraduate studies. These recommendations help in defining the extent of such study attainments in ECTS credits.

The number of pages can also be of help in defining the extent:
40–70 pages = 1 ECTS cr

6.4. Master-level Courses

Master-level courses not included in the previous degree can be included **only in studies supporting the field of research**. The extent of such courses cannot exceed 15 ECTS credits.

University pedagogy studies offered by LUT (25 ECTS credits) may be included in supporting studies as a module of 8 ECTS credits.

6.5. Other Scientific Study Attainments

Other scientific study attainments can include e.g. conferences or seminars.

Conferences

A maximum of 8 ECTS credits may be included in the postgraduate degree, provided that the conference had a review board and the student gave a presentation. The study attainment may not be included in an article-based dissertation.

Seminars

Seminars that the organiser (university, graduate school) offers to its postgraduate students are commonly accepted in the ECTS credit extent defined by the organiser.

7. Examiners and Evaluation of Licentiate Theses

The Faculty Council appoints two examiners for a Licentiate thesis. One may be the supervisor of the thesis, but the other shall be a person outside LUT. The examiners are to give a written statement on the thesis to the Faculty Council within four weeks. The examiners may also submit one joint statement instead of two. The Faculty Council will evaluate the thesis.

8. Examiners and Evaluation of Dissertations

The dissertation committee gives a statement on the dissertation manuscript before the Faculty Council initiates the actual examination process, that is, appoints the preliminary examiners.

Next, the supervisor puts forward a proposal to the Faculty Council on the preliminary examiners for the dissertation. The preliminary examiners may not be involved in the supervision or research related to the dissertation.

Based on statements from the preliminary examiners, the Faculty Council decides on granting permission to publish the dissertation, and appoints one or two examiners for the dissertation based on the supervisor's proposal. The supervisor of postgraduate studies is the custos of the public examination. Based on the statement from the opponent(s), the Faculty Council decides on the approval and grading of the dissertation.

9. Grades (Section 58) and Degree Certificates (Section 21)

- All postgraduate study attainments are assessed as *approved*, *approved with distinction* or *failed*.

- A scale of 1 to 5 can only be used for courses that are part of the Master's degree curriculum.
- All completed study attainments entered into the student's records must be graded.
- If a course is assessed according to a scale of 1 to 5, the grades 4 and 5 are equivalent to *passed with honours* and the grades 1 to 3 *passed*.
- If a course taken outside LUT is assessed on a scale different from the above, the assessment has to be made again by the supervisor using the LUT scale.
- The grade *passed with honours* can be awarded for the major subject when over half of the studies in that subject, in terms of courses weighted according to the credits they are worth, have been completed with the grade of *passed with honours*.
- The supervisor makes the final decision on the overall grade for the major subject.

The Licentiate / Doctoral Degree Certificate states

- the degree awarded and the faculty
- the major subject and the overall grade (not the grades of individual study attainments)
- the title and grade of the licentiate thesis / doctoral dissertation.

In addition, the doctoral degree certificate includes information on the public examination of the dissertation, the opponent and the custos.

10. Services for Postgraduate Students

Applications for postgraduate studies, degree requirements, and the choice of examiners and the assessment of the licentiate thesis:

- preparation: faculty study affairs services
- processing: Faculty Council

Contact:

Ms Sari Damstén
 Head of Study Affairs
 Office 6303 (Faculty Office)
 tel. 0400 176 701
 sari.damsten(at)lut.fi

Presenting the manuscript to the dissertation committee, appointment of preliminary examiners of a dissertation, permission to print, appointing the opponent/opponents, approval and grading of a dissertation, degree certificates:

- preparation: Research and Innovation Services
- processing: Dissertation Committee, Faculty Council

Contacts:

- Ms Eeva Häyrinen
 Student Affairs Secretary (secretary of the dissertation committee, also issues connected to student register)
 Office 1535 (Research and Innovation Services)
 tel. + 358 5 621 6057
 eeva.hayrinen(at)lut.fi
- *Presenting matters related to dissertations to the Faculty Council*
 Ms Sari Damstén
 Head of Study Affairs
 Office 6303 (Faculty Office)
 tel. 0400 176 701
 sari.damsten(at)lut.fi

11. Instructions of LUT

More information concerning postgraduate studies is given on the web pages of LUT at <http://www.lut.fi/en/lut/studies/postgraduate>. The site includes e.g. the dates of dissertation committee meetings, recommendations of the committee for dissertations, and instructions on publication.

11.1. Dissertation Process and Instructions

- the different stages of the examination process
- the role of the Dissertation Committee
- appointing the preliminary examiners and the opponent(s)
- instructions for the preliminary examiners and the opponent(s)
- public examination of a doctoral dissertation at LUT

Please see <http://www.lut.fi/en/lut/studies/postgraduate/instructions>

II Graduate School of LUT and the Doctoral Programmes of the Faculty

1. **Doctoral Programme of Chemical Engineering** (director: prof. Marjatta Louhi-Kultanen)
 - **Graduate School in Chemical Engineering (GSCE)**
<http://www.abo.fi/gsce/>
 Contact: Professor Marjatta Louhi-Kultanen (LUT Chemistry), tel. + 358 40 701 8078
 - **International Doctoral Programme in Bioproducts Technology (PaPSaT)**
<http://www.tkk.fi/Units/Papsat/index.html>
 Contacts: Professor Isko Kajanto (LUT Chemistry), tel. +358 40 507 3314 or Programme Coordinator Heli Järvelä (Aalto University School of Science and Technology), tel. + 358 50 344 0942
 - **National Graduate School in Informational and Structural Biology (ISB)**
<http://web.abo.fi/isb>
 Contact: Professor Heli Sirén (LUT Chemistry), tel. +358 40 357 7794

2. **Doctoral Programme of Computational Fluid Dynamics** (director: prof. Timo Hyppänen)
 - **The Finnish Graduate School in Computational Fluid Dynamics (CFD)**
www.lut.fi/gscfd (in Finnish)
 Contact: Senior Researcher Teemu Turunen-Saaresti (LUT Energy), tel. +358 50 539 5733

3. **Doctoral Programme of Electrical Energy Engineering** (director: prof. Juha Pyrhönen)
 - **The Graduate School in Electrical Energy Engineering**
http://www.lut.fi/en/technology/lutenergy/electrical_engineering/research/graduateschool
 Contact: Senior Researcher Pia Lindh (LUT Energy), tel. +358 400 152 420

4. **Doctoral Programme of Energy Technology** (director: prof. Esa Vakkilainen)
 - **Graduate School for Energy Science and Technology (EST)**
http://energia.tkk.fi/en/est_home/
 Contact: Professor Esa Vakkilainen (LUT Energy), tel. +358 40 357 8684

5. **Doctoral Programme of Mathematics and Physics** (director: prof. Heikki Haario)
 - **Graduate School of Inverse Problems**
<http://www.mathstat.helsinki.fi/research/inverseproblems/gradschool/> (in Finnish)
 Contact: Professor Heikki Haario (LUT Mathematics and Physics), tel. +358 400 814 092

- **Finnish Doctoral Programme in Computational Sciences (FICS)**

fics.hiit.fi/

Contact: Professor Heikki Haario (LUT Mathematics and Physics), tel. +358 400 814 092

- **National Graduate School in Materials Physics (NGSMP)**

tfy.tkk.fi/gradschool

Contact: Professor Erkki Lähderanta (LUT Mathematics and Physics), tel. +358 5 621 6800

6. Doctoral Programme of Mechanical Engineering (director: prof. Aki Mikkola)

- **National Graduate School in Engineering Mechanics**

<http://www.tkk.fi/Units/Materialmechanics/>

Contact: Professor Timo Björk (LUT Metal Technology), tel. +358 400 553 508

- **The Graduate School of the Processing of Polymers and Polymer-based Multimaterials**

http://www.tut.fi/plastics/graduate_school

Contact: Professor Juha Varis (LUT Metal Technology), tel. + 358 40 501 7478

- **Graduate School CE Tampere**

<http://webhotel2.tut.fi/gsceTampere/index.htm>

Contact: Professor Heikki Handroos (Laboratory of Intelligent Machines), tel. +358 40 510 7599, heikki.handroos(at)lut.fi

III Postgraduate Courses / Faculty of Technology

Courses with a rotating scientific content may be included in the degree more than once.

FV11A9350 English Clinic for Researchers and PhD Students (5 ECTS cr) is an obligatory course for the doctoral students of Faculty of Technology.

FV11A9350	ENGLISH CLINIC FOR RESEARCHERS AND PHD STUDENTS	5 ECTS cr
Year and Period	Period 3-4	
Teacher(s)	N.N.	
Aims	The aim of the course is to assist doctoral students and junior researchers with the writing and preparation of a paper for publication in a journal or at a conference. On successful completion of the course, students will have an improved understanding of the language of the genre of academic writing – structure, style, unity, cohesion etc, the skills to approach the writing of academic articles effectively, and a draft version of a short paper ready for submission to a journal or conference.	
Content	The course will address issues such as the publishing process, approaches to writing, structure and language, common problems for non-native speakers of English, and drafting, revision and review.	
Modes of Study	Language of instruction: English. 48 contact hours in the form of seminars, small group work and individual study, plus the time required to produce a paper ready for submission. The course is made up of at least 125 hours of work.	
Evaluation	Pass / Fail	
Study materials	Provided by the teacher.	
Prerequisites	A research area and research question.	
Further Information	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

LUTJ0000 Science, Research and the Researcher (5 ECTS cr) is recommended to all doctoral students of LUT.

LUTJ0000	SCIENCE, RESEARCH AND THE RESEARCHER	5 ECTS cr
	The course can be included in the studies supporting the field of research. Registration for the course through WebOodi, max. 35 students.	
Year and Period	1 st period.	
Teacher(s)	Professor Karl-Erik Michelsen	
Aims	The course aims to give doctoral students a profound understanding of science as a social and cultural phenomenon. In addition, we study the structures and objectives of scientific knowledge. What is scientific and technological research, and how societies utilize scientific knowledge. The goal of the course is to strengthen the professional identity of doctoral students and give a clear picture of why dissertations are prepared, and what is the role of dissertation and doctoral student in the scientific community.	
Content	The course consists of three parts, the first of which deals with the nature and construction of science and scientific knowledge and the science as a social system. The second part examines the practices of conducting research, the creation and change mechanisms of scientific and technological knowledge, and research ethics. The third part examines the position of science and technology in society, different modes of research, and national and international science and technology policies.	
Modes of Study	Lectures 18 h. Successful completion requires attendance in lectures, discussions based on lecture literature, and two completed assignments: an interim report, which is a scientific argumentation on a topic chosen by the student, and a final report, which is a scientific critique examining topical questions related to science and research policies.	
Study materials	Course literature available in electronic form and announced in connection with the course schedule on the web site of School of Business.	

Energy and Environmental Technology

BH10AJ100	ENERGIATEKNIIKAN JATKO-OPINTOJAKSO	2 - 10 op
	Postgraduate Course in Energy Technology	
	Järjestetään tarvittaessa.	
Opettaja(t)	professori, TkT Jari Backman dosentti, TkT Payman Jalali professori, TkT Timo Hyppänen professori, TkT Riitta Kyrki-Rajamäki professori, TkT Jaakko Larjola professori, TkT Risto Tarjanne professori, TkT Esa Vakkilainen	
Tavoitteet	Opiskelija perehtyy jatkotutkintoonsa liittyvin energiatekniikan erikoiskysymyksiin.	
Sisältö	Vaihtuvat energiatekniikkaan liittyvät aiheet. Opintojakso voi sisältyä jatkotutkintoon useamman kerran.	
Suoritustavat	Sovitaan tarpeen mukaan (seminariesitelmä, harjoitustyö ja/tai tentti tai kirjatentti).	
BH20AJ100	NUMERICAL MODELING AND DATA ANALYSIS	10 ECTS cr
	METHODS IN HEAT AND FLUID FLOW ENGINEERING: MACROSCALE AND NANOSCALE	
	Numeerinen mallinnus ja data-analyysimenetelmät lämpö- ja virtaustekniikassa - makro- ja nanoskaala	
	Periods 1-2, or 3-4 for participants present in LUT if the number of participants is at least 5.	
Year and Period	Period 1-2/3-4	
Teacher(s)	Docent, D.Sc. (Tech.) Payman Jalali	
Aims	This course is organized to teach different types of numerical methods used in heat and fluid flow problems existing in mechanical and chemical engineering for systems through macroscale to nanoscale. Moreover, specific practical applications are introduced for which certain numerical simulation and postprocessing methods are employed.	
Content	Basic equations in fluid and heat flow and various methods of numerical simulation; Boundary element method in potential problems; Introduction to dynamical system approach for the modeling of turbulence; Semi-deterministic methods of turbulence modeling; Wavelets: the mathematical functions as filters in turbulence modeling; Introduction to molecular dynamics (MD) simulations; Introduction to Monte Carlo (MC) simulations; Basic knowledge of statistics for the analysis of fluctuations and time series; Wavelets and their applications in signal processing and function approximation; Overall view of heterogeneous media; Microstructural characterization of multiphase materials; Transport phenomena within multiphase materials; Granular materials and particulate systems; numerical modeling in biological systems.	
Modes of Study	14 h lectures + 14 h practices, homework, project on 3rd period. 14 h lectures + 14 h practices, homework, seminar on 4th period. Material available from the Internet or sent to participants by email, distant participation is possible individually.	
BH20AJ105	INTRODUCTION TO TECHNICAL AND SCIENTIFIC WRITING	2 - 4 ECTS cr
	Johdatus teknilliseen ja tieteelliseen kirjoittamiseen	
	Arranged any time if the number of participants is at least 5.	
Year and Period	Period Int.	
Teacher(s)	Docent, D.Sc. (Tech.) Payman Jalali	
Aims	The main purpose of this course is to help postgraduate students and researchers to improve their skills for writing scientific articles, reports, proposals as well as presentations for research. Basic tools and databases for scientific research and writing are introduced.	
Content	The importance of technical and scientific writing. How scientific publications are graded? Searching databases of scientific sources. Primary steps for writing different parts of an article: Abstract, Introduction, Methods & Formulation, Results & Discussions, Conclusions,	

Modes of Study	References, Figures & Tables. How to write scientific and technical reports, theses and proposals? Introduction to generating high-quality figures and demonstrations. Judgement and criticizing articles, how to rebuttal? Intensive course. Lectures 10 h, writing of scientific article as a project work, acting as a referee of an article, seminar presentations of project works.
BH20AJ110	THEORY AND MODELING OF MULTIPHASE FLOWS 10 ECTS cr
Year and Period	Monifaasivirtausten teoria ja mallinnus
Teacher(s)	Periods 1-2, or 3-4 for participants present in LUT if the number of participants is at least 5.
Aims	Period 1-2/3-4 Docent, D.Sc. (Tech.) Payman Jalali
Content	The course gives a basic knowledge about formulation of conservation equations for multiphase flows with examples of different multiphase flows found in energy engineering. The course presents mathematical models, simplifying assumptions and simulation models used for solving multiphase flow problems. The course starts with an introduction to basic vector and tensor algebra and different notations commonly used in continuum mechanics. Fundamentals of continuum mechanics: Vectors in a cartesian coordinate system - Tensor algebra - Summation convention and tensor notations. Problems in continuum mechanics: Navier-Stokes equations for 1-phase fluid flows - Basic principles and definitions in two-phase flows - Conservation equations in two-phase flows. Flow models in Two-Phase Flows: Homogeneous model, Separated two-phase flow model. Mathematical Formulation of the 'Mixture Model' for Multiphase Flows: Balance equations for the mixture and continuity equation for a phase - Drag force and force balance equation - Model applications.
Modes of Study	Suspensions of solids in fluids: Fluidized beds and fluidization phenomenon - Mathematical modeling of fluidized and packed beds - Computer simulation methods in gas-solid systems. 14 h lectures + 14 h practices, homework, project on 1st period. 14 h lectures + 14 h practices, homework, seminar on 2nd period. Material available from the Internet or sent to participants by email, distant participation is possible individually.
BH20AJ115	SUMMER SCHOOL IN HEAT AND MASS TRANSFER 3 - 5 ECTS cr
Year and Period	Lämmönsiirron kesäkoulu
Teacher(s)	Period Int. Professor, D.Sc. (Tech.) Timo Hyppänen
Aims	The objective of the Summer School is to gather researchers and students from universities, research centers and industry to study and discuss topical issues on heat and species transfer in energy and process industry. The main topic of the course will change annually.
Content	Lectures by invited lecturers from different universities, research centers and industry. Seminar presentations given by participating postgraduate students and specialists from industry.
Modes of Study	Intensive course. 16 h lectures and seminar presentations, web exam based on seminar material. Listening lectures and seminar material, web exam, 3 ECTS, additional 2 ECTS credits for those who will give presentation in the summer school.
BH20AJ120	THEORY AND SIMULATION OF DISPERSED-PHASE MULTIPHASE FLOWS 10 ECTS cr
Year and Period	Dispergoituneen faasin monifaasivirtaukset - teoria ja simulointi
Teacher(s)	Periods 1-2, or 3-4 for participants present in LUT if the number of participants is at least 5.
Aims	Period 1-2/3-4 Docent, D.Sc. (Tech.) Payman Jalali
Content	The course is in continuation of the course BH20AJ110 with more specific insights into the theories and simulation methods of multiphase flows. Since dispersed-phase flows are the most common type of flow found in energy and environmental technologies as well as chemical technology, this course teaches postgraduate students in these fields to understand the theoretical concepts and the methods of simulations of dispersed-phase flows.

Content	Introduction (Industrial applications and theoretical study), Basic properties of dispersed phase flows, size distribution definitions, Particle-fluid interaction model, Particle-particle interaction model, Continuous phase equations. Droplet-particle cloud equations, Numerical modeling: 1. Dilute flows (Lagrangian models), 2. Dilute flow (two-fluid model), 3. Dense flows (Lagrangian approach), 4. Dense flows (Eulerian approach), Molecular Dynamics (MD) simulation techniques, 1. Event-driven algorithms, 2. Soft-sphere or Discrete Element Method (DEM).
Modes of Study	14 h lectures + 14 h practices, homework, project on 1st period. 14 h lectures + 14 h practices, homework, seminar on 2nd period. Material available from the Internet or sent to participants by email, distant participation is possible individually.

BH30AJ101	YDINVOIMATEKNIIKAN JATKO-OPINTOKURSSI	3 - 8 op
	Postgraduate Course in Nuclear Engineering	
	Luennoidaan tarvittaessa, seuraavan kerran lukuvuonna 2010–2011.	
Ajankohta	periodi 1	
Opettaja(t)	professori, TKT Riitta Kyrki-Rajamäki tuntiopettaja, N. N.	
Tavoitteet	Opintojakso perehdyttää opiskelijan tiettyyn ydinvoimatekniikan erikoisalueeseen.	
Sisältö	Opintojakso järjestetään vaihtuvista ydintekniikkaan liittyvistä aiheista. Voidaan suorittaa useamman kuin yhden kerran.	
Suoritustavat	Luentoja ja/tai seminaari. Seminaaritutkielman kirjoittaminen ja esittäminen ja/tai seminaarikokonaisuuden tenttiminen. Kirjatentit.	
Oppimateriaalit	Ilmoitetaan osallistujille yksilöllisesti.	

BH30AJ105	YDINTURVALLISUUSKURSSI	9 op
	Basic Professional Training Course on Nuclear Safety	
	Järjestetään vuosittain.	
Opettaja(t)	professori, TKT Riitta Kyrki-Rajamäki tuntiopettaja, N. N.	
Tavoitteet	Muodostaa kokonaiskuva ydinvoimalaitosten turvallisuuden perusteista ja käytännöstä Suomessa vaativiin asiantuntijatehtäviin.	
Sisältö	Suomen oloihin sovellettu IAEA:n kurssiin perustuva "Basic Professional Training Course on Nuclear Safety".	
Suoritustavat	Viisi viikon pituista intensiivijaksoa, jotka sisältävät luentoja, ryhmätöitä ja harjoituksia tai omatoiminen opiskelu Internetin välityksellä (luentolyhennelmät, kalvot ja videoidut luennot).	

BH30AJ110	FUUSIOENERGIATEKNIikka	4 op
	Fusion Technology	
	Järjestetään intensiivikurssina tarvittaessa.	
Opettaja(t)	professori, TKT Riitta Kyrki-Rajamäki	
Tavoitteet	Opintojakson tavoitteena on perehdyttää opiskelija fuusioenergian hyväksikäytön mahdollisuuksiin, fuusiovoimalaitoksen periaatteisiin ja fuusiotutkimuksen nykytilaan.	
Sisältö	Maailman energiavarat ja fuusio. Fusion perusfysiikkaa, fuusioreaktiot, Lawsonin kriteeri. Plasmafysiikan perusteita. Plasman magneettinen ja inertiaalikoossapito. Myonikatalysoitu fuusio. Tokamakfuusioreaktorin periaate, plasman koossapito, kuumennus, virranajo ja diagnostiikka. Fuusiovoimalaitoksen periaatteet, erikoispiirteet, turvallisuus, ympäristövaikutukset ja kustannukset. Fuusiotutkimuksen nykytila, kansainväliset fuusiotutkimushankkeet.	
Suoritustavat	Intensiivikurssi.	
	Luentoja 18 h, harjoituksia 18 h. Tenti ja harjoitustyö.	
Oppimateriaalit	Luentomoniste.	

BH50AJ110	KATTILASUUNNITTELUN JATKO-OPINTOSEMINAARI	2 - 11 op
	Postgraduate Seminar on Boiler Design	
	Osallistujamäärän ja halun mukaan. Järjestetään sekä 1.-2. että 3.-4. periodilla.	

Ajankohta	periodi 1-2,3-4
Opettaja(t)	professori, TKT Esa Vakkilainen
Tavoitteet	Opintojaksolla perehdytetään osallistujia kattilan rakenteiden lämpö- ja virtaustekniseen optimointiin.
Sisältö	Lämpöpintojen optimaalinen sijoittelu, luonnonkiertopiirin suunnittelu, läpivirtauskattilan suunnittelu, virtausepästabiilisuudet ja lämpöpintojen optimaalinen rakenne. Kurssi perustuu kirjaan Ishigai, Seikan, 1999, Steam Power Engineering, Cambridge University Press.
Suoritustavat	Luentoja 8-14 h, 1-4 harjoitustyötä sekä seminaariesitys kurssimateriaaliin perustuen. Opintopistemäärä riippuu luentoihin osallistumisesta sekä harjoitus- ja seminaariesityksien tekemisestä.
BH60AJ100	ILMANSUOJELUPÄIVÄT 3 op
	Air Protection Seminar
	Järjestetään vuosittain elokuussa Lappeenrannassa.
Opettaja(t)	professori, KTT, DI Lassi Linnanen
Sisältö	Ilmansuojelupäiville kutsutaan vuosittain lähes 30 luennoitsijaa. Luentoaiheet vaihtelevat vuosittain. Teemoina joka vuosi järjestettävillä ilmansuojelupäivillä on mm. ilmansuojeludirektiivit, ilmastokysymys, biologiset vaikutustutkimukset, hiukkaset, hajut, päästöjen vähentäminen ja ilmanlaatuindeksi. Kurssi järjestetään yhdessä Etelä-Karjalan kesäyliopiston, Ilmansuojeluyhdistyksen, Ympäristöministeriön ja Lappeenrannan teknillisen yliopiston kanssa.
Suoritustavat	Luentoja n.16 h, tentti. Osallistuminen kaksipäiväiseen seminaariin ja tentti.
BH60AJ105	VALTAKUNNALLISET JÄTTEEN HYÖTYKÄYTTÖPÄIVÄT 3 op
	Waste Recycling Seminar
	LUT järjestää Valtakunnalliset jätteen hyötykäyttöpäivät vuosittain marraskuussa.
Opettaja(t)	professori, TKT Mika Horttanainen
Sisältö	Seminaarin luentoaiheet vaihtelevat vuosittain. Seminaariin kutsutaan ulkopuoliset luennoitsijat yritysten, teollisuuden ja viranomaisten piiristä. Päivillä käsitellään mm. seuraavia teemoja: Jätteiden käsittely kuntasektorilla. Jätteen kaasutus ja polttotekniikat. Materiaalihyötykäytön tehostaminen. Jätteiden keräilyjärjestelmät, kuljetus ja loppusijoitus. Elinkaariarviointi.
Suoritustavat	Luentoja n.16 tuntia, kirjallisuustyö ja/tai tentti. Osallistuminen kaksipäiväiseen seminaariin, kirjallisuustyö ja/tai tentti.
BH60AJ110	JÄTTEEN ENERGIAHYÖTYKÄYTTÖ 2 - 11 op
	Waste-to-Energy Technologies
	Järjestetään tarvittaessa.
Opettaja(t)	professori, TKT Mika Horttanainen
Tavoitteet	Opintojaksolla perehdytään jätteen energiahyötykäyttöön. Painopiste on jätteenpoltoon liittyvissä tekniikoissa.
Sisältö	Jätteiden ominaisuudet polton kannalta, jätteiden poltto kansainvälisesti, jätteiden esikäsitteilytarpeet ennen polttoa, jätteen poltto- ja kaasutusteknologiat, jätteenpolton päästöt, päästöjen hallinta, energiakäytön jätteiden käsittely ja hyötykäyttö. Kurssi perustuu kirjaan Niessen, Combustion and Incineration processes sekä muuhun myöhemmin ilmoitettavaan materiaaliin.
Suoritustavat	Luentoja 8-14 h, 1-4 seminaariesitystä kurssimateriaaliin perustuen. Opintopistemäärä riippuu luentoihin osallistumisesta ja seminaariesityksien tekemisestä.
BH60AJ115	JÄTEHUOLTOJÄRJESTELMÄT JA ELINKAARIAJATTELU 2 - 8 op
	Waste Management Systems and Life Cycle Inventory
	Järjestetään tarvittaessa.

Opettaja(t) Tavoitteet	professori, Tkt Mika Horttanainen Perehdytään elinkaariajattelun soveltamiseen jätehuollossa ja jätehuoltojärjestelmien kehittämisessä.
Sisältö	Jätehuoltojärjestelmät ja niiden kehitys, elinkaariarviointi ja sen soveltaminen jätteisiin ja jätehuoltoon, esimerkkitapauksia, jätteiden keräily ja käsittely, esimerkki LCI-mallinnuksesta jätehuollossa.
Suoritustavat	Kurssi perustuu alan kirjallisuuteen (esim. McDougall et al., Integrated Solid Waste Management: a Life Cycle Inventory. Kirjallisuutta käydään läpi seminaariesitysten muodossa. Lisäksi tehdään harjoitustyönä jätehuoltojärjestelmän esimerkkitapauksen tarkastelu opituilla menetelmillä. Suoritettava opintopistemäärä riippuu seminaareihin osallistumisesta ja esitysten pitämisestä.
BH60AJ120	JÄTEHUOLLON TALOUSKYSYMYKSET 2 - 5 op
Opettaja(t) Tavoitteet Sisältö Suoritustavat	The Economics of Waste Järjestetään tarvittaessa. professori, KTT, DI Lassi Linnanen professori, Tkt Mika Horttanainen Perehdytään jätehuoltoon talouden näkökulmasta. Jätteen muodostuminen, keräys ja käsittely taloudellisesta näkökulmasta. Kierrätyksen talous. Erityisjätteiden talouskysymykset. Kurssi perustuu kirjaan Porter The Economics of Waste. Kirja käydään läpi seminaariesitysten muodossa. Suoritettava opintopistemäärä riippuu seminaareihin osallistumisesta ja esitysten pitämisestä.
BH60AJ125	YMPÄRISTÖJOHTAMISEN JATKO-OPINTOSEMINAARI 2 - 9 op
Opettaja(t) Tavoitteet Sisältö Suoritustavat	Postgraduate Seminar on Environmental Management Järjestetään tarvittaessa. professori, KTT, DI Lassi Linnanen Opintojakson tavoitteena on perehdyttää ympäristöjohtamisen erikoiskysymyksiin. Seminaareja ajankohtaisista ympäristöjohtamisen aiheista. Opintojakson suorittajat osallistuvat seminaariin. Tentti seminaarimateriaalista 4 op. Seminaarin tekijät laativat aiheestaan kirjoitelman, laajuudesta riippuen 2-5 op.
BH60AJ130	YMPÄRISTÖTEKNIIKAN JATKO-OPINTOJAKSO 2 - 10 op
Opettaja(t) Tavoitteet Sisältö Suoritustavat	Postgraduate Course in Environmental Engineering Järjestetään tarvittaessa. professori, KTT, DI Lassi Linnanen professori, Tkt Mika Horttanainen professori, Tkt Risto Soukka Opiskelija perehtyy jatkotutkintoonsa liittyviin ympäristötekniikan erikoiskysymyksiin. Vaihtuvat aiheet. Opintojakso voi sisältyä jatkotutkintoon useamman kerran. Sovitaan tarpeen mukaan (seminaariesitelmä, harjoitustyö ja/tai tentti tai kirjatentti).

In addition to the postgraduate courses above, the Master's-level courses in technology listed below may be included in postgraduate studies. (The suitability for postgraduate studies is mentioned in the course description.)

BH30A0400 Ydinreaktorien fysiikka
 BH30A0600 Säteilysuojelu
 BH30A0700 Luotettavuustekniikka
 BH30A1100 Ydinjätehuolto
 BH30A1200 Ydinvoimalaitosten termohydrauliikka
 BH30A1300 Ydinonnettomuuksien hallinta
 BH40A0500 Turbokonetekniikan seminaari

BH40A0600 Rajakerrosteoria
BH40A1100 Kaasudynamiikka
BH40A1200 Turbokoneiden konstruktitekniikka
BH60A2300 Waste heat recovery techniques
BH70A0001 Numerical Methods in Heat Transfer
BH70A0101 Advanced Modeling Tools for Transport Phenomena

Chemical Engineering

BJ20AJ126	CHEMICAL ENGINEERING UNIT OPERATIONS II	8 ECTS cr
	Kemiantekniikan yksikköoperaatiot II	
	Lectured annually (autumn term).	
Teacher(s)	Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen Associate Professor, D.Sc. (Tech.) Harri Niemi	
Aims Content	To familiarize students with separation techniques and the theory of mass transfer. The topics are as follows: 1. Industrial crystallization: theory, operation and design of crystallizers, and the basics of precipitation. 2. Multicomponent mass transfer: differences between mass transfer in binary and multicomponent systems, basic theory and examples in evaporation, distillation, desorption, membrane separation, heterogeneous reaction etc. 3. Membrane separation: Mass transfer, modelling, process design, simulation of industrial membrane processes.	
Modes of Study	Lectures 18 h, exercises 42 h. Laboratory work, Matlab case studies, reports passed.	
Study materials	Individual reports on selected topics. Written examination. Will be informed at lectures.	
BJ20AJ131	ADVANCED COURSE IN ENVIRONMENTAL TECHNOLOGY AND UNIT OPERATIONS	9 ECTS cr
	Ympäristötekniikan ja yksikköoperaatioiden jatkokurssi	
	Lectured annually (spring term).	
Teacher(s)	Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen Professor, D.Sc. (Tech.) Antti Häkkinen Docent, Ph.D. Sergei Preis	
Aims Content	To teach students to use the new role of chemistry and technology in today's community. Recent results of chemical engineering and treatment of industrial and municipal wastes. Case studies of various unit operations and waste treatment applications.	
Modes of Study	Lectures 24 h, exercises 16 h. Individual reports on selected topics and seminar presentations.	
Study materials	To be announced later.	
BJ20AJ135	INDUSTRIAL CRYSTALLIZATION AND FILTRATION	3 - 5 ECTS cr
	Teollinen kiteytys ja suodatus	
	Lectured when needed.	
Teacher(s)	Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen Professor, D.Sc. (Tech.) Antti Häkkinen Associate Professor, D.Sc. (Tech.) Ritva Tuunila Associate Professor, D.Sc. (Tech.) Harri Niemi	
Aims Content	To familiarize students with industrial crystallization and solid-liquid separation techniques. The topics are as follows: 1. Industrial crystallization: theory, operation and design of crystallizers, and the basics of precipitation. Lectures 12 h, exercises 3 h. 2. Filtration: fundamentals of filtration, filtration methods, operation of filters, cake formation and washing, deliquoring, design and modeling of filters. Lectures 12 h, exercises 3 h. One week intensive course. Demonstrations.	
Modes of Study	3 ECTS cr: Topic 1 or 2 and individual literature report on the selected topic. Written examination. 5 ECTS cr: Topics 1 and 2 and individual literature report on the selected topic. Written examination.	
Study materials	Additional material will be informed.	
BJ20AJ140	MIXING	5 ECTS cr
	Sekoitus	
	Lectured when needed.	

Teacher(s)	Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen
Aims	To familiarize students with mixing processes.
Content	Fundamentals of mixing, rheology, mixing equipment, design of mixers and scale-up. Mass and heat transfer in mixing device. Multiphase (solid, liquid and/or gas) mixing systems. Static mixers.
Modes of Study	One week intensive course. Reports passed. Individual report on selected topics. Written examination.
Study materials	Additional material will be informed at lectures.
BJ20AJ150	WATER TREATMENT IN CHEMICAL ENGINEERING APPLICATIONS 5 ECTS cr
	Vedenkäsittely kemiantekniikan sovellutuksissa
	Lectured when needed.
Teacher(s)	Docent, Ph.D. Sergei Preis Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen Professor, Ph.D. Heli Sirén
Aims	To familiarize students with water treatment and quality monitoring techniques.
Content	The topics are as follows: 1. Basics in water/wastewater treatment. 2. Water treatment based on chemical engineering. 3. Advanced oxidation processes (AOPs). 4. Water quality monitoring.
Modes of Study	One week intensive course co-organized by Laboratory of Separation Technology and Laboratory of Chemistry. Reports passed. Individual report on practical exercises and selected topics. Written examination.
Study materials	Will be informed at lectures.
BJ30AJ100	PROSESSITUTKIMUKSEN, -KEHITYKSEN JA - SUUNNITTELUN MENETELMÄT 3 - 6 op
	Methodology in Process Research, Development and Design
	Toteutetaan tarpeen mukaan.
Opettaja(t)	professori, TkT Ilkka Turunen
Tavoitteet	Opintojakson tavoitteena on perehdyttää valittuihin alan uusimpiin ja ajankohtaisiin menetelmiin.
Sisältö	Kulloinkin valitun aiheen mukaisesti.
Suoritustavat	Luentoja ja seminaarieselmiä 28 h, harjoitustehtäviä. Vaihtoehtoinen suoritustapa: valitun kirjallisuuden tenttiminen.
BJ40AJ100	CREATIVE DESIGN 5 ECTS cr
	Luova suunnittelu
	Lectured annually (autumn term).
Teacher(s)	Professor, Ph.D. Andrzej Kraslawski
Aims	Types of innovation. Product, process, service innovation. Innovations in process engineering. Models of creativity. Enhancement of creativity (brainstorming, synectics, morphological analysis, case-based reasoning, quality function deployment, TRIZ).
Modes of Study	Lectures and exercises 56 h. Subject of exercises: debottlenecking, operation problems, control problems, new products design. Exercises and presence at the lectures. Written examination.
BJ50AJ100	ADVANCED COURSE IN MEMBRANE TECHNOLOGY 5 ECTS cr
	Kalvotekniikan jatkokurssi
	Lectured every second year or when needed.
Teacher(s)	Professor, Ph.D. Marianne Nyström Professor, D.Sc. (Tech.) Mika Mänttari Invited lecturers from Europe

Aims	To give the student a deeper understanding on membrane technology and its use in various applications.	
Content	Membrane processes (microfiltration, ultrafiltration, nanofiltration, reverse osmosis, pervaporation, membrane distillation, membrane reactors, membrane bioreactors, membrane contactors, electrodialysis etc.). Novel membranes and their manufacturing, materials, modification and characterisation. Calculations, modeling and applications.	
Modes of Study	Intensive course. Lectures, demonstrations and seminars 40 h, individual assignments. Final exam.	
Study materials	Will be announced at the beginning of the course. Lecture notes.	
BJ50AJ105	SYNTEETTISET POLYMEERIT: LIIMAT JA HARTSIT	5 op
	Synthetic Polymers: Glues and Resins	
	Luennoidaan tarvittaessa.	
Opettaja(t)	professori, FT Marianne Nyström professori, TKT, MMT Timo Kärki	
Tavoitteet	Syventää opiskelijan tietämystä synteettisten polymeerien kemiasta, määrittämenetelmistä ja käytöstä teollisuudessa.	
Sisältö	Hartsien ja liimojen valmistus ja niiden käyttö teollisuudessa, erikoisesti puunjalostusteollisuudessa. Synteettisten polymeerien valmistus. Homopolymeerit, kopolymeerit ja polymeerien silloitus. Polymeerien kemialliset reaktiot ja analyysimenetelmät. Polymeerien käyttökohteet. Hartsit ja liimat.	
Suoritustavat	Intensiivikurssi. Luentoja 35 h ja seminaarityö. Seminaarityö, harjoitukset, tehdaskäynti ja loppuentti.	
BJ50AJ110	PROTEIINIEN KEMIA JA MIKROBIOLOGIA	4 op
	Protein Chemistry and Microbiology	
	Luennoidaan tarvittaessa.	
Opettaja(t)	professori, FT Marianne Nyström professori, FT Heli Sirén TKT Svetlana Butylina	
Tavoitteet	Syventää opiskelijan tietämystä proteiinien kemiasta ja polyelektrolyyttien kemiasta. Opintojakso antaa myös tietoa proteiinien hyödyntämisestä sekä mikrobiologian perustietoa, varsinkin elintarviketekniikassa esiintyvistä mikrobeista.	
Sisältö	Proteiinien rakenne ja kemialliset reaktiot. Proteiinien karakterisointimenetelmät. Proteiinien erotus ja fraktiointi käyttämällä kromatografisia menetelmiä ja suodatusmenetelmiä. Elintarvikkeiden tärkeät proteiinit. Mikrobin luokitus, kemia, analysointi ja viljelymenetelmät.	
Suoritustavat	Luentoja 28 h, laboratoriotöitä 40 h. Luennot, laboratoriotyöt ja loppuentti.	
BJ50AJ115	NEW TRENDS IN MEMBRANE TECHNOLOGY	4 - 8 ECTS cr
	Kalvosuodatustekniikan uudet suuntaukset	
	Contact the lecturer for details.	
Teacher(s)	Professor, D.Sc. (Tech.) Mika Mänttari	
Aims	To make the student familiar with new research trends in membrane technology and to teach them to write and review scientific papers. The aim is also to facilitate the co-operation of students and researchers.	
Content	Monthly seminars during one year or two years, review works and presentations and conclusions of the reviewed papers.	
Modes of Study	Monthly seminars, problem based learning, case studies, possible lectures (scientific communication).	
Study materials	Will be announced during the course.	
BJ60AJ100	PAPERITEKNIIKAN JATKO-OPISKELIJASEMINAARI	3 op
	Postgraduate Seminar in Paper Technology	
	Järjestetään joka toinen vuosi kevätlukukaudella. Seuraavan kerran kevätlukukaudella 2012.	

Opettaja(t)	Professori N. N.
Tavoitteet	Opintojakson tarkoituksena on tukea paperitekniiikan ja paperikemian jatko-opintoja perehtymällä ajankohtaisiin tutkimusalueisiin ja niiden erityiskysymyksiin.
Sisältö	Seminaariesityksiä joko omasta tutkimusaiheesta tai tätä varten erikseen annetuista aiheista.
Suoritustavat	Luentoja ja seminaariesitelmää 28 h.
Arvostelu	Hyväksytyt/hylätyt, läsnäolo 80 % tunneista.

BJ70AJ110	DESIGN OF EXPERIMENTS AND SAMPLING	6 ECTS cr
	Koesuunnittelu ja näytteenotto	
Teacher(s)	Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Professor, Ph.D. Heikki Haario Professor, Ph.D. Heli Sirén Lecturer, N. N. International guest lecturers	
Aims	The aim is to introduce fundamentals of Design of Experiments (DoE) and Theory of Sampling (ToS). DoE begins with basic methods, and continues with more advanced concepts, principles and requirements including mixture design. ToS includes an introduction to the meaning of representative sampling, as well as how the sampling procedures and equipment should be designed and audited. In addition, procedures of estimation of sampling uncertainty are considered.	
Content	Two independent modules: MODULE 1, DoE: Is organized jointly with the Department of Mathematics and Physics and with the Department of Chemical Technology. It includes a two-day intensive course with lectures provided by the course BM20A3401 Design of Experiments. The course covers an introduction to the importance of experimental design, and the basic techniques: the factorial 2N designs, Central Composite designs, mixture designs, the Taguchi principles. An introduction to experimental optimisation of engineering processes by optimal experimental design and regression analysis of the response data. MODULE 2, ToS: Is organized by the Department of Chemical Technology as a three-day intensive course. The content introduces basic concept of sampling: dimensionality of the sampling target, sources of sampling error, correct and incorrect sampling, sample pre-treatment, estimation and optimization of sampling uncertainty of multistep sampling procedures. Participants will make an individual assignment or a project work on DoE or on ToS. These two modules are independent. The Module 1 is suitable for engineers, under and post graduate students of various fields, while the Module 2 is oriented to chemical engineering although available to the same target audience as the Module 1.	
Modes of Study	Lectures and exercises 32 h.	
Study materials	Individual assignment, report and written examination. Lecture material. G.Box, S. Hunter, W.G. Hunter: Statistics for experimenters, Wiley 2005, 2nd Edition Francis F. Pitard, Pierre Gy's Sampling Theory and Sampling Practice, Vol 1 and Vol 2, Boca Raton, FL: CRC Press (1989). CITAC / EURACHEM GUIDE, Guide to Quality in Analytical Chemistry; An Aid to Accreditation, 2002. EURACHEM / CITAC Guide CG 4, Quantifying Uncertainty in Analytical Measurement, 2000. More materials to be listed.	

BJ70AJ115	MULTIVARIATE METHODS IN INDUSTRY	4 ECTS cr
	Monimuuttujamenetelmät teollisuudessa	
	Lectured next time autumn 2010.	
Teacher(s)	Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Professor, Ph.D. Heikki Haario Researcher, M.Sc. (Tech.) Jarno Kohonen Lecturer, N. N. International guest lecturer	
Aims	To teach participants modern multivariate techniques, with emphasis on industrial applications.	
Content	Is organized jointly with the Department of Mathematics and Physics and with the Department of Chemical Technology. Content covers a wide range of industrial applications, e.g., pharmaceutical, petrochemical, pulp and paper, metallurgy or mining applications. Also	

Modes of Study	environmental emission data, remote sensing applications as well as multivariate image analysis is discussed. Course includes: Introduction multivariate data analysis. Classification and pattern recognition techniques. Calibration with spectral (signal) data. Introduction to classical calibration methods, applications of PCA and PLS in multivariate statistical process control (MSPC), neural network applications. Advanced topics on multivariate methods, e.g., handling spectral data, support vector machines, multi-block methods, multi-way methods for 3D data, etc (varying topics).
Study materials	Lectures and exercises 32 h. Individual assignment or an examination. Lecture material. R.G. Brereton, Chemometrics: Data Analysis for the Laboratory and Chemical Plant, John Wiley & Sons, United Kingdom, 2006. More lecture material to be listed.
BJ80AJ100	FYSIKAALISEN KEMIAN JATKO-OPINTOKURSSI 2 - 10 op
Opettaja(t)	Advanced Physical Chemistry for Postgraduate Students
Tavoitteet	Toteutetaan tarpeen mukaan.
Sisältö	tutkijaopettaja, dosentti, TkT Jaakko Partanen
Suoritustavat	Opintojakson tavoitteena on syventää tietoja jollakin valitulla fysikaalisen kemian, erityisesti liuoskemian, osa-alueella. Vaihtuu tarpeiden mukaan. Suoritustavat ja annettava opetus sovitaan erikseen.
BJ90AJ110	DYNAMICS OF ADSORPTION COLUMNS 10 ECTS cr
Teacher(s)	Adsorptiokolonnien dynamiikkaa
Aims	Contact the lecturer for details.
Content	Post-Doctoral Researcher, D.Sc. (Tech.) Tuomo Sainio Understanding the theory of adsorption in multicomponent systems and dynamics of adsorption, ion exchange, and chromatography columns. Practical skills in mathematical modeling of adsorption processes and solution of such models.
Modes of Study	Fundamental phenomena occurring in adsorption, ion exchange, and chromatography columns (retention mechanisms, mass transfer resistances). Theory of multicomponent chromatography. Mathematical modeling of adsorption columns and numerical solution schemes for hyperbolic-parabolic PDEs. Process alternatives for adsorptive separation, ion exchange, and chromatography.
Study materials	Lectures, simulation homework, and a written examination in two parts. Lecture notes; Guiochon et al., Fundamentals of Preparative and Nonlinear Chromatography, Academic Press, 1994; Ruthven, D. M., Principles of Adsorption and Adsorption Processes, John Wiley & Sons, 1984; Wankat, P. C., Rate-controlled separations, Springer, 2005.

In addition to the postgraduate courses above, the Master's-level courses in technology listed below may be included in postgraduate studies. (The suitability for postgraduate studies is mentioned in the course description.)

BJ30A0500 Project on Process and Plant Design
 BJ30A0600 Yksikköprosessien mallinnus
 BJ30A1401 Process and Product Innovations
 BJ30A1600 Advanced Process Simulation
 BJ60A1000 Fiber and Paper Technology; Personal Assignment
 BJ60A1100 Fiber and Paper Technology; Personal Assignment
 BJ60A1300 Usage and Properties of Paper
 BJ60A1400 Chemical Pulping Technology
 BJ80A0900 Todellisten liuosten kemialliset ominaisuudet
 BJ90A0400 Catalysis
 BJ90A0710 Chemical Separation Methods

Mechanical Engineering

BK20AJ100	HITSAUSTEKNIIKAN JATKO-OPINTOKURSSI	10 op
	Postgraduate Course in Welding Technology	
Opettaja(t)	professori, TkT Jukka Martikainen	
Tavoitteet	Opintojakson tarkoituksena on perehdyttää hitsaustekniikan jatko-opiskelijat peruskoulutusta laajemmin ja syvällisemmin hitsaustekniikan kehittämiseen, kansainväliseen tutkimukseen ja tulevaisuuden näkymiin.	
Sisältö	Opintojakson aihepiiri muuttuu lukuvuosittain. Jatko-opintojen teema-alue on "Hitsaustekniikan globaalit kehitysnäkymät". Opintojakson syventymiskohde muuttuu vuosittain.	
Suoritustavat	Seminaariesitelmät, opponointeja ja luentoja.	
BK30AJ100	LASERTYÖSTÖN JATKO-OPINTOKURSSI	10 op
	Postgraduate Course in Laser Processing	
	Kurssi pidetään vuosittain.	
Opettaja(t)	professori, TkT Veli Kujanpää	
Tavoitteet	Opintojakson tarkoituksena on perehdyttää lasertyöstön jatko-opiskelijat peruskoulutusta laajemmin ja syvällisemmin lasertyöstötekniikan kehittämiseen, kansainväliseen tutkimukseen ja tulevaisuuden näkymiin.	
Sisältö	Opintojakson aihepiiri muuttuu lukuvuosittain. Painopistealueena on uusien lasertyöstömenetelmien prosessit, niiden sovellukset ja tuotteiden suunnittelu laser menetelmiä varten. Jatko-opintokurssi toteutetaan LUT:ssa, mutta se on avoin myös Aalto-yliopiston teknillisen korkeakoulun, TTY:n ja OY:n hitsaustekniikan jatko-opiskelijoille.	
Suoritustavat	Seminaariesitelmät, opponointeja ja luentoja.	
BK50AJ100	TUOTANTOTEKNIIKAN JATKO-OPINTOKURSSI	10 op
	Postgraduate Course in Production Engineering	
	Ajankohta ilmoitetaan ja sovitaan myöhemmin, tavoitteena järjestää vähintään yksi kurssi lukuvuosittain.	
Opettaja(t)	professori, TKT Juha Varis	
Tavoitteet	Opintojakson tarkoituksena on perehdyttää tuotantotekniikan jatko-opiskelijat peruskoulutusta laajemmin ja syvällisemmin tuotantotekniikkaan, erityisesti sen kehittämiseen ja kehittämiseen, kansainväliseen tieteelliseen tutkimukseen ja tulevaisuuden skenaarioihin ja trendeihin.	
Sisältö	Opintojakson aihepiiri muuttuu lukuvuosittain. Toteutusmuotona seminaarit, joissa perehdytään tieteellisen tutkimuksen lähestymistapoihin ja menetelmiin. Seminaareissa käsitellään myös alan keskeisiä tutkimusaiheita, ja jatko-opiskelijat esittelevät ja opponovat tutkimusaiheitaan.	
Suoritustavat	Luennot, seminaarit, tentit ja opponointia.	
BK50AJ105	DESIGN FOR MANUFACTURABILITY AND ASSEMBLY 6 ECTS cr (DFM/DFMA)	
	Valmistusjärjestelmien tuotesuunnittelu	
Year and Period	Period 1-4	
Teacher(s)	Researcher/Teacher, D.Sc. (Tech.) Harri Eskelinen Senior Research Scientist (DFM/DFMA)	
Aims	The goal of this postgraduate course is to go deep into the theory of a product's design process and focus at manufacturability and assembly aspects than in basic courses. During the first part of the course (theory) various tools for cost-effective DFMA-process are discussed and several approaches to manage product's design and manufacturing processes are considered. Students will also learn means to analyse different kinds of design processes and products from the manufacturability point of view. The aim of the second part of the course (applications) is to study both industrial and scientific applications of different kinds of products to learn how to develop and establish the rules and mathematical equations of DFMA for novel approaches.	
Content	Part I. Theory (3 ECTS). Manufacturability Interest Areas. Models of Design Processes. Principles of DFM/DFMA. Design Management Systems. Framework of Quality Engineering. Concurrent Engineering	

Modes of Study	Design. Part II. Applications (3 ECTS). Computer Aided CE. Cross-Technological Approaches for Supporting Effective CE-processes. Collaborative-Concurrent Design. Applications of VM and IPT's in a CE-process. Applications and Aspects of DFM/DFMA for Various Product and Production Types, Manufacturing Technologies and Hybrid- and Multiprocessing Methods. It is possible to take a degree of this course either by utilizing conventional lectures and seminars during the 1st and the 2nd period (details will be determined at the beginning of the course) or also by utilizing distance learning methods during the teaching weeks of terms (individual research topic will be given by the teacher).
BK60AJ100	KONEIDEN MALLINTAMISEN JA SIMULOINNIN JATKO-OPINTOKURSSI B 6 op
Opettaja(t) Tavoitteet	Modelling and Simulation of Mechatronic Machines Luennoidaan tarvittaessa. professori, TKT Heikki Handroos Antaa opiskelijalle monitekniisten konejärjestelmien aihepiiriin liittyviä syventäviä teoreettisia valmiuksia. Monitekniisten konejärjestelmien mallinnukseen ja simulointiin liittyvien ongelmien teoreettista analysointia, tehonsiirtoon, ohjaukseen ja säätöön painottuen.
Sisältö	Monitekniisten konejärjestelmien mallinnukseen ja simulointiin liittyvien ongelmien teoreettista analysointia, tehonsiirtoon, ohjaukseen ja säätöön painottuen.
Suoritustavat	Luentoja ja/tai seminaareja 14 h, ohjattuja harjoituksia 7 h. Luentoja ja/tai seminaareja 14 h, ohjattuja harjoituksia 7 h. Kotitehtäviä ja mallinnustöitä n. 60 h.
Oppimateriaalit	Hyväksytysti suoritettavat harjoitukset, kotitehtävät ja kirjallinen tentti. Vaihtuu vuosittain.
BK60AJ105	INDUSTRIAL ROBOTICS 6 ECTS cr
Teacher(s) Aims	Teollisuusrobotiikka Lectured annually if needed. Professor, D.Sc. (Tech.) Huapeng Wu The goal of this postgraduate course is to go deep into the theory of industrial robotics. The course gives the student ability to carry out advanced kinematic and dynamic analysis of various robot structures including stiffness and singularities. The course also deals with motion and force control methods proposed for actuator, joint and Cartesian space control. In addition, the student gets an overview about upper level control problems such as axis interpolation.
Content	Overview of kinematic structures of robots. Direct kinematics and inverse kinematics. Mapping. Robot dynamics. Cartesian, joint and actuator space control methods. Force control methods. Upper level control methods.
Modes of Study Study materials	Lectures and seminars. Details will be determined at the beginning of the course. Course literature will be announced at the beginning of the course.
BK60AJ110	POSTGRADUATE COURSE IN CONTROL OF MECHATRONIC MACHINES 6 ECTS cr
Teacher(s) Aims	Mekatronisten koneiden säätötekniikan jatko-opintokurssi Adjustable according to the needs of students. Professor, D.Sc. (Tech.) Heikki Handroos To give the postgraduate students ability to apply advanced methods in solving the control problems of hydraulically and electrically driven mechatronic machines.
Content	Modelling and control of hydraulically and electrically driven servos with flexible mechanical systems. Linearization, state-space description, control methods utilizing state-feedbacks, observers etc., digital control. Contents are subject to change according to the needs of the participating student groups.
Modes of Study Study materials	Seminars, computer class exercises, personal exercises. Announced at the beginning of the course.

BK70AJ105	ELEMENTTIMENETELMÄN JATKO-OPINTOKURSSI 6 op
	Postgraduate Course in Finite Element Method Ajankohta ilmoitetaan myöhemmin.
Opettaja(t)	professori, TkT Aki Mikkola tutkijaopettaja, TkT Pasi Tanskanen
Tavoitteet	Opintojakson tarkoituksena on antaa jatko-opiskelijalle elementtimenetelmään liittyviä syventäviä teoreettisia valmiuksia.
Sisältö	Differentiaaliyhtälöiden teoriaa, variaatioperiaate, Ritzin menetelmä, siirtymämenetelmään perustuvien elementtien muodostaminen, isoparametristen elementtien muodostaminen, sekamenetelmä, elementtimenetelmän konvergentti ja tarkkuus, ominaisarvototehtävän ratkaisu, epälineaarisen elementtimenetelmän perusteet.
Suoritustavat	Seminaariesitelmää ja luentoja.
Oppimateriaalit	Hyväksytysti suoritettavat harjoitukset ja kirjallinen tentti. Bathe K-J, 1995, Finite Element Procedures (soveltuvin osin). Cook R.D et. al., 2001, Concepts and Applications of Finite Element Analysis, 4th Edition (soveltuvin osin).
BK70AJ110	KONEIDEN MALLINTAMISEN JA SIMULOINNIN JATKO-OPINTOKURSSI A 6 op
	Modelling and Simulation of Mechatronic Machines Luennoidaan joka toinen vuosi, seuraavan kerran lukuvuonna 2010 - 2011.
Opettaja(t)	professori, TkT Aki Mikkola
Tavoitteet	Antaa opiskelijalle monitekniikan konejärjestelmien aihepiiriin liittyviä syventäviä teoreettisia valmiuksia. Monitekniikan konejärjestelmien mallinnukseen ja simulointiin liittyvien ongelmien teoreettista analysointia, tehonsiirtoon, ohjaukseen ja säätöön painottuen.
Sisältö	Monitekniikan konejärjestelmien mallinnukseen ja simulointiin liittyvien ongelmien teoreettista analysointia, mekaanisiin järjestelmiin painottuen.
Suoritustavat	Luentoja ja/tai seminaareja 14 h, ohjattuja harjoituksia 7 h, 3. periodi. Luentoja ja/tai seminaareja 14 h, ohjattuja harjoituksia 7 h, 4. periodi. Kotitehtäviä ja mallinnustöitä n. 60 h.
Oppimateriaalit	Hyväksytysti suoritettavat harjoitukset, kotitehtävät ja kirjallinen tentti. Vaihtuu vuosittain.
BK80AJ100	TERÄSRAKENTEIDEN JATKO-OPINTOKURSSI 15 op
	Postgraduate Course in Steel Structures Ajankohta ilmoitetaan myöhemmin.
Opettaja(t)	professori, TkT Timo Björk tutkijaopettaja, TkT Pasi Tanskanen yliassistentti, TkT Timo Nykänen tutkijaopettaja, TkT Tapani Halme
Tavoitteet	Opintojakson tarkoituksena on perehdyttää teräsrakenteiden jatko-opiskelijat peruskoulutusta laajemmin ja syvällisemmin teräsrakenteiden tutkimukseen ja suunnitteluun, mm. seuraaviin aihealueisiin: väsymisanalyysit, murtumismekaniikka, värähtelymekaniikka, levyjen-, laattojen- ja kuorirakenteiden teoriaa, ohutlevyrakenteiden mitoituksen erityispiirteet ja stabiiliusanalyysit, valmistuksen lujuustekninen simulointi, rakenteiden optimointi ja rakenteiden epälineaariset FE-rakennepuhtausanalyysit.
Sisältö	Opintojakson aihepiiri ja opintopistemäärä muuttuu lukuvuosittain. Kurssi toteutetaan LUT:ssa ja on avoin TKK:n, TTY:n ja OY:n aihepiiriin keskittyville jatko-opiskelijoille.
Suoritustavat	Luentoja, seminaariesitelmää, harjoituksia. Vierailuluentoja, osallistumista kansainväliseen yhteistyöhön ja opiskelijavaihtoon.
BK90AJ100	PUUTEKNIIKAN JATKO-OPINTOKURSSI 6 op
	Postgraduate Course in Wood Technology Järjestetään kevätlukukaudella.
Opettaja(t)	professori, TkT, MMT Timo Kärki
Tavoitteet	Opintojakson tavoitteena on perehdyttää puutekniikan jatko-opiskelijat peruskoulutusta laajemmin ja syvällisemmin alueen uusimpaan tekniikkaan, tutkimukseen, kehitystyöhön ja

Sisältö	puutekniikan talouden ja markkinoinnin alueisiin. Opintojakson aihepiiri muuttuu lukuvuosittain. Toimintavuoden teemana ovat alan uusin tutkimus ja mekaanisen metsäteollisuuden tulevaisuuden skenaariot. Opintojakso sisältää sekä alan asiantuntijoiden esityksiä että tutkijakoulutettavien aihealueista valmisteltuja luentoja.
Suoritustavat	Seminaariesitelmää, opponointeja ja luentoja.

In addition to the postgraduate courses above, the Master's-level courses in technology listed below may be included in postgraduate studies. (The suitability for postgraduate studies is mentioned in the course description.)

BK60A0300 Servo Control Engineering
BK60A0400 Mekatroniikan erityisopintojakso
BK60A0601 Process and Product Innovations
BK70A0201 Koneen simuloinnin erityisopintojakso
BK80A1401 Väsymiskestävyys

Mathematics and Physics

BM20AJ100	SOVELLETUN MATEMATIIKAN JATKO- OPINTOKURSSI	5 - 7 op
	Advanced Topics in Applied Mathematics	
	Luennoidaan tarpeen mukaan.	
Opettaja(t)	professori, FT Heikki Haario	
Tavoitteet	Perehdytään johonkin sovelletun matematiikan erikoisalueeseen.	
Sisältö	Vaihtuva-aiheinen kurssi laitoksen omien ja vierailevien tutkijoiden erikoisaloilta, esim. DY/ODY-mallinnuksen, data-analyysin, signaali-analyysin, stokastiikan, numeriikan ja matematiikan kehittyvien sovellusten parista.	
Suoritustavat	Luentoja ja seminaariesityksiä. Seminaariesitelmä/raportti/harjoitustyö/ kirjan tenttiminen. Ajankohta sovitaan professorin kanssa.	
Oppimateriaalit	Ilmoitetaan luentojen alkaessa.	
BM20AJ105	MATEMAATTINEN TEKNOLOGIA	5 op
	Mathematical Technology	
	Ajankohta ilmoitetaan myöhemmin.	
Opettaja(t)	professori, FT Matti Heiliö	
Tavoitteet	Lisätä tietämystä matematiikan sovelluksista, antaa valmiuksia matemaattisen mallinnuksen ja ongelmanratkaisun kysymyksiin ja matemaattiseen osaamiseen perustuvien kehitysprojektien suunnitteluun ja toteutukseen.	
Sisältö	Eri aiheita sovelletun matematiikan alalta.	
Suoritustavat	Viiikoittaiset seminaariesitykset, syys- ja kevätlukukausi. Suoritus edellyttää yhden lukukauden ajan mukanaoloa seminaarissa, 1-2 pidettyä esitelmää sekä 1-2 aineistopohjaista projektiraporttia, jotka sovitaan luennoitsijan kanssa.	
Oppimateriaalit	Ilmoitetaan luentojen alkaessa.	
BM20AJ110	SUMEAT SYSTEEMIT	5 op
	Fuzzy Systems	
	Luennoidaan tarpeen mukaan. Osallistujista riippuen kurssin opetuskieli on joko suomi tai englanti.	
Opettaja(t)	dosentti, FT Jorma Mattila	
Sisältö	Sumeiden systeemien mallinnusta ja sovelluksia: OWA-tekniikat, seulonta, päätöksenteon menetelmiä sumeilla käsitteillä.	
Suoritustavat	Luentoja ja/tai seminaariesityksiä. Seminaariesitelmä sekä aiheeseen liittyvän kirjan tenttiminen tai kurssin tentti.	
Oppimateriaalit	Kirjallisuus ilmoitetaan kurssin alussa.	
Edellytykset	Suosittelaa BM20A3101 Fuzzy Sets and Fuzzy Logic ja BM20A3202 Fuzzy Engineering.	
BM20AJ115	ADVANCED KALMAN FILTERING	5 - 12 ECTS cr
	Kalman-suodatuksen erikoiskurssi	
	Period will be announced later.	
Teacher(s)	Professor, Ph.D. Heikki Haario	
Aims	Students get a deeper understanding of several Kalman filtering methods, and learn to apply Kalman filtering to solve practical problems.	
Content	Basic and extended Kalman filters, optimization formulations, ensemble and particle filters. Applications to engineering problems.	
Modes of Study	Lectures and seminar presentations. Practical assignments.	
Study materials	Will be announced at lectures.	
BM20AJ120	STATISTICAL METHODS FOR INVERSE PROBLEMS	5 - 12 ECTS cr
	Inversio-ongelmien tilastolliset menetelmät	
	Period will be announced later.	

Teacher(s)	Professor, Ph.D. Heikki Haario
Aims	Students get a deeper understanding of statistical methods for inverse problems and learn to apply the methods to practical problems.
Content	Bayesian approach to inverse problems. Various Markov chain Monte Carlo methods, together with different prior and likelihood formulations. Applications to science and industrial engineering problems.
Modes of Study	Lectures and seminar presentations. Practical assignments.
Study materials	Will be announced at lectures.
BM20AJ125	SEMINAR ON TIME SERIES 4 ECTS cr
Year and Period	Seminar on Time Series Period 1-4
Teacher(s)	Researcher/Teacher, Ph.D. Tuomo Kauranne
Aims	Students get familiar with different kind of time-series applications and their analysing methods.
Content	Content varies depending on presentations.
Modes of Study	Seminar presentations. Attendance at ten seminars and one seminar presentation during each of the two semesters is required.
BM30AJ100	MODERNIN OPTIIKAN JATKO-OPINTOKURSSI 6 op
Opettaja(t)	Advanced Topics in Modern Optics Luennoidaan tarpeen mukaan. tutkijaopettaja, FT Erik Vartiainen
Tavoitteet	Perehdytään johonkin modernin optiikan erikoisalueeseen.
Sisältö	Vaihtuva-aiheinen kurssi laitoksen omien ja vierailevien tutkijoiden erikoisaloilta, esim. fotonikan, optisen mittaustekniikan, optisten spektroskopioiden sekä laskentamenetelmien sovellusten parista.
Suoritustavat	Luentoja ja seminaariesityksiä. Seminaariesitelmä/raportti/harjoitustyö/kirjan tenttiminen.
Oppimateriaalit	Ilmoitetaan luentojen alkaessa.
BM30AJ105	ADVANCED COURSE ON IC-TECHNOLOGY 6 ECTS cr
Teacher(s)	IC teknologian erikoiskurssi Will be arranged upon request. Professor, Ph.D. Tuure Tuuva
Aims	Student acquires deep knowledge of a special subject in Integrated Circuit Technology.
Content	Deep knowledge of a special subject.
Modes of Study	Seminar or special assignment.
Study materials	According to an agreement. For example Silicon VLSI Technology, J.D. Plummer, M.D. Deal and P.B. Griffin, Prentice Hall.

In addition to the postgraduate courses above, the Master's-level courses in technology listed below may be included in postgraduate studies. The suitability for postgraduate studies is mentioned in the course description.

BM20A1900 Statistics II
 BM20A2000 Simulation
 BM20A2201 Logic and Discrete Methods
 BM20A2500 Linear Algebra and Normed Spaces
 BM20A2800 Nonlinear Optimization
 BM20A2901 Discrete Optimization
 BM20A3001 Statistical Analysis in Modelling
 BM20A3101 Fuzzy Sets and Fuzzy Logic
 BM20A3202 Fuzzy Engineering
 BM20A3301 Stochastic Theory and Models
 BM20A3401 Design of Experiments
 BM20A3602 Fuzzy Data Analysis

BM20A3801 Advanced Mathematical Methods
BM20A4000 Case Study Seminar
BM20A4201 Applied Functional Analysis
BM20A4500 Evolutionary Computation
BM20A4600 Jatkuvat mallit
BM20A4701 Modelling with Partial Differential Equations
BM30A0601 Optoelectronics
BM30A1500 Advanced Topics in Material Science
BM30A1600 Microelectronics
BM30A1700 Physics of Semiconductor Devices
BM30A2200 Semiconductor and Superconductor Physics

Electrical Engineering

BL10AJ100	A CROSS BORDER POSTGRADUATE COURSE IN ELECTRICAL ENGINEERING	5 ECTS cr
	Sähkötekniikan jatko-opintokurssi toteutetaan rajan ylittävässä yhteistyössä	
	This postgraduate course will be arranged as the need arises. The course will be organized in cooperation with lecturers from LUT's partner universities in St. Petersburg. Information about course contents and periods will be made available to students on the website of the Graduate School of Electrical Engineering.	
Teacher(s)	Professor, D.Sc. (Tech.) Jarmo Partanen Professor, D.Sc. (Tech.) Juha Pyrhönen Professor, D.Sc. (Tech.) Pertti Silventoinen Professor, D.Sc. (Tech.) Jero Ahola Professor, D.Sc. (Tech.) Olli Pyrhönen Guest lecturer from one of LUT's partner universities in St. Petersburg.	
Aims	The aim of the course is to introduce students to selected topics of advanced electrical engineering.	
Content	The amount and type of content covered by the lectures will change from course to course, and will depend on the interest of the students and lecturers involved.	
Modes of Study	Lectures and exercises. Examination and/or seminar work depending on the subject.	
BL10AJ105	SÄHKÖTEKNIIKAN JATKO-OPINTOKURSSI	4 - 12 op
	Postgraduate Course in Electrical Engineering	
	Tämä jatko-opintokurssi on osa sähköenergiatekniikan tutkijakoulun toimintaa. Toteutetaan tarpeen mukaan.	
Opettaja(t)	Vastuuhenkilö(t): professori, TkT Jarmo Partanen professori, TkT Juha Pyrhönen professori, TkT Olli Pyrhönen professori, TkT Pertti Silventoinen professori, TkT Jero Ahola professori, TkT Satu Viljainen Muut tutkijakoulun vastuupettajat	
Tavoitteet	Jatko-opintojakson tavoitteena on syventää tietoja jollakin valitulla sähkötekniikan ajankohtaisella erikoisalueella.	
Sisältö	Vaihtuvat aiheet.	
Suoritustavat	Luentoja, mahdollisesti seminaariesitelmää tai harjoitustyö ja/tai tentti. Opintojakson aihe, ajankohta ja suoritustapa ilmoitetaan sähköenergiatekniikan tutkijakoulun nettisivulla.	
BL40AJ100	SÄÄTÖTEKNIIKAN JATKO-OPINTOSEMINAARI	7 - 12 op
	Postgraduate Seminar in Control Systems	
	Järjestetään kevätlukukausittain tarpeen mukaan.	
Opettaja(t)	professori, TkT Olli Pyrhönen	
Tavoitteet	Kurssilla perehdytään johonkin säätötekniikan ajankohtaiseen erikoisalueeseen.	
Sisältö	Seminaarikurssi vuosittain vaihtuvista aiheista. Jokainen osallistuja vuorollaan valmistelee ja pitää seminaariesityksen tietystä kurssin pohjaksi valitun kirjan tai muun vastaavan materiaalin osasta.	
Suoritustavat	Luentoja, seminaariesitelmää, harjoitustyö ja/tai tentti.	

In addition to the postgraduate courses above, the Master's-level courses in technology listed below may be included in postgraduate studies. (The suitability for postgraduate studies is mentioned in the course description.)

BL20A0200 Sähkökaupan pörssipeli

BL20A0201 Power Exchange Game for Electricity Markets

BL20A0500 Sähkönjakelutekniikka

BL20A1000 Sähköverkkojen relesuojaus

BL20A1100 Sähkökauppa
BL30A0400 Design of an Electrical Machine
BL30A0600 Power Electronics
BL30A0900 Tehoelektronikan komponentit
BL30A1001 Electrical Drives
BL30A1200 Numerical Methods in Electromagnetism
BL40A0700 Digitaalinen suodatus
BL40A0800 Digitaalisen signaalinkäsittelyn erikoiskurssi
BL40A1500 Sääntötekniikan erikoiskurssi
BL40A2000 Tietoliikenne-elektronikan komponentit
BL40A2201 Process and Product Innovations
BL50A0600 Electromagnetic compatibility in power electronics
BL50A0800 Laite- ja järjestelmäsuunnittelu
BL50A0900 Analogiasignaalin käsittely
BL50A1300 Advanced Course in Electronics
BL50A1400 Analogiaelektronikka