

# Catalogue report

LUT School of Energy Systems

## Master's Programme in Sustainable Production in Mechanical Engineering

**Master's Programme in Sustainable Production in Mechanical Engineering 2017-2018 (120 ECTS cr)**

### Facts

- Degree Master of Science in Technology (M.Sc. Tech.), (Diplomi-insinööri in Finnish)
- Higher university degree, gives eligibility to apply for scientific doctoral studies
- Extent 120 ECTS credits
- Duration two years, full-time studies of 60 ECTS per academic year.

### Learning outcomes of MSc programme in Sustainable Production in Mechanical Engineering

After completing Master's Programme in Sustainable Production in Mechanical Engineering a student will be ready to engage in modern, world-class manufacturing for a sustainable future. A student will learn to see the possibilities and restrictions of sustainable production. During the studies, a student will develop skills enabling to participate in demanding global development tasks of product and production design. A student will be able to analyse challenging production tasks also by using simulation software.

A student will

- be able to demonstrate a comprehensive understanding of manufacturing as a whole and an essential part of the company business
- have adopted the principles of the most common and widely used manufacturing processes
- be able to work with others in task-orientated groups participating and interacting in the group in a productive manner and lead and manage individual production
- be able to logically think through existing manufacturing problems in daily use and solve them, to contribute to innovative thinking
- be able to understand possibilities of automation and robots for manufacturing stages
- be able to understand the meaning of material selection and design for manufacturing of products and sustainability viewpoints
- be able to rethink existing manufacturing methods and generate innovative new methods for improving the whole factory concept and production
- be able to well understand economy of manufacturing.

### Degree Structure

The Master's degree (120 ECTS) consists of core studies, specialisation studies, minor studies and free elective studies. The Master's Thesis and Seminar is included in the specialisation studies.

See Uni-portal:

[Sustainable Production in Mechanical Engineering](#)

# Degree structures

## Degree Structure

The Master's degree (120 ECTS) consists of core studies, specialisation studies, minor studies and free elective studies. The Master's Thesis and Seminar is included in the specialisation studies, and the Thesis must be written in English in the programmes taught in English.

Students may choose any minor offered by LUT (check the required prerequisites, if any) or do the minor during exchange abroad (upon application).

Students are recommended to choose one of the following minors:

KoDSaManu Modern Manufacturing  
 KoDSaMate Advanced Materials Engineering or  
 KoDSaSusta Sustainability

Please notice that the extent of the minors of Mechanical Engineering is 25 ECTS cr.

Free elective studies can be any courses offered by LUT if the required prerequisites are fulfilled. Studies in other universities/from abroad or a max. of 10 ECTS of internship (BK10A1400 Work Internship in Master's Degree, 2-10 ECTS) may be included upon application, too. Language studies are recommended, especially English courses and Finnish courses for international students.

See the degree structure for details.

## Master's Programme in Sustainable Production in Mechanical Engineering 2017-2018 (muok. 29.6.2017)

Degree structure status: published

Academic year: 2017-18

Beginning date of the academic year: 01.08.2017

### Core Studies (min 34 cp)

KoDCore: Core Studies, 30 - 40 cp

*Obligatory Studies 34-35 ECTS cr*

BK10A1200: Research Methods and Methodologies, 4 cp

BK10A3800: Principles of Industrial Manufacturing Processes, 5 cp

BK10A3900: Reliability Based Machine Element Design, 5 cp

BK10A4000: Design of Advanced Plate and Shell Structures, 5 cp

BK10A4100: Management and Leadership Skills in Mechanical Engineering, 5 cp

BK50A2701: Selection Criteria of Structural Material, 5 cp

BK70A0001: Simulation of a Mechatronic Machine, 5 cp

*Only for students coming outside LUT*

BK10A0300: Introduction to M.Sc. Studies, 1 cp

### Specialisation Studies (min 55 cp)

KoDSuPro: Sustainable Production in Mechanical Engineering, 50 - 70 cp

*Obligatory Studies 55 ECTS cr*

BK10A1501: Master's Thesis and Seminar, 30 cp

BK50A3500: Development of Sustainable Materials and Machinery for Packaging Technology, 5 cp

BK50A3600: Manufacturing Processes for Recyclable Products, 5 cp

BK50A3700: Productivity and Sustainability in Sheet Metal Production, 5 cp

BK50A3800: Productivity and Sustainability of Metal Cutting, 5 cp

BK50A3900: Integration of Product's Design, Sustainable Production and Material Selection, 5 cp

## Minor Studies (min 20 cp)

Students may choose any minor studies taught at LUT if the required prerequisites are fulfilled. Students are recommended to choose minor studies in Modern Manufacturing (code KoDSaManu), Advanced Materials Engineering (code KoDSaMate) or Sustainability (code KoDSaSusta).

## Free Elective Studies

Choose enough free elective studies to attain the full 120 ECTS cr. Free elective studies can include any courses offered by LUT if the required prerequisites are fulfilled. Students are recommended to include an internship that improves professional skills to elective studies. An internship may be worth a maximum of 10 ECTS credits. More information: BK10A1400 Work Internship in Master's Degree 2-10 ECTS cr. Also language studies are recommended, especially English courses and Finnish courses for international students.

# Courses and study modules not included in degree structures

## Minor Studies

The extent of the minor is a min. of 20 ECTS. Students may choose any minor offered by LUT (check the required prerequisites, if any) or do the minor during exchange abroad (upon application).

Students are recommended to choose one of the following minors:

KoDSaManu Modern Manufacturing

KoDSaMate Advanced Materials Engineering or

KoDSaSusta Sustainability

Please notice that the extent of the minors of Mechanical Engineering is 25 ECTS cr.

Other minors taught at LUT in the academic year 2017-2018 are:

Mechanical Engineering:

KoDSaLaser Advanced Digital Laser Based Photonic Production

Energy Technology:

EnSaM100 Energiatekniikka (in Finnish)

EnSaM150 Energiatekniikka, laaja (in Finnish)

EnDSaBT Bio-Energy Technology

EnDMES Modelling of Energy Systems

Environmental Technology:

YmKSaYmte Ympäristötekniikka (in Finnish)  
YmDSaResp Environmental Responsibility

Electrical Engineering:

SaSaM100 Sähkötekniikka (in Finnish)  
SaSaM101 Sähkötekniikka, laaja (in Finnish)  
SaDSaIE Industrial Embedded Systems  
SaDREE Renewable Energy and Energy Efficiency  
SaDSaEDM2 Power Electronics and Electrical Drives

Industrial Engineering and Management:

TuKSOTekn Tuotantotalous, sivuopinnot muu tekniikka (in Finnish)  
TuDSO Tuotantotalous, sivuopinnot laaja (in Finnish)  
TuSOYritt Yrittäjyys, sivuopinnot (in Finnish)  
TuSOEntr Entrepreneurship, minor  
TuSOMBAN Business Analytics

Computer Science:

TikSOTite Tietotekniikka (in Finnish)  
TiDSOSE Software Engineering (extensive)

Business Administration:

KaSOLiik Liiketoimintaoaaminen (in Finnish)  
KaSOIbm International Business and Management.

Computational Engineering:

MaKSaM180 Teknillinen matematiikka (in Finnish)  
FyKSaM110 Teknillinen fysiikka (in Finnish)  
MaKSaM190 Älykäs laskenta (in Finnish)  
MaDIntM300 Technomathematics  
FyDInt300 Technical Physics  
MaDSaM300 Intelligent Computing

Chemical and Process Engineering:

KeSoM200 Kemia (in Finnish)  
KeSoM300 Kemian prosessitekniikka (in Finnish)

KoDSaMate: Advanced Materials Engineering, 20 - 30 cp

*Obligatory Studies 25 ECTS cr*

BK90C1900: Introduction to Materials Engineering, 4 cp  
BK90C2000: Hybrid Materials, 3 cp  
BK90C2100: Functional Properties of Nanomaterials, 3 cp  
BK90C2200: Sustainable Manufacturing of Advanced Materials, 5 cp  
BK90C2300: High Performance Products, 5 cp  
BK90C2400: Project course in Material Engineering, 5 cp

KoDSaManu: Modern Manufacturing, 20 - 30 cp

*Obligatory Studies 25 ECTS cr*

BK50A4000: Production Processes in Modern Job Shops, 5 cp  
BK50A4100: Manufacturing Systems and Scheduling, 5 cp  
BK50A4200: Product Flow in Job Shops, 5 cp  
BK50A4300: Managing Job Shops, 5 cp  
BK50A4401: Fabrication Laboratory, 5 - 10 cp

KoDSaSusta: Sustainability, 20 - 30 cp

*Obligatory Studies 24-27 ECTS cr*

BH60A2101: Advanced Course in Life Cycle Assessment, 7 cp  
BJ02A4051: Development of New Sustainable Products and Solutions, 5 cp  
CS30A1691: Social Sustainability, 6 cp  
CT10A7002: Green IT and Sustainable Computing, 6 cp

*Students, who haven't done BH60A0000 Ympäristötekniikan perusteet in their earlier studies, are required to do Introduction to Sustainability.*

BH60A4400: Introduction to Sustainability, 3 cp

## Course descriptions

### Descriptions of courses and study modules included in the degree structures

#### **KoDCore: Core Studies, 30 - 40 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Study module

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

No course descriptions.

*Obligatory Studies 34-35 ECTS cr*

#### **BK10A1200: Research Methods and Methodologies, 4 cp**

**Validity:** 01.08.2012 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Harri Eskelinen

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Docent, D.Sc. (Tech.) Harri Eskelinen

**Aims:**

After having passed this course module the student is able to:

- plan, lead and organize the research project according to the established scientific practices and procedures
- compare, choose and utilize proper scientific practices to carry out research projects in industrial environments
- write and present a scientific research plan and research report.

**Contents:**

Learning outcomes: Criteria to evaluate the scientific contribution of research. Scientific research projects in engineering science. Principles of qualitative and quantitative analysis. Viewpoints on how to illustrate the results of quantitative analysis. Different means to carry out literature reviews, interviews and surveys. Utilisation of silent knowledge. Contents and structures of research plans and research structures based on the IMRAD principle. Viewpoints of writing scientific articles and conference papers. Practical advice about giving a conference presentation. Guidelines for acting as an opponent in a scientific conference or seminar.

**Teaching Methods:**

Lectures and discussions 14 h, 1st period. Individual guidance and exercises 14 h, 1st period. Independent study and literature search 28 h, 1st-2nd period. Written research plan 48 h, 2nd period. Total workload 104 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, continuous and comprehensive evaluation

**Course Materials:**

Lectures in the Moodle. For Finnish students: Eskelinen & Karsikas, Tutkimusmetodiikan perusteet - Tekniikan alan oppikirja, Tammertekniikka, 2014.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**BK10A3800: Principles of Industrial Manufacturing Processes, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Juho Ratava, Juha Varis

**Note:**

uusi opintojakso

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Postdoctoral Researcher, D.Sc. (Tech.) Juho Ratava

**Aims:**

After having completed this course module the student should be able to describe the principles of machining products and production, sheet metal production and products, generally used welding processes, extrusion process, packaging processes, characteristics describing manufacturability aspects of different materials and quality measurement. The student will be able to write technical and scientific text, as well as search for scientific information, evaluate it critically and use it in their report.

**Contents:**

The course focuses on the most typical and used processes in manufacturing technology, subtitles informed detailed in "Aims". The course runs through the various processes having a strong connection to product design. The Design for Manufacturing will be pointed out.

**Teaching Methods:**

Lectures 21 h  
Seminar lecture 3h, period 1  
Seminars 4 h, period 2  
Seminar work (pair work) and working as an opponent 90 h  
Industrial visit 12 h, period 2  
Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Assessment:**

0-5, exam 40 %, seminar 60 %  
Intermediate seminar presentation, final presentation and working as opponent. Participation in industrial visit and seminar

**Course Materials:**

Course material is available on the Moodle.

**Places for exchange-students? (Yes, number/No):**

Yes, 10

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK10A3900: Reliability Based Machine Element Design, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Harri Eskelinen, Kimmo Kerkkänen

**Note:**

Uusi kurssi

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Docent, D.Sc. (Tech.) Harri Eskelinen

University Lecturer, D.Sc. (Tech.) Kimmo Kerkkänen

**Aims:**

After having passed this course, the student will be able to:

- utilize two reliability measures: safety index and probability of failure
- apply tools and techniques for risk analysis of a machine or mechanical system
- use principles, with which the designer can improve the geometries, shapes, sizes, material properties, and topology of a product to reduce the failure probability
- utilize statistical information to support reliability design
- apply failure mode analysis, especially in context of wear and corrosion phenomena
- choose an appropriate distribution to analyze reliability aspects of a component

**Contents:**

The importance of multidisciplinary optimization including reliability-based constraints in design is discussed. Two significant reliability measures, safety index and probability of failure, are compared and discussed. Tools and techniques for both qualitative and quantitative risk analysis of an assembly or any technical system are presented. Principles, with which the designer can modify the geometries, shapes, sizes, material properties, and topology of a product to reduce the failure probability are discussed. Possibilities to utilize statistical information to support reliability design are evaluated. Aspects, how uncertainties associated with statistical distributions and any insufficient information may lead to large errors in probability calculations in engineering, are clarified. Tools for analyzing failure modes of machine elements, machines and technical systems especially in context of wear and corrosion phenomena, are taught. Guidelines to choose an appropriate distribution to analyze reliability aspects and lifetime of a component are presented.

**Teaching Methods:**

Lectures total 28 h, periods 1 - 2. Literature search 20 h, periods 1 - 2. Team and project work 74 h, periods 1 - 2. Seminar 8 h, period 2. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, team and project work 70 %, seminar 30 %.

**Course Materials:**

Patrick O'Connor, Andre Kleyner, Practical Reliability Engineering, 5th Edition, 978-0-470-97982-2. Erdman, A.G., Mechanism Design. Norton, R.L., Design of Machinery. Lectures in Moodle

**Prerequisites:**

B.Sc. (Tech.) Degree or equivalent knowledge

**Places for exchange-students? (Yes, number/No):**

Yes, 5

**Places for Open University Students?(Yes, number/No):**



No

**Related to:**

to sustainability

**BK10A4000: Design of Advanced Plate and Shell Structures, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Ilkka Pöllänen, Timo Björk

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Ilkka Pöllänen, M.Sc. (Tech.)

Timo Björk, D.Sc. (Tech.), Professor

**Aims:**

After having passed this course module the student is able to:

- recognize different type of plate and shell structures and their application in mechanical engineering
- understand the behavior of plates and shells in term of strength and capacity and can design simple structures and analyze fabrication processes
- choose purposeful solution in terms of design, fabrication and material (steels, other metals and composites) for certain application and can design simple constructions
- design the fabrication such as bending, forming and cutting of plate as a workshop processes
- understand and utilize the capability of FEA in design and fabrication on plate and shell structures
- design and fabrication of cell structures (laser, 2D-printing and extruding-processes)

**Contents:**

During the course the student will become familiar with:

- the basic theory of plate and shell structures
- design of plate and shell structures considering stiffness, vibrations, stability and simple plastic limit state
- simulation of fabrication, such as brake pressing, mechanical cutting and punching of plate
- fabrication possibilities of plate and shell structures
- laboratory tests of plate and shell structures to compare the results with analytical and FEA.

**Teaching Methods:**

Lectures 42 h, laboratory work 4 h, guided exercises 14 h, exercises and home works individually and in groups 70 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, Exercises (40 %), examination (60 %).

**Course Materials:**

Lectures on Moodle.

**Prerequisites:**

Book recommendation: Benham, Crawford &amp; Armstrong, Mechanics of Engineering Materials. Recommended BK80A2701 Lujuusoppi

**Limitation for students? (Yes, number, priorities/Leave empty):**

Yes

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**BK10A4100: Management and Leadership Skills in Mechanical Engineering, 5 cp****Validity:** 01.08.2016 -**Form of study:** Basic studies**Type:** Course**Unit:** LUT School of Energy Systems**Grading:** Study modules 0-5,P/F**Teachers:** Kimmo Kerkkänen, Tapio Saarelainen, Harri Eskelinen**Year:**

M.Sc. (Tech.) 1

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**Docent, Ph.D. (Mil.), Tapio Saarelainen  
University Lecturer, D.Sc. (Tech.) Kimmo Kerkkänen  
Docent, D.Sc. (Tech.) Harri Eskelinen**Aims:**

After having passed this course, focusing on engineering tasks, the students will be able to:

- utilize basics of effective delegation and meeting management also in a networking environment
- employ effective communication techniques and apply both social and leadership skills to optimize end results and to manage possible conflicts in contexts of teamwork or projects
- set and achieve goals for the set work and projects and lead themselves
- identify opportunities to enhance cooperation among their colleagues
- manage day-to-day challenges of leading a team and manage time and prioritize work
- use effective strategies for organizing projects and negotiating resources
- apply problem-solving and decision-making skills to accomplish tasks
- assess their flexibility and openness to new ideas to inspire other team members and to

create and sustain a positive, productive atmosphere

- create and implement changes as applicable to lead team work or projects
- understand the role of financial and business management in engineering projects.

**Contents:**

This course introduces fundamentals of leadership and management as regards contexts of engineering projects. The students gain experience in project work, develop team work skills, apply self-management and implement work discipline. Through interactive activities, self-assessments, discussions, and practical team and project work, the students learn how to lead either product design tasks, production or larger scale projects with the focus on the field of mechanical engineering in particular. The skills introduced include communicating effectively, solving problems, making decisions, working in teams, building relationships, creating and implementing changes in an organization, and aligning one's goals with the organization's mission, goals, and objectives. Depending on the given task within the course module, the students are advised to recognize the special skills and competences needed for leading design tasks, production or larger scale projects.

**Teaching Methods:**

Lectures and literature review 8 h, period 1, orientation meetings 6 h, period 2 and group discussions 10 h, periods 2-4. Participation in the board meetings of virtual companies 24 h, periods 1-4. Building of a networking environment for the teamwork and project management 10 h, period 1. Exercises and the utilization of a leadership journal to get practical experience in working as a project manager, production manager, design manager, workshop manager, engineering team leader etc. 72 h, periods 1-4. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, continuous and comprehensive evaluation of success in teamwork and project work, peer review of management and leadership skills and the evaluation of a leadership journal.

**Course Materials:**

Lecture notes, books and articles used for the literature review.

**Prerequisites:**

B.Sc. (Tech.) Degree or equivalent knowledge

**Places for exchange-students? (Yes, number/No):**

Yes, 5

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**BK50A2701: Selection Criteria of Structural Material, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Harri Eskelinen, Sari Pärssinen, Jörg Wunderlich

**Note:**

Replaces the course BK50A2700 Selection Criteria of Structural Material.

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Docent, D.Sc. (Tech.) Harri Eskelinen

**Aims:**

After having passed this course module the student is able to:

- apply and develop systematic and analytical means and tools of systematic material selection approaches into solving cross-technological material selection tasks
- define and analyse the properties, the strengths, the weaknesses and the application areas of the main groups of constructional materials for different types of applications
- is able to justify and build generalized models to take into a count both the functionality and the manufacturability aspects in addition to the total costs and environmental aspects of the product in solving the material selection task
- is able to evaluate and utilize recent results and documents of material science
- derive analytical models based on the principles of LCC's, LCA's and MIPS-factors in material selection.

**Contents:**

During the course the student will become familiar with the properties and application areas of different constructional materials. The recent scientific results dealing with material science and technology will be discussed. Aspects of selecting and comparing different materials are discussed from the viewpoints of functionality, manufacturing aspects, costs and environmental aspects of the product. Future trends in materials science are discussed briefly. Metals and their alloys, polymers, ceramics, composites, wood materials, adaptive materials, nanomaterials. Environmental aspects of material selection from the viewpoint of LCC and LCA and the basics of MIPS calculations. Innovative solutions of the material selection tasks will be discussed. Principles to formulate and solve the materials solution tasks based on analytical and systematic approaches and means to develop models to support the selection process starting from the product's requirement list will be discussed in details. Multi-language teaching environment will be utilized during the project work.

**Teaching Methods:**

Lectures 14 h, 1st period. Lectures 14 h, 2nd period. Exercises in small teams 28 h, 1st-2nd period. Project work and poster presentation 54 h, 1st-2nd period. Independent study 20 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, comprehensive and continuous evaluation

**Course Materials:**

Mangohon, P., The Principles of Materials Selection for Engineering Design. Strong, A. B., Plastics, Materials and Processing. Kalpakjan, S. & Schmid, S., Manufacturing Engineering and Technology. Lectures and exercises in Moodle. For Finnish students: Eskelinen &

Karsikas, Vihreän teknologian näkökulmat konstruktiomateriaalien valinnassa, ISBN 978-952-265-457-1.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**Related to:**

to sustainability

### **BK70A0001: Simulation of a Mechatronic Machine, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Aki Mikkola

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Aki Mikkola

**Aims:**

The student possesses the theories and practices of mathematical modeling and computer simulation of machine systems, which are either hydraulically or pneumatically actuated. The student is able to utilize simulations as an integrated tool of product design and he/she can utilize his/her skills to generalize the theories of engineering design to solve multidisciplinary design tasks and real-life problems. The student is able to compare and justify the use of different constructional solutions for linear and rotating motion mechanism based on their static, kinematic and dynamic analysis. The student is able to individual scientific work to simulate mechatronic machines.

**Contents:**

Principles of multibody dynamics, modelling of actuators, coupled simulation. Use of the concept of virtual work. Constraint equations and Lagrangian multipliers. Inertia of rigid bodies. Modelling of hydraulic components. Numerical integration of the equation of motion. Individual utilisation of simulation software, including the principles of how to apply previously mentioned mathematical theories to handling and solving abstract and multidisciplinary problems.

**Teaching Methods:**

Lectures 24 h, 1st-2nd period. Teamwork in multi-cultural working environment 30 h, 1st-2nd period. Supervised tutorials 24 h, 1st-2nd period. Independent study 52 h, 1st-2nd period. Total loading 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

Yes

**Examination in Exam (Yes/No):**

No

**Number of mid-term examinations:**

2

**Assessment:**

0-5, examination and two mid-term exams, examinations 60 %, simulation work 20 %, in class quizzes 10 %, homework 10 %.

**Course Materials:**

Lecture notes. Shabana, A. A.: Computational Dynamics, John Wiley & Sons, Inc., 1st edition, 1994. ISBN 0-471-30551-0.

**Prerequisites:**

Students are recommended to have completed BK80A2600 Mekaniikka and BK60A0200 Mekatroniikka.

**Places for exchange-students? (Yes, number/No):**

Yes, 30

**Places for Open University Students?(Yes, number/No):**

This course has 1-15 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

*Only for students coming outside LUT*

**BK10A0300: Introduction to M.Sc. Studies, 1 cp**

**Validity:** 01.08.2007 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** John Bruzzo Escalante, Marja Talikka

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Doctoral Student, M.Sc. (Tech.) John Bruzzo, Information Specialist M.Sc. (Tech.) Marja Talikka

**Aims:**

The main objective of this course is to provide the student with the initial needed tools in order to familiarize the university philosophy and how to prepare the development of their degree. Most of the initial doubts related to evaluations, choosing a thesis topic as well as exchange and internships are covered. In practical level, the course addresses three main subjects:A) The course provides the student with basic knowledge of studying at LUT in general and particularly in their degree program. The course helps the student to plan and follow the progress of their studies at LUT with a help of a personal study

plan.B) Students will learn to use different distance learning applications. Students will learn how to find electronic material from the Academic Library collections and databases.C) Students participate in team activities that allows them to gather more information on the study characteristics in the Finnish culture.

**Contents:**

The Orientation Days activities. Degree requirements. Planning of Master's studies. Making of the electronic personal study plan at the ePSP workshop. Use of the Moodle learning base. The Academic Library collections and databases. Team activities.

**Teaching Methods:**

Participation in the Orientation Days activities 15 h, period 1. Library tour 1 h, period 1. Assignments on general information about Master Studies 1h, information retrieval, library use and databases in Moodle. Information sources and information retrieval, Team work and exercises 2 h, period 1. ePSP workshop 2 h, period 1. Independent study 6 h. Total workload 27 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

Pass/Fail

**Course Materials:**

Material given during the orientation Days, Study Guide, Information retrieval course in Moodle, the Academic Library collections and databases.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

## **KoDSuPro: Sustainable Production in Mechanical Engineering, 50 - 70 cp**

**Validity:** 01.08.2016 -

**Form of study:** Major studies

**Type:** Study module

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

No course descriptions.

*Obligatory Studies 55 ECTS cr*

### **BK10A1501: Master's Thesis and Seminar, 30 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Katriina Mielonen

**Note:**

Replaces the course BK10A1900 Diplomityö ja seminaari JEDI

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

N.N.

**Aims:**

The Master's thesis is the final project of the Master's degree, which demonstrates the student's knowledge of a topic of scientific or societal importance in the professional field in question. Student is able to combine theory and practice: he/she can exploit theory in solving problems in scientific research. The student must demonstrate the ability to carry out the project independently and following a plan and student , can set goals for him/her self-concerning results and time schedules. The student manages extensive and versatile data acquisition knowhow.

**Contents:**

The Master's thesis is a research project by nature, which requires approximately 6 months of work. It is related to the student's major subject and its topic is agreed on by the supervisor and the student together. During the work, student must show capability to work independently according to defined plans and goals. Course includes seminars.

**Teaching Methods:**

The Master's thesis is a written report on the research work involved, presenting the stages of the work, the methods, results and explanations. Thesis includes a seminar, where are present students who are starting to write the Master's thesis and students who are about to graduate, and their supervisors. In the final stages, each student in his/her turn represents briefly their work's goals, content and results. Student must participate other seminars (listen at least 5 seminars) before starting his/her own thesis, and also have his/her own at the end of the work. Student also have to participate to one (1) layout and references exercise before the evaluation can be started.

Seminars 2 h, 1st-4th period. Layout and references exercise 1h (student have to participate when his/her thesis is almost ready), 1st, 2nd, 3rd or 4th period. Writing press release 1 h. Independent study 776 h. Total workload 780 h. Seminar listening points are valid till the student will graduate

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, Master's thesis 100%. Seminars passed; students have to attend at least 5 seminars and give their own presentation (possibility to online presentation and listening). One layout and references lecture participated. Press release Pass/fail.

**Course Materials:**

LUT final thesis instructions. Seminar instructions in Moodle.

**Places for exchange-students? (Yes, number/No):**

No



**Places for Open University Students?(Yes, number/No):**

No

**Related to:**

to sustainability

**BK50A3500: Development of Sustainable Materials and Machinery for Packaging Technology, 5 cp****Validity:** 01.08.2016 -**Form of study:** Basic studies**Type:** Course**Unit:** LUT School of Energy Systems**Grading:** Study modules 0-5,P/F**Teachers:** Kaj Backfolk, Katriina Mielonen, Ville Leminen, Panu Tanninen, Sami-Seppo Ovaska, Amir Toghyani**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor D.Sc. (Tech.) Kaj Backfolk, D.Sc. (Tech.) Katriina Mielonen

**Aims:**

After having passed this course module student is able to:

- compare the packaging related properties of various packaging materials
- compare various ways to combine materials with paper and paperboard
- choose and evaluate paper and board converting techniques
- explain and categorize operations and functions of packaging lines

**Contents:**

Content:

- Trends in packaging
- Packaging materials, manufacturing process (glass, paperboard, plastic, metal)
- Paper and paperboard as a raw material in packages (coating and lamination e.g. liquid packaging board)
- Designing of package, industrial design, graphical design
- CAD and CAM, manufacturing of tools
- Manufacturing of packages, unit operations in packaging line, robotics
- Converting (cutting, creasing, sealing, perforation), tray forming
- Printing and varnishing
- Functional packages (intelligent packages, ergonomic packages)

**Teaching Methods:**

Lectures 28 h, project work 22 h, independent studies 40 h. Total workload 90 h.

**Suitability for doctoral studies (Yes/Leave empty):**

Yes

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Assessment:**

0-5. Written examination 70 %, project work 30 %.

**Course Materials:**

Lecture material will be distributed via Moodle.

**Places for exchange-students? (Yes, number/No):**

Yes, 5

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK50A3600: Manufacturing Processes for Recyclable Products, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Timo Kärki

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Agr. & For.) Timo Kärki

**Aims:**

Main aim of the course is to highlight the potential of recyclable materials for different end products. Global industrial waste recycling and services market is witnessing strong growth and an increasing importance on recovery of key materials resources in the industrial waste streams as well as in construction and demolition waste is reflected in recycling services with rapid growth. After having completed this course, the student should be able to: understand the potential of recyclable materials define technical processes for utilization of recyclable materials can put new ideas into action.

**Contents:**

What are recyclable materials? Waste policy and waste hierarchy in EU and globally. Pre-treatment and sorting processes for recyclable materials. Extrusion and moulding as methods for recycled materials. Other potential methods. Recycled end products and EoW legislation.

**Teaching Methods:**

Lectures 28 h, independent study 72 h, seminar 30 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, examination 70 %, seminar 30 %.

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Places for exchange-students? (Yes, number/No):**

Yes, 10

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK50A3700: Productivity and Sustainability in Sheet Metal Production, 5 cp****Validity:** 01.08.2016 -**Form of study:** Basic studies**Type:** Course**Unit:** LUT School of Energy Systems**Grading:** Study modules 0-5,P/F**Teachers:** Juha Varis**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Juha Varis

**Aims:**

After having completed this course the student should:

- be able to manufacture sheet metal products either in the own factory or manufactured products in subcontractors,
- be able to comprises where the price of the sheet metal product is formed and will be able to compare on the basis of different production and procurement methods
- know how to design sheet metal products in 3D software and simulate manufacturability of the components
- be able to apply knowledge of modern sheet metal manufacturing in practice
- be able to understand the simulation, automation and robotics importance of the efficient manufacture of sheet metal products
- be able to recognize the connection of 3D design to used materials, manufacturing methods and machine systems and their goal of sustainable and productive manufacturing

**Contents:**

The course focuses on manufacturing and manufacturability of sheet metal products in such a way that the students will reach a comprehensive understanding of the manufacturing cost

factors in sheet metal products manufacturing. Material quality, different coatings, subassembly's accuracy, process properties and as well as qualitative preparations of multi-technical products are affecting to sheet metal subassembly' and final assembly'. These aspects are explored in this course. In addition, the focus of this course is on sheet metal production: in automation practices and safety issues. The course covers traditional and automated sheet metal manufacturing processes' trends and visions. Numerous case examples used in this course are straight from the real world, examples are analyzed and solutions are searched in teams. The course is related to sustainable development.

**Teaching Methods:**

Lectures 28 h, exercises and individual guidance 18 h, project work 36 h, independent work 50 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Assessment:**

0-5, exam 50 %, group work 50 % Exercises will gain points for the actual Moodle exam.

**Course Materials:**

Literature to be announced during lectures. Course material is available in the Moodle

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**Related to:**

to sustainability

**BK50A3800: Productivity and Sustainability of Metal Cutting, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Juho Ratava, Timo Kärki, Juha Varis, Antti Salminen

**Year:**

M.Sc. (Tech.) 2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Postdoctoral Researcher, D.Sc. (Tech.) Juho Ratava

**Aims:**

After having completed this course module the student should be able to describe the machining processes which are used in machine shops (principles, applications, used tools

and machines tools, also the advantages and limitations). Student will be also able to describe the principle of chip formation process, compare together the different machining processes and also compare these processes to other manufacturing processes. The student is also able to describe the modern NC machines operating principles and recognize their applications, including their potential and limitations. The student knows the most common safety risks in machine shops and know how to avoid them and how to protect workers from them. Students will be know the supervisor's responsibility for safety matters. The student will be able to write a short technical and scientific texts, as well as search for scientific information, evaluate it critically and use it in their reports.

**Contents:**

The course focuses on mathematical modeling of chip formation and cutting forces for static and dynamic analysis, cutting fluids, and other factors affecting cutting and machining possibilities and limitations. The course runs through the various non-conventional machining processes: sawing, boring, broaching, grinding, honing and lapping. Also this course will explore the execution of processes and application, green cutting fluids and green machining. In addition, NC-machining will be introduced.

**Teaching Methods:**

Introduction lecture 2h. Recorded lectures in Moodle 26 h, Seminars in Moodle 41 h. Tutorials 4 h, independent work 57 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Number of mid-term examinations:**

2

**Assessment:**

0-5, exam 100 %. Exercises are voluntary, but will gain points for the actual exam.

**Course Materials:**

All the material is available in the Moodle

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK50A3900: Integration of Product's Design, Sustainable Production and Material Selection, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Harri Eskelinen

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Docent, D.Sc. Harri Eskelinen

**Aims:**

After having passed this course, the student will be able to:

- apply systematic and analytical means for carrying out the DFMA-analysis of different types of components and assemblies and suggest improvements either to product design, material selection, manufacturing stages or production
- utilize analytical tools to evaluate products' manufacturability and assembly aspects in industrial production and integrate these aspects with the results of functionality analysis of different product variants
- take care of material related DFMA-viewpoints in the context of sustainability
- build an analytical overall model for integrating aspects of product design, sustainable production and environmental friendly material selection
- utilize commercial manufacturability data from industrial workshops in DFMA-analysis
- compare objectively different subcontractors for industrial production

**Contents:**

Different systematic and analytical means for carrying out the DFMA-analysis of different types of components and assemblies. Analytical tools to evaluate products' manufacturability and assembly aspects in industrial production and means to integrate these aspects with the results of functionality analysis of different product variants. Practical ways to recognize material related DFMA-viewpoints in the context of sustainability. Tools to build an analytical overall model for integrating aspects of product design, sustainable production and environmental friendly material selection. Means to utilize commercial manufacturability data from industrial workshops in DFMA-analysis and compare objectively different subcontractors for industrial production.

**Teaching Methods:**

Introduction lecture 2 h, period 1, DFMA-analysis of product variants 50 h, project work and written report 78 h, periods 1-4. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, comprehensive and continuous evaluation

**Course Materials:**

Lecture notes and DFMA-evaluation tools in Moodle.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**Related to:**

to sustainability

## Descriptions of courses and study modules not included in the degree structures

### KoDSaMate: Advanced Materials Engineering, 20 - 30 cp

**Validity:** 01.08.2016 -

**Form of study:**

**Type:** Study module

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

No course descriptions.

*Obligatory Studies 25 ECTS cr*

### BK90C1900: Introduction to Materials Engineering, 4 cp

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Timo Kärki

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) , D.Sc. (Agr. & For.) Timo Kärki

**Aims:**

Aim of the course is to introduce possibilities of Material Engineering to students. Diverse possibilities of different materials is taken into consideration when optimizing the variable possibilities in Product Designing. After having completed this course, the student should be able to: understand the influence of material selection to the product design recognize the variable possibilities of different materials show creative and innovative expertise in the field of Materials Engineering

**Contents:**

Basics of Materials Engineering and Product Design. Principles of materials selection and introduction to materials selection procedures. Choice of fabrication techniques including case studies related to different materials. Selecting polymers and composites as raw materials: structure, properties, processing characteristics and applications for the commercially important polymers including general classes of polymers: commodity, engineering and specialty thermoplastics, thermosetting resins and rubbers. Introduction to specific metals, alloys and minerals: metallurgy, properties, applications and potentialities of

metals, alloys and minerals in a wide variety of engineering environments. Wood materials. Introduction to engineering ceramics. Properties and manufacturing of carbon based materials. Recycled Materials as a raw material source.

**Teaching Methods:**

Lectures 21 h. Independent study 63 h. Seminar 20 h. Total workload 104 h.

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, examination 70 %, seminar 30 %

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Prerequisites:**

-

**Places for exchange-students? (Yes, number/No):**

Yes, 10

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK90C2000: Hybrid Materials, 3 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Ossi Martikka

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Project Researcher, D.Sc. (Tech.) Ossi Martikka

**Aims:**

Organic-inorganic hybrids and composites have been playing a major role in research and society in recent years. This course aims to give the participants an understanding of the properties of the organic and inorganic components, preparation methods, characterisation techniques and also examples of functional hybrid materials. After having completed this



course, the student should be able to: structure hybrid materials from separate raw material sources characterize hybrid materials with various testing methods can work in teams and solve problems related to hybrid materials

**Contents:**

Combinations of different materials. Various structures of hybrid materials. Properties of biopolymers and bionanomaterials. Different characterization methods: optical, morphological, surface, interfacial and mechanical characterization. Designing of Hybrid Materials. Performance of Hybrid Materials.

**Teaching Methods:**

Lectures 14 h. Exercises and individual guidance 20 h. Independent study 44 h. Total workload 78 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, oral examination in evaluation panel 40 %, exercises and seminar 50 %, weekly quizzes 10%.

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Prerequisites:**

-

**Places for exchange-students? (Yes, number/No):**

Yes, 10

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK90C2100: Functional Properties of Nanomaterials, 3 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Irina Turku

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Irina Turku

**Aims:**

Aim of the course is to get students familiar to different types of nanomaterials. Manufacturing processes of nanomaterials are also highlighted. After having completed this course, the student should be able to: understand the variety of nanomaterials and have the readiness to understand the usability of nanomaterials in processes and products can work in teams and solve problems.

**Contents:**

What is nanoscience about? Classification of nanomaterials. Nanomaterial structures, fundamentals and properties. Carbon based nanomaterials, ceramics, "smart" polymers and bio-based nanomaterials. Analytical tools in nanoscience. Applications of nanomaterials. Synthesis of nanoscale materials. Bottom-up and top-down approaches. Safety of nanomaterials.

**Teaching Methods:**

Lectures 14 h. Exercises and individual guidance 20 h. Independent study 44 h. Total workload 78 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Assessment:**

0-5, oral examination in evaluation panel 60 %, exercises and seminar 40 %.

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Prerequisites:**

-

**Places for exchange-students? (Yes, number/No):**

Yes

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK90C2200: Sustainable Manufacturing of Advanced Materials, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Timo Kärki, Marko Hyvärinen, Katriina Mielonen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech,), D.Sc. (Agr. &amp; For.) Timo Kärki

**Aims:**

Aim of the course is to demonstrate awareness of the range of modern manufacturing techniques for advanced materials and to select an appropriate manufacturing technique for a given component/use. After having completed this course, the student should be able to: apply various manufacturing methods to advanced materials processing define processing methods based on material selection can understand and identify possibilities of entrepreneurship in sustainable manufacturing.

**Contents:**

Introduction to processing technology and overview of manufacturing processes. Usable material forms: short fibers, non-woven mat, unidirectional, bidirectional, multi-axial and braided weaves. Fundamentals of laminate construction: ply orientation, balance and symmetry. Manufacturing methods: wet layup, prepreg layup, filament winding, automated tape layup, automated fiber placement, resin infusion, press molding and pultrusion. Matrix resins: thermoset vs. thermoplastic polymers, process temperatures, service limits, storage requirements, shelf life limits and pot life/work life. Process equipment: oven, autoclave and platen press. Extrusion, injection moulding and moulding as manufacturing methods. Coating and laminations methods in packaging solutions. Future process developments.

**Teaching Methods:**

Lectures 28 h. Independent study 72 h. Seminar 30 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, examination 70 %, seminar 30 %.

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Places for exchange-students? (Yes, number/No):**

Yes, 10

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**BK90C2300: High Performance Products, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Timo Kärki

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.), D.Sc. (Agr. & For.) Timo Kärki

**Aims:**

Aim of the course is to highlight the developments in the design of energy systems, aircraft, cars, electronic equipment, constructions, packaging, etc., which depend critically upon the availability of novel materials. Of equal importance is an understanding of both advanced processing techniques, the latest computer based design procedures and environmental aspects essential for product commercialization from the concept phase. After having completed this course, the student should be able to: define concepts and entities related to high performance products have a good understanding about product range manufactured with various methods can solve real-life problems related to high performance products.

**Contents:**

Composite industry overview: applications for composites, history and current technologies. Health and safety and industry terminology in high performance products. Applications in energy systems, aeronautical industry, automotive industry, marine industry, construction industry and smart materials in packaging industry.

**Teaching Methods:**

Lectures 28 h. Independent study 72 h. Seminar 30 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, examination 70 %, seminar 30 %.

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Places for exchange-students? (Yes, number/No):**

Yes, 10

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Marko Hyvärinen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Laboratory Engineer, D.Sc. (Tech.) Marko Hyvärinen

**Aims:**

Aim of the course is to get the students familiar to the project type working in materials engineering. Typical project will start with selection of materials and manufacturing method for a certain end product. After having completed this course, the student should be able to: ability to build up material selection route from end product and manufacturing methods to raw materials ability to work in a project organisation in certain role can act and communicate in groups and networks.

**Contents:**

Projects are completed across the full spectrum of manufacturing, including energy systems, automotive, construction industry, packaging etc. Project titles are varied and cover areas of operational improvement, strategic decision-making and organizational management. Sub-areas for project can be following: material optimization, selection of manufacturing method, testing, production planning, scheduling and inventory optimization, capacity utilization, lead time reduction, quality improvement and control, new product development process, effective maintenance, energy usage, layout floor planning, inter-departmental effectiveness, feasibility study in to a new technology, market approval, sales, marketing and business strategy, new markets, products, company strategies, competitors and routes to market.

**Teaching Methods:**

Lectures 6 h, exercises and individual guidance 28 h, project work 96 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, project work 70 %, exercises 30 %.

**Course Materials:**

Course material in Moodle. Other literature to be announced during lectures.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

This course has 1-10 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

## **KoDSaManu: Modern Manufacturing, 20 - 30 cp**

**Validity:** 01.08.2016 -

**Form of study:**

**Type:** Study module

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

No course descriptions.

*Obligatory Studies 25 ECTS cr*

### **BK50A4000: Production Processes in Modern Job Shops, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Juho Ratava, Mika Lohtander

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Researcher, D.Sc. (Tech.) Mika Lohtander

**Aims:**

After completing the course, the students:

1. can choose the manufacturing processes for the most common products
2. are able to design a manufacturing order for a modern product
3. are able to evaluate manufacturing time and manufacturing costs based on basic mathematics.

**Contents:**

The course focuses production processes, material handling and storage methods needed in modern job shops. During the course, students become familiar with the basic metal industry processes as well as manual and automatic assembly processes. Individual works allows students to familiarize themselves to different kind of manufacturing processes. Students presents case-tasks to other students.

**Teaching Methods:**

Lectures 24 h, lecture exercises and week works 12 h. Independent work 94 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, activity during course 33 %, learning diary 34 %, lecture exercises 33 %.

**Course Materials:**

Literature to be announced during lectures. Course material is available in the Moodle.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**BK50A4100: Manufacturing Systems and Scheduling, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Esko Niemi, Mika Lohtander

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Researcher, D.Sc. (Tech.) Mika Lohtander

**Aims:**

After completing the course, the student:

1. is able to evaluate the most important production parameters like lead time and bottlenecks by means of simulation
2. is able to design fundamentals of the manufacturing systems
3. is able to evaluate manufacturing time and manufacturing costs based on manufacturing simulation

**Contents:**

The course focus on production management and analysis methods needed in modern job shops. Production was analyzed by computational methods and manufacturing simulation is introduced and some case studies will analyzed. Example tasks are calculated and discussed in small groups. Every lecture includes its own exercise.

**Teaching Methods:**

Lectures 24 h, lecture exercise 24 h. Individual work 82 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, activity during course 50 %, individual work 50 %.

**Course Materials:**

Literature to be announced during lectures. Course material is available in the Moodle.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**BK50A4200: Product Flow in Job Shops, 5 cp****Validity:** 01.08.2016 -**Form of study:** Basic studies**Type:** Course**Unit:** LUT School of Energy Systems**Grading:** Study modules 0-5,P/F**Teachers:** Mika Lohtander**Lectured every other academic year (Yes, next realization year/Leave empty):**

Yes, lecturing every second year, next time in period 1. and 2. in year 2018.

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Researcher, D.Sc. (Tech.) Mika Lohtander

**Aims:**

After having passed the course, the student will:

1. know the the factory management duty and responsibility
2. is able to take responsibility for the daily operations of a production plant
3. know the stakeholders role for production

**Contents:**

The course lectures will discuss the meaning of overall function of manufacturing and stakeholder's point of view. The topics cover everyday information technology, stakeholder cooperation and internal operation of the plant. A personal work will dealt more in-depth point of view to management.

**Teaching Methods:**

Lectures 24 h, individual work 106 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**



No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, learning diary 50 %, individual work 50 %.

**Course Materials:**

Literature to be announced during lectures. Course material is available in the Moodle.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**BK50A4300: Managing Job Shops, 5 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Mika Lohtander

**Note:**

The course will be lectured for the first time during the academic year 2017-2018.

**Lectured every other academic year (Yes, next realization year/Leave empty):**

Yes, 2017-2018.

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Researcher, D.Sc. (Tech.) Mika Lohtander

**Aims:**

After having passed the course, the student will:

1. know the factory management duty and responsibility
2. is able to take responsibility for the daily operations of a production plant
3. know the stakeholders role for production

**Contents:**

The course lectures will discuss the meaning of overall function of manufacturing and stakeholder's point of view. The topics cover everyday information technology, stakeholder cooperation and internal operation of the plant. A personal work will dealt more in-depth point of view to management.

**Teaching Methods:**

Lectures 24 h, individual work 106 h. Total workload 130 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, learning diary 50 %, individual work 50 %.

**Course Materials:**

Literature to be announced during lectures. Course material is available in the Moodle.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

No

**BK50A4401: Fabrication Laboratory, 5 - 10 cp****Validity:** 01.08.2017 -**Form of study:** Basic studies**Type:** Course**Unit:** LUT School of Energy Systems**Grading:** Study modules 0-5,P/F**Teachers:** Mika Lohtander**Note:**Replaces the course 50A4400 Fabrication Laboratory 5 ECTS cr.  
Suitable also for doctoral studies.**Year:**

M.Sc. (Tech.) 1-2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Researcher, D.Sc. (Tech.) Mika Lohtander

**Aims:**

After having passed the course, the student will:

1. get touch some important research topics in field of manufacturing
2. be familiar how to transfer research result to practice
3. is capable to create or build simple and practical solutions.

**Contents:**

The course lectures will discuss the annually changing research themes. During the course the students will built and program simple modern production equipment prototypes. Students will present their Project Work results to public audience.

**Teaching Methods:**

Lectures 12 h, project work 118 h. Total workload 130 h.

**Suitability for doctoral studies (Yes/Leave empty):**

Yes

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0-5, practical part of project work 50 %, theoretical part of project work 50 %.

**Course Materials:**

Literature to be announced during lectures. Course material is available in the Moodle.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

Yes, this course have 1-5 places for open university students. More information on the web site for Open University instructions.

## **KoDSaSusta: Sustainability, 20 - 30 cp**

**Validity:** 01.08.2016 -

**Form of study:**

**Type:** Study module

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

No course descriptions.

*Obligatory Studies 24-27 ECTS cr*

## **BH60A2101: Advanced Course in Life Cycle Assessment, 7 cp**

**Validity:** 01.08.2010 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Sanni Väisänen, Risto Soukka, Ivan Deviatkin

**Note:**

Suitable also for doctoral studies.

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English/Finnish

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Risto Soukka

**Aims:**

Upon completion of the course the student is expected to be able to

1. explain the basic life cycle concepts,
2. plan, implement and analyse assessments to select products and services which fulfil the requirements of sustainable development,
3. plan, implement and analyse assessments to reveal development needs of products and services,
4. recognise the most inexpensive ways to reduce the environmental impact, and
5. perform life cycle assessments using software.

**Contents:**

Introduction to life cycle assessment, carrying out life cycle assessment, aspects related to inventory analysis, aspects related to impact assessment, calculating a carbon footprint, introduction to life cycle costing, aspects related to life cycle costing, LCA and LCC examples. This course is also suitable for postgraduate students.

**Teaching Methods:**

3rd period: 10 h of lectures, 3 h of computer training. Assignment 1 with a Quiz, literature and computational part, individual and pair work (approx. 38 h).

4th period: 4 h of lectures, 4 h of computer training. Assignment 2 with Life cycle modelling task, final report and result presentation meeting, group work (approx. 82 h).

Examination and preparation for it (approx. 41 h). Total workload 182 h.

**Suitability for doctoral studies (Yes/Leave empty):**

Yes

**Doctoral School course where enrollment is in WebOodi (Yes/Leave empty):**

Yes

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

Yes

**Examination in Exam (Yes/No):**

No

**Assessment:**

0 - 5. Assignments 75 %, examination 25 %.

**Course Materials:**

Walter Klöpffer, Birgit Grahl Life Cycle Assessment (LCA), A Guide to Best Practice. Moodle. Standards ISO 14040 and ISO 14044.

**Prerequisites:**

Recommended: BH60A2401 Energy Recovery from Solid Waste and BH60A0252 Solid Waste Management Technology and BH60A1600 Basic Course on Environmental Management and Economics.

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

**Grading:** Study modules 0-5,P/F

**Teachers:** Sami-Seppo Ovaska, Katriina Mielonen

**Note:**

Replaces the course BJ02A4050 Biomaterials Design and Application  
Suitable also for doctoral studies

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Katriina Mielonen/Edited 27.6.17/ml

**Aims:**

To give an overview about the use of modern biochemicals such as nanocellulose, hemicellulose lignin in various applications.

After the completing the module, the student ought to:

- describe how various renewable resources is utilized in various applications.
- have an insight into material and molecular design and its role for the end product performance
- describe how biomaterials, and in particular wood derived, are used for example in food, pharmaceuticals, composites, and smart materials.

**Contents:**

Use of fibers, cellulose (derivatives), lignin in various non-paper applications. Fundamentals about biomaterial design, modification, synthesis and use in various products.. Chemical and mechanical modification, separation methods, mixing and drying methods. Product specification requirements and characterization methods.

**Teaching Methods:**

Lectures 28h Self studies 42h Project work 30h.

**Suitability for doctoral studies (Yes/Leave empty):**

Yes

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Number of mid-term examinations:**

0

**Assessment:**

0-5. 70% written examination 30% project work.

**Course Materials:**

Lecture material will be distributed via Moodle.

**Prerequisites:**

BJ02A4040 Processing of biomaterials

**Places for exchange-students? (Yes, number/No):**

Yes, 5

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**CS30A1691: Social Sustainability, 6 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Business and Management

**Grading:** Study modules 0-5,P/F

**Teachers:** Suvi-Jonna Martikainen, Helinä Melkas, Satu Pekkarinen, Rakhshanda Khan, Suvi Konsti-Laakso

**Year:**

B.Sc. (Tech.) 3

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Helinä Melkas

**Aims:**

The student learns to understand the significance and meaning of social sustainability in development of business, organization as well as product and service processes. This aim is approached by looking into the theme both from theoretical and practice-based viewpoints. The student gains insight into the kinds of tools and methods that enable social sustainability to become part of business, management as well as product and service development. The student recognizes appropriate situations for applying these methods, and gains elements for critical thinking.

**Contents:**

Core content: social sustainability at different levels (global, societal and organizational), social innovation, frugal innovation, social enterprise, end-user involvement, employee involvement, human impact assessment  
Supplementary content: practical cases, methods and Living Lab activities

**Teaching Methods:**

Lectures (intensive teaching) and small group assignments during the lectures 5 h; case exercise to be given during the lectures 60 h; independent and/or group studies 66 h; presentation of case exercises in a closing seminar 10 h; personal learning diary 15 h = total 156 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0 - 5. Case exercise 70%, learning diary 30%.

**Course Materials:**

The study materials consist of course slides and selected articles (will be announced later).

**Places for exchange-students? (Yes, number/No):**

Yes, 15

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

**CT10A7002: Green IT and Sustainable Computing, 6 cp**

**Validity:** 01.08.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Business and Management

**Grading:** Study modules 0-5,P/F

**Teachers:** Jari Porras

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Jari Porras

**Aims:**

After the course students are familiar with technologies for Green IT and sustainable computing. Students know critical thinking and argumentation principles and are able to apply these skills in discussions carried over the topic. Students are able to discuss about the topic and examine it critically.

**Contents:**

The course emphasizes Green IT and sustainable computing field in sustainable development. The topic is covered through books and scientific articles. Students may be divided into small groups that will each study the topic.

**Teaching Methods:**

Lectures 2 h, seminars and discussions 8 h, homeworks 16 h, self-study 24 h, 3. period.  
Seminars and discussions 20 h, homeworks 26 h, self-study 60 h, 4. period. Total 156 h.

**Examination in Examination schedule (Yes/No):**

No

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

No

**Assessment:**

0 - 5. Seminar work(s), active participation in discussions, homeworks.

**Course Materials:**

To be announced in Moodle pages before the course.

**Limitation for students? (Yes, number, priorities/Leave empty):**

Yes, 36. Priority is given to Software Engineering students.

**Places for exchange-students? (Yes, number/No):**

Yes, 5

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability

*Students, who haven't done BH60A0000 Ympäristötekniikan perusteet in their earlier studies, are required to do Introduction to Sustainability.*

**BH60A4400: Introduction to Sustainability, 3 cp**

**Validity:** 01.08.2013 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

**Grading:** Study modules 0-5,P/F

**Teachers:** Virgilio Panapanaan, Mirja Mikkilä, Risto Soukka

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Risto Soukka

**Aims:**

Upon completion of the course the students are expected to be able to:

- 1) explain the interaction between the environment, society and business and understand the relationships of various actors in these fields and their impacts on the society and the environment;
- 2) understand the core idea and thinking behind sustainability and its importance in order to limit or decelerate environmental damages and improve our quality of life while pursuing a more sustainable lifestyle and business within the planetary boundaries;
- 3) understand and apply practically the learned principles and concepts of sustainability in relation to current production and consumption habits;
- 4) know and be guided about the different value-adding activities and tools that promote sustainability; and
- 5) demonstrate the ability to reflect sustainability principles in the assignment, studies and desirably in thinking and lifestyles.

**Contents:**

The general objective of the course is to introduce students to different sustainability challenges that our world is facing as a consequence of human activities and natural causes. The idea is to learn and understand those sustainability challenges and their interconnectedness, and find out how we could move or transit towards a more sustainable world.

**Teaching Methods:**



1st period: 14 h of lectures. Independent study (approx. 64 h): assignment (group work) and seminar (approx. 26 h). Preparation for the examination and the exam (approx. 38 h). Total workload 78 h.

**Examination in Examination schedule (Yes/No):**

Yes

**Examination in Moodle (Yes/No):**

No

**Examination in Exam (Yes/No):**

Yes

**Assessment:**

0 - 5. Examination 70 %, assignment 30 %.

**Course Materials:**

Will be announced during lectures. Moodle.

**Limitation for students? (Yes, number, priorities/Leave empty):**

Yes, 80, priority is given to the students who have this course as an obligatory in their degree structure

**Places for exchange-students? (Yes, number/No):**

No

**Places for Open University Students?(Yes, number/No):**

This course has 1-5 places for open university students. More information on the web site for open university instructions.

**Related to:**

to sustainability