# Catalogue report

**LUT School of Energy Systems**

# Master's Programme in Mechatronic System Design

## Master’s Programme in Mechatronic System Design 2018-2019 (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 the MSc Programme in Mechatronic System Design**

After the completion of the Master's Programme in Mechatronic System Design a student will acquire extensive knowledge of the design, hydraulics, control, dynamics and simulation of machines. A student will also learn about environmentally conscious design and the development of new technologies to solve current and future global problems. During the studies, a student will be able to apply simulation tools to analyse demanding machine systems. This expertise can be applied to the most demanding research and development processes of the global industry.

A student will

- be able to demonstrate a comprehensive understanding of dynamics of mechatronic machines, simulation tools and usage of them, multidisciplinary product development process
- have adopted the principles of applying theoretical methods into practice using virtual tools
- have ability to design and implement control systems for mechatronic machines
- be able to work with others in task-orientated groups participating and interacting in the group in a productive manner and lead and manage design projects
- be able to logically think through industrial research and development problems and solve them, to contribute to innovative thinking
- be able to understand the needs and special features of other disciplines out of core competence in mechanical engineering design

**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:
Mechatronic System Design

# 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).

Minors of Mechanical Engineering are:

KoDSaManu Modern Manufacturing
KoDSaMate Advanced Materials Engineering
KoDSaLate Laser Processing and
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 Mechatronic System Design 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

## Core Studies (min 34 cr)

KoDCore: Core Studies, 30 - 40 cr
- *Obligatory Studies 34-35 ECTS cr*
  - BK10A1200: Research Methods and Methodologies, 4 cr
  - BK10A3800: Principles of Industrial Manufacturing Processes, 5 cr
  - BK10A3900: Reliability Based Machine Element Design, 5 cr
  - BK10A4100: Management and Leadership Skills in Mechanical Engineering, 5 cr
  - BK10A5400: Digitised Design and Production in Welded and 3D-printed Structures, 5 cr
  - BK50A2701: Selection Criteria of Structural Materials, 5 cr
  - BK70A0001: Simulation of a Mechatronic Machine, 5 cr
- *Only for students coming outside LUT*
  - BH60A4600: Introduction to M.Sc. Studies, 1 cr

## Specialisation Studies (min 55 cr)

KoDMecha: Mechatronic System Design, 50 - 70 cr
- *Obligatory Studies 55 ECTS cr*
  - BK10A1501: Master's Thesis and Seminar, 30 cr
  - BK60A0800: Fluid Power, 5 cr
  - BK60A1001: Control of Mechatronic Machines, 5 cr

BK70A0501: Machine Dynamics, 5 cr
BK70A0102: Simulation, Laboratory Course, 5 cr

*Alternative Studies. Students, who wish to focus their studies in business and industrial oriented design, should select the first of the following courses and students, who wish to focus their studies in scientific research, should select the latter of the following courses.*

BK60A1500: Practical Laboratory Course in Motion Control and Mechatronics, 5 cr
BK70A0600: Computational Methods in Mechanics, 5 cr

### Minor Studies (min 20 cr)

Students may choose any minor studies taught at LUT if the required prerequisites are fulfilled. Minor studies of Mechanical Engineering are Modern Manufacturing (KoDSaManu), Laser Processing (KoDSaLate), Advanced Materials Engineering (KoDSaMate) and Sustainability (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).

Minors of Mechanical Engineering are:

KoDSaManu Modern Manufacturing
KoDSaMate Advanced Materials Engineering
KoDSaLate Laser Processing and
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 2018-2019 are:

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)
SaDREE Renewable Energy and Energy Efficiency

Industrial Engineering and Management:
TuKSOTekn Tuotantotalous, sivuopinnot muu tekniikka (in Finnish)
TuDSO Tuotantotalous, sivuopinnot laaja (in Finnish)
TuSOEntr Entrepreneurship, minor

Computer Science:
TikSOTite Tietotekniikka (in Finnish)

Business Administration:
KaSOLiik Liiketoimintaoaaminen (in Finnish)
KaSOIbm International Business and Management

Computational Engineering:
MaKSaM180 Teknillinen matematiikka (in Finnish)
FyKSaM110 Teknillinen fysiikka (in Finnish)
MaKSaHahmo Data-analytiikka (in Finnish)
MaDIntM300 Technomathematics
FyDInt300 Technical Physics
MaDSaCompu Computer Vision and Pattern Recognition

Chemical and Process Engineering:
KeSoM200 Kemia (in Finnish)
KeSoM300 Kemian prosessitekniikka (in Finnish)
KeSoD200 Advanced Water Treatment
KeSOD400 Biobased Chemical Engineering
KeSOD500 Advanced Chemistry

All minor subjects offered in academic year 2018-2019 can be found in the study guide "Minor Studies 2018-2019".

KoDSaMate: Advanced Materials Engineering, 20 - 30 cr
- *Obligatory Studies 25 ECTS cr*
  - BK90C1900: Introduction to Materials Engineering, 4 cr
  - BK90C2000: Hybrid Materials, 3 cr
  - BK90C2100: Functional Properties of Nanomaterials, 3 cr
  - BK90C2200: Sustainable Manufacturing of Advanced Materials, 5 cr
  - BK90C2300: High Performance Products, 5 cr
  - BK90C2400: Project course in Material Engineering, 5 cr

KoDSaLate: Laser Processing, 20 cr
- *Alternative Studies. Choose at least 20 ECTS cr from following courses.*
  - BK30A0803: Digital Advanced Manufacturing with Lasers, 5 cr
  - BK30A0901: Additive Manufacturing - 3D Printing, 5 cr
  - BK30A1201: Laser Materials Processing, 5 cr
  - BK30A1301: Laser Based Manufacturing for Design, 5 cr
  - BK30A1400: Individual Project Work of Laser Technology, 5 cr

KoDSaManu: Modern Manufacturing, 20 - 30 cr
- *Obligatory Studies 25 ECTS cr*
  - BK50A4000: Production Processes in Modern Job Shops, 5 cr
  - BK50A4100: Manufacturing Systems and Scheduling, 5 cr
  - BK50A4200: Product Flow in Job Shops, 5 cr
  - BK50A4300: Managing Job Shops, 5 cr
  - BK50A4401: Fabrication Laboratory, 5 - 10 cr

KoDSaSusta: Sustainability, 20 - 30 cr
- *Obligatory Studies 24-27 ECTS cr*
  - BH60A2101: Advanced Course in Life Cycle Assessment, 7 cr
  - BJ02A4051: Development of New Sustainable Products and Solutions, 5 cr

CS30A1691: Social Sustainability, 6 cr
CT10A7004: Sustainability and IT, 6 cr

*Students, who haven't done BH60A0001 Ympäristötekniikan perusteet in their earlier studies, are required to do Introduction to Sustainability.*

BH60A4400: Introduction to Sustainability, 3 cr

# Course descriptions

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

### KoDCore: Core Studies, 30 - 40 cr

**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 cr

**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

**Note:**

The course is arranged concurrently in face-to-face learning and distance learning environment.
Replaces the course BK10A1700 Tutkimusmetodiikka JEDI.

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, 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:**

For face-to face learning (1-2 period): Introduction lecture 2 h, 1st period, Learning diary 26h 1st period, Personal guidance and literature search 28 h, 2nd period. Written research plan 48 h, 2nd period. Total workload 104 h.
For distance learning (non-stop): Independent study and literature search 54 h, Written research plan 48 h, Skype-exam and -meetings 2h, Total workload 104 h.
The course is suitable for distance learning.

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

No

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

No

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

No

**Assessment:**

For face-to face learning, 0-5, Learning diary 50 %, Written research plan 50 %
For distance learning: 0-5, Written research plan 50 %, Skype-exam 50 %

**Course Materials:**

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

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

The possibility to pass the course via distance learning is meant only for students of LUT's distance learning programs (JEDI, MEC).

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

No

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

No

### BK10A3800: Principles of Industrial Manufacturing Processes, 5 cr

**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, Juho Ratava

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Postdoctoral Reseacher, 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, the extrusion process, packaging processes. The student is introduced to 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 own text.

**Contents:**

The course focuses on the most typical and used processes in manufacturing technology, as detailed in course objectives. The course runs through the various processes having a strong connection to product design and Design for Manufacturing (DFM) aspects.

**Teaching Methods:**

Lectures 28 h, period 1
Seminar lecture 4 h, period 1
Seminars 4 h, period 2
Project work (groups) and working as an opponent 94 h, periods 1 - 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 seminar.

**Course Materials:**

Course material is available on the Moodle.

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

max 10

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

max 5

### BK10A3900: Reliability Based Machine Element Design, 5 cr

**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, Harri Eskelinen

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, 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. Team and project works deal with practical industrial applications of reliability based engineering.

**Teaching Methods:**

Lectures total 28 h, periods 1 - 2. Literature search 20 h, periods 1 - 2. Team and project work 73 h, periods 1 - 2. Seminar 9 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, continuous and comprehensive evaluation of 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 and exercises in Moodle.

**Prerequisites:**

B.Sc. (Mech.Eng.) Degree or equivalent knowledge.

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

max 5

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

No

**BK10A4100: Management and Leadership Skills in Mechanical Engineering, 5 cr**

**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, Tapio Saarelainen

**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):**

Max 5

### BK10A5400: Digitised Design and Production in Welded and 3D-printed Structures, 5 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Energy Systems
**Grading:** Study modules 0-5,P/F

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Timo Björk, D.Sc. (Tech.), Professor
Antti Salminen, D.Sc. (Tech.), Professor

**Aims:**

After completing the course students:
- have an overview about all production phases of platestructures (from design to end-using and recycling)

- can define the essential phenomena involved in eachprocess phase and can solve them
- understand how the digitalization can be utilized inorder to enhance the efficiency of production

**Contents:**

Introduction: examples of plated structures for demanding applications (ships, boats, cars, bridges, cranes, booms, beam and frame structures, vehicle frames, process equipment, silos, towers, pipes, chimneys, pressure vessels, shell structures, etc..
Material selection based on needs from end users, fabrication and recycling
Design for use and considering the requirements from fabrication, transportation, assembly, maintenance and recycling
Design for manufacturing including: pretreatment, cutting and forming processes of plates, preparing of joints considering welding processes and finishing processes considering the aspect of strength and quality
Lead time and cost control
Design and life cycle control of plate structures based on calculation and monitoring
Digitalization of the production including design, fabrication processes and life cycle control
Design of detail by using 3Dprinting
One personal homework/ guided exercise concerning design of plate structures with documented report:
Geometrical design based on life cycle (loading) control and material selection, fabrication plan incl. cutting, forming and joint preparing, design of bolted and welded joints for chosen process, finishing processes, quality and inspection plan.

**Teaching Methods:**

Lectures 28 h, writing the report/homework 70 h, additional individual work 32 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. Grade is based on the quality of documented report.

**Course Materials:**

Lectures in Moodle.

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

No

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

No

### BK50A2701: Selection Criteria of Structural Materials, 5 cr

**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:**

The course is arranged concurrently in face-to-face learning and distance learning environment.
Replaces the course BK10A2900 Konstruktiomateriaalit ja niiden valinta JEDI

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, 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 staring from the product's requirement list will be discussed in details. Multi-language teaching environment will be utilized during the project work.
Project work focuses to selecting structural materials for industrial applications.

**Teaching Methods:**

For face-to-face learning (3-4 period): Introduction lecture 2 h, 3rd period. Learning diary 36 h, 3rd-4th period. Exercises in small teams 28 h, 3rd-4th period. Project work and poster presentation 44 h, 3rd-4th period. Independent study 20
h. Total workload 130 h.
For distance learning (non-stop):Project work 60 h, Independent study 68 h, Skype-exam and-meetings 2 h.
The course is suitable for distance learning.

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

No

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

No

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

No

**Assessment:**

For face-to-face learning,  0-5, comprehensive and continuous evaluation 50 %, project work 50 %
For distance learning: 0-5, Skype-exam 50 %, project work 50 %

**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 and distance learning: Eskelinen &
Karsikas, Vihreän teknologian näkökulmat konstruktiomateriaalien valinnassa, ISBN 978-952-265-457-1.

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

The possibility to pass the course via distance learning is meant only for students of LUT's distance learning programs.

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

No

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

No

## BK70A0001: Simulation of a Mechatronic Machine, 5 cr

**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

**Note:**

Replaces the course BK10A3101 Simulation of a Mechatronic Machine JEDI

**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 hydraulically 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 22 h, 1st-2nd period. Teamwork in multi-cultural working environment 32 h, 1st-2nd period.Supervised tutorials 24 h, 1st-2nd period. Independent study 52 h, 1st-2nd period. Total loading 130 h.
The course is suitable for distance learning.

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

Yes

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

No

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

No

**Number of mid-term examinations:**

2 (mid-term examinations in Moodle)

**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):**

15–

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

max 15

*Only for students coming outside LUT*

### BH60A4600: Introduction to M.Sc. Studies, 1 cr

**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:** Risto Soukka, Sanni Väisänen, Aki-Pekka Grönman, Katja Hynynen, Marjaana Lehtinen

**Note:**

Lectures together withall students of International Master's programs in Energy Technology, Electrical Engineering, Mechanical Engineering and Sustainability Science and Solutions.
Lectures for students of MSc programme in Circular Economy will be arranged in Lahti or online (announced in the beginning of the course).

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-Doctoral Researcher, TkT Sanni Väisänen
Post-Doctoral Researcher, TkT Katja Hynynen
Associate Professor, TkT Ahti Jaatinen-Värri
University Lecturer, TkT Kimmo Kerkkänen

**Aims:**

Upon completionof the course the student is expected to be able to:
1. describe the content of the Degree Programme, interpret the study guide andalso describe the research areas of School of Energy Systems,
2. prepare his/her individual study plan (ePSP) and follow the progress ofhis/her studies with the help of WebOodi's personal study plan,
3. observe the university's examination practices and degree programmepractices (incl. instructions of the Master's Thesis),
4. use the services of the library, retrieve information independently and usethe information sources in accordance with good practices, and also toobserve the copyrights,
5. understand how to manage the studies and how to find help when needed duringhis/her studies,
6. use the Moodle learning environment,
7. knowshow to improve information security during his/her daily use ofuniversity networks,
8. understandthe concept of career planning and use the services of career services,
9. understand the concept of cultural differences and how it mighteffect on his/her daily social intercourse.

**Contents:**

Getting to know the School of EnergySystems and the Master's programs Studies (incl. Master's Thesis). Studyand exam culture in LUT. LUT library collections, databases,reference practices, and copyrights, information security, career planningand cultural difference related issues. Study Skills and Motivation. ePSPworkshop. Research areas of School of Energy Systems. The course is related to sustainability.

**Teaching Methods:**

1st and 2nd period: 15 hof obligatory lectures (incl. participation in an ePSP workshop. 1stperiod: Information security training and Information searchning web courses (2+ 5 h). 2nd period: Individual discussion with a teacher tutor 1 h. Individualwork 3 h. Total workload 26 h.

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

No

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

No

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

No

**Assessment:**

Pass/fail. Passing the course requires attendance at the lectures, ePSP, passing individual Information security training and Information searching web courses, written assignment, and discussion with teacher tutor.

**Course Materials:**

Study Guide, Moodle, LUT library collections, and databases.

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

No

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

No

## KoDMecha: Mechatronic System Design, 50 - 70 cr

**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 cr

**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

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Katriina Mielonen, University Lecturer, D.Sc.
Harri Eskelinen, Professor, D.Sc.

**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.
1st-4th period. Elevator speech when thesis is ready.
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 %. Elevator speech passed.

**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

**BK60A0800: Fluid Power, 5 cr**

**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:** Heikki Handroos

**Note:**

The course is suitable both for the students present in LUT and for students participating distantly. The major part of activities such as lectures and tutorials are given through Moodle. The activities required may slightly vary between the two groups.
Replaces the course BK10A3000 Fluid Power JEDI

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Heikki Handroos

**Aims:**

To understand the structure and behaviour of fluid power transmission components and systems. Skills for dimensioning hydraulic components for various systems. Skills for designing fluid power transmissions for industrial and mobile machines. Ability to analyse hydraulic components and systems through modelling and simulation.

**Contents:**

Fluid power system structures, hydraulic fluids, hydraulic transmission lines, pumps, motors, cylinders, basic control valves, servo valves, accessories, hydraulic servo systems, modelling and simulation of hydraulic components and circuits.

**Teaching Methods:**

Video lectures recorded in Moodle 42 h, periods 3-4. Tutorials and simulation assignment 42 h, periods 3-4. Laboratory work 16 h including modelling and simulation of a fluid power transmission system.

Independent study 30 h. Total workload 130 h.
The course is suitable for distance learning.

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

Yes

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

No

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

Yes

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

Yes

**Assessment:**

0-5, examination 75 %, tutorials, assignment and laboratory work 25 %.

**Course Materials:**

Lecture notes in Moodle. Ebook: Rabie, M. Galal: Fluid Power Engineering, McGraw-Hill, 2009.

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

max 5

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

max 5

### BK60A1001: Control of Mechatronic Machines, 5 cr

**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:** Hamid Roozbahani

**Note:**

BK10A4600 Control of Mechatronic Machines JEDI

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Hamid Roozbahani

**Aims:**

Mechatronics is a multidisciplinary field of science that includes a combination of mechanical engineering,
electronics, computer engineering, telecommunications engineering, systems engineering and control engineering. As technology advances, the subfields of engineering multiply and adapt. Mechatronics' aim is a
design process that unifies these subfields. Originally, mechatronics just included the combination of mechanics
and electronics, hence the word is a combination of mechanics and electronics, however, as technical

systems
have become more and more complex the definition has been broadened to include more technical areas.
The aim of this course is to develop theoretical and practical expertise in the field of Mechatronics. Via this
course, students learn to analyze, design, develop and control Mechatronic systems. Programming and control of
Mechatronic systems are an important part of this course which powers up the students IT skills. The application
of control systems covers a wide area of the science and technology in every field and the course provides a
sound basis for the study of both classical and modern techniques.
After having passed this course module, the student will be able to:
- Develop mathematical Model of Mechatronic systems
- Develop control algorithm to control the modeled systems
- Develop simulations based on real mechatronic systems and control both systems
- Design servo control systems for hydraulic, pneumatic and electrical systems e.g. by utilizing the frequency and time domain methods
- Programming and control of mechatronic machines e.g. a robotic systems.

**Contents:**

This course introduces common industrial servo control systems: hydraulic, pneumatic, and electrical systems.
The dynamic analysis of these servo systems is studied in the time and frequency domain. Different control
strategies are introduced, mainly classical with some concepts of modern control. The design and analysis of
digital control will be introduced. During this course, design, analysis and simulation are conducted using Matlab/Simulink.
The course theoretical content is as below:
- Introduction to the course
- Theory of Control
- Electrical Systems
- Hydraulic Systems
- Pneumatic Systems
- Sensors
- Digital Control
- Signal Processing
- Haptics

**Teaching Methods:**

Lectures 36 h, 1st-2nd period. Tutorials 36 h, 1st-2nd period. Exercises 14 h, 1st-2nd period. Project work 30 h.
2nd period. Independent study 14 h. 1st-2nd period. Total loading 130 h.
The course is suitable for distance learning.

**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):**

Yes

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

Yes

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

Yes

**Assessment:**

0-5, final exam 40 %, tutorials: 30 %, final project: 30 %.

**Course Materials:**

- Lecture notes.
- Selected chapters from the following textbooks:
[1] Modern Control Engineering (5th Edition): Katsuhiko Ogata
[2] Jelali Mohieddine: 'Hydraulic servo systems, modeling, identification and control'.

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

15–

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

15–

## BK70A0501: Machine Dynamics, 5 cr

**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:** Jussi Sopanen

**Note:**

Replaces the course BK10A3201 Machine Dynamics JEDI

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Jussi Sopanen

**Aims:**

The student will learn theories and practices of structural dynamics and knows how to apply the knowledge in the design of machine systems. He/she is able to model dynamic machine systems, solve the equations of motion in frequency and time domains and analyze the results from simulations and measurements. The student knows the basics of vibrations measurements and experimental modal analysis. The student is able to review and interpret his/her student mate’s simulation results resembling the tasks in the later career. Some of the practical examples and assignments are real-life cases arising from co-operation with industrial companies.

**Contents:**

Multiple degree-of-freedom vibrations, solution and interpretation of natural frequencies and modes. Response to the harmonic and general force excitation. Derivation of the equations of motion of the system and solution in the frequency and time domain. Vibration measurements and experimental modal analysis. Introduction to rotor dynamics. Torsional vibrations.

**Teaching Methods:**

Lectures 28 h, periods 1-2. Online tutorials 24 h, periods 1-2. Laboratory work or analysis of measurement results 4 h, homework 68 h, periods 1-2. Preparation for exam 10 h, periods 1-2. Total workload 134 h. Lectures, tutorials and lab sessions are possible to follow online. The course is suitable for distance learning.

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

No

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

Yes

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

No

**Assessment:**

0-5, online examination or online mid-term examinations 60 %, homework and laboratory exercises 40 %.

**Course Materials:**

Lecture notes. Inman, D. J.: Engineering vibration, 3rd ed., Pearson Education Inc., New Jersey, 2007. ISBN 0-13-228173-2.

**Prerequisites:**

Students are recommended to have basic skills on Dynamics. Experience or basic studies of Finite Element Method (FEM) is also recommend, but not required.

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

15–

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

max 10

### BK70A0102: Simulation, Laboratory Course, 5 cr

**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:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**Aims:**

The student will learn the advanced theories and practices of the mathematical modelling and computer simulation of machine systems. The student will be able to utilise advanced simulations to solve a practical design assignment. The student will be able to verify and evaluate the accuracy of simulation models. The student will be able to conduct individual scientific work to analyse the dynamics of machine systems.

**Contents:**

Spatial kinematics, modelling of flexible bodies in multibody applications, modal reduction methods, real-time simulation, embedded systems, contact modelling, multibody dynamics on failure analysis, vehicle modelling, model verifications, practical measurements.

**Teaching Methods:**

Lectures 22 h, periods 3-4. Teamwork in a multi-cultural working environment 32 h, periods 3-4. Supervised tutorials 36 h, periods 3-4. Independent study 40 h, periods 3-4. Total workload 130 h.

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

Yes

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

No

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

No

**Number of mid-term examinations:**

2

**Assessment:**

0-5, examination or mid-course examinations 45 %, simulation work 45 %, in class quizzes 10 %.

**Course Materials:**

Lecture notes. Shabana, A. A.: Dynamics of Multibody Systems, Cambridge University Press, 3rd edition, 2005. ISBN 0-521-85011-8. Shabana, A. A.: Computational Dynamics, John Wiley & Sons, Inc., 1st edition,1994. ISBN 0-471-30551-0.

**Prerequisites:**

Recommended: BK70A0001 Simulation of a Mechatronic Machine completed.

**Number of exercise groups where enrollment is in WebOodi (Number/Leave empty):**

1

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

max 10

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

max 15

*Alternative Studies. Students, who wish to focus their studies in business and industrial oriented design, should select the first of the following courses and students, who wish to focus their studies in scientific research, should select the latter of the following courses.*

### BK60A1500: Practical Laboratory Course in Motion Control and Mechatronics, 5 cr

**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:** Hamid Roozbahani

**Year:**

M.Sc. (Tech.) 2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Hamid Roozbahani

**Aims:**

Mechatronics is a design process that includes a combination of mechanical engineering, electrical engineering, control engineering and computer engineering. Control is the engineering discipline that applies control theory to design systems with desired behaviors.
To give the student a deeper understanding of mechatronic systems from the practical perspective. The student will learn how to use experimental tools to verify simulation models and analyzes. He/she is able to form the design of experiments, arrange an appropriate environment for the studied device or machine to get reliable measured results. The student is also able to run the planned tests and analyze the results. In this course, advanced modeling, programming and simulation tools and methods are introduced for students.
Students will learn how the related simulation tools such as MATLAB & SIMULINK can be used to solve and analyze Control and Mechatronic problems. Students learn also how to use modern automation systems in order to implement controllers using SIMULINK, LabVIEW and C programming languages. This course provides a mathematical basis for problem formulation, and coding/solving using the above-mentioned computational packages. Students will learn how to solve simple control problems using their own codes, algorithms and designs. After this course, they will be able to start working on various topics in mechatronic for advanced designs or analysis.

**Contents:**

This course introduces common industrial servo control systems: hydraulic, pneumatic, and electro-mechanic systems. The dynamic analysis of these systems is studied in both time- and Frequency - domain. Different control strategies are introduced, mainly classical with some concepts of modern control. Design and analysis of digital control will be introduced.
This course has three major parts: demonstration lectures, tutorials and project work. The course content is as below:

- Introduction to Control & Mechatronics and related problems
- Theoretical and practical expertise in the analysis and design of control systems
- Mechatronic machines e.g., a robotic machine
- The application of control system strategies in wide area of both classical and modern techniques
- Model and simulation of control of mechatronic machines
- Design control systems for hydraulic, pneumatic and electro-machines e.g., by utilizing the frequency- and time-domain or discrete digital controllers
- LabVIEW training
- NI myRIO training: Using LabVIEW in action for measurement and control using FPGA
- Development of simple mechatronic system to study sensing and actuating
- PLC and embedded control.
- C programming
- MATLAB & SIMULINK training
- dSPACE Medkit training : Using SIMULINK in action for measurement and control
- Development of simple mechatronic system to study sensing and actuating

Tutorials: (14 Tutorials for 36 hours):
Every week, after every lecture, the student will receive one Tutorial/Exercise to do independently during the week. On the next tutorial session, student and lecturer will check the student's solutions together and then lecturer solves the tutorial for all students. Every tutorial problems is based on the same week lecture topic. Student will receive 25% of his final grade based on his activities for tutorials.

Project work:
A project is done in one of the laboratories of the department. The project is planned together with the supervisor(s) and consists mainly of laboratory work, literature work and report writing. The essential part of the work is to use simulation tools to predict the behavior of the system and verify the results using measurements in practice. The project may also be

planned together with industry and then carried out at some industrial location.
Students will teamed up in the first week of the course and the available projects will introduce to them. Every team has the whole semester to:
1. Finalize the project
2. Prepare a report
3. Give a presentation about the project and results

Software:LabVIEW, Matlab/Simulink, C++, dSPACE Target Link, dSPACE ControlDesk
Hardware:NI myRio, LEGO Mindstorm EV3, dSPACE MedKit, dSPACE DS1013

**Teaching Methods:**

Lectures 36 h, 1st-2nd period. Tutorials 36 h, 1st-2nd period. Independent study and exercise 18 h. Project work 40 h. Total loading 130 h.

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

Yes

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

Yes

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

Yes

**Assessment:**

0-5, final exam 25 %, tutorials 25 %, final project 50 %.

**Course Materials:**

Lecture notes.
Selected chapters from the following text books:
1) Modern Control Engineering (5th Edition): Katsuhiko Ogata
2) Matlab & SIMULINK user manual based on Mathworks database
3) NI LabVIEW
4) Digital Control of Dynamic Systems: Gene F. Franklin
5) Digital Control Systems, Design, Identification and Implementation, Ioan D. Landau

**Prerequisites:**

The course is designed for students, who have background in mechanical or electrical engineering studies.

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

15–

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

15–

### BK70A0600: Computational Methods in Mechanics, 5 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Energy Systems
**Grading:** Study modules 0-5,P/F

**Year:**

M.Sc. (Tech.) 2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Grzegorz Orzechowski

**Aims:**

The student will learn and practice a computational methods commonly used in mechanics. The special attention will be put to numerical analysis of the kinematics and dynamics of the vibrating and rigid multibody systems. The student familiarizes with the basic theory behind such a systems and the numerical methods commonly used to solve them. This will include solution of the nonlinear systems of equations, sparse and dense linear algebra, integration of the equations of motion and modal analysis. Good programming practices will be strongly emphasize. The student will learn how to write efficient, clear and manageable engineering code using the high-level linear algebra software, like Matlab.

**Contents:**

Techniques for correct and efficient programming using Matlab. Sparse and dense matrix computations, debugging and profiling of the code. Common code mistakes and good practices. Numerical solution of the equations of motion of vibrating and multibody systems. Numerical integration of the ordinary differential equations and differential-algebraic equations. Explicit and implicit integration methods and constraint stabilization. Newton-Raphsonmethod for solution of nonlinear systems of equations. Work with version control system (GIT). Introduction to unit tests.

**Teaching Methods:**

Lectures with hands-on exercises 42 h, Periods 3-4
Homework 20 h, Periods 3-4
Teamwork in a multi-cultural working environment 28 h, Periods 3-4
Projectwork 44 h, Periods 3-4
Total workload 134 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, mid-term and final projects 60 %, homework and hands-on exercises 40 %

**Course Materials:**

Matlab documentation.
LingeS. and Langtangen H. P., Programming for Computations - MATLAB/Octave: A GentleA Gentle Introduction to Numerical Simulations with MATLAB/Octave. Springer,2016, ISBN 978-3-319-32451-7.

**Prerequisites:**

Students are recommended to have basic skills in programming and matrix calculus.Experience in kinematics and dynamics is also recommend, but not required.

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

max 5

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

max 5

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

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

**Validity:** 01.08.2016 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Energy Systems
**Grading:** Study modules 0-5,P/F

**Aims:**
After completing this minor subject the student will be able to:
- understand the influence of material selection to the product design
- structure hybrid materials from separate raw material sources
- have the readiness to understand the usability of nanomaterials and ceramics in processes and products
- apply various manufacturing methods to advanced materials processing and define concepts and entities related to high performance products
- ability to build up material selection route from end product and manufacturing methods to raw materials

*Obligatory Studies 25 ECTS cr*

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

**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):**

max 10

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

max 10

**BK90C2000: Hybrid Materials, 3 cr**

**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 50 %, exercises and seminar 50 %.

**Course Materials:**

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

**Prerequisites:**

-

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

max 10

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

max 10

### BK90C2100: Functional Properties of Nanomaterials, 3 cr

**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, liquid crystals properties and application, nanocellulose and 'smart" polymers. Analytical tools in nanoscience. Applications of nanomaterials. Synthesis of nanoscale materials. Bottom-up and top-down approaches. Safety of nanomaterials.

**Teaching Methods:**

14 h of lectures, 2 h of laboratory work, 14 h of tutorials, total workload 78 h, 3rd period

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

No

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

No

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

Yes

**Assessment:**

Numerical assessment, 0-5; Final grade will include: examination 60 %, essay 40 % and laboratory work (pass).

**Course Materials:**

M.F. Ashby et al. Nanomaterials, Nanotechnologies and Design, ELSIVIER Ltd, 2009; Lecture materials; Internet resources.

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

15–

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

max 10

### BK90C2200: Sustainable Manufacturing of Advanced Materials, 5 cr

**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, Katriina Mielonen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**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, undirectional, 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):**

No

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

No

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

Yes

**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):**

max 10

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

max 10

### BK90C2300: High Performance Products, 5 cr

**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:**

Laboratory Engineer, D.Sc. (Tech.) Marko Hyvärinen
Post-Doctoral Researcher, D.Sc. (Tech.) Sami-Seppo Ovaska

**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):**

No

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

No

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

Yes

**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):**

max 10

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

max 10

### BK90C2400: Project course in Material Engineering, 5 cr

**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):**

max 10

## KoDSaLate: Laser Processing, 20 cr

**Validity:** 01.08.2017 -

**Form of study:**

**Type:** Study module

**Unit:** LUT School of Energy Systems

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

**Aims:**

After completing this minor subject the student will be able to:
- understand the principles of material processing lasers and laser based manufacturing systems and components
- understand the principles of laser materials processing in various processes for different materials
- utilize the advantages of digital photonic production in product design
- utilize additive manufacturing and 3D printing in product development and production
- apply the information to utilize laser for development of new manufacturing processes
- realizes and is able handle the occupational safety issues of industrial lasers

*Alternative Studies. Choose at least 20 ECTS cr from following courses.*

**BK30A0803: Digital Advanced Manufacturing with Lasers, 5 cr**

**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:** Antti Salminen, Ilkka Poutiainen

**Note:**

Replaces the course BK10A2401 Digital Advanced Manufacturing with Lasers JEDI

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Antti Salminen
M.Sc. (Tech.) Marika Hirvimäki

**Aims:**

After having passed the course, the student will:
- understand how laser beams are generated in a laser resonator and what kind of optical arrangements are required for a laser materials processing system
- be able to compare and generalize the special features of laser processing systems in production
- understand the risks, hazards and regulations involved in laser materials processing and procedures how these risks are handled in practice
- understand the practical aspects of laser materials processing of different materials
- have skills that are needed in the work life

**Contents:**

Knowledge on different laser equipment, resonator types, accessories and processing systems and requirements of different ways to process material with a laser beam. The principles of systems used for production. Optical components used for laser processing, safety and quality assurance. Tools for beam forming, guiding and modification. Practical use of laser processes. Participation in laser processing demonstrations.

**Teaching Methods:**

Lectures 28 h, 1st and 2nd period. Guided individual working (5x2h) 10 h.
Design, execution and reporting seminar work 92 h. Total work load 130 h.
The course is suitable for distance learning.

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

No

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

No

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

No

**Number of mid-term examinations:**

2 (online mid-term examinations)

**Assessment:**

Written individual report 50 %. Evaluation of learning 50%.

**Course Materials:**

Lecture notes. Steen, W., Laser Material Processing.

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

No

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

max 5

**BK30A0901: Additive Manufacturing - 3D Printing, 5 cr**

**Validity:** 01.08.2015 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Energy Systems
**Grading:** Study modules 0-5,P/F
**Teachers:** Antti Salminen, Heidi Piili

**Note:**

Replaces the course BK10A2500 Additive Manufacturing - 3D Printing JEDI

**Year:**

M.Sc. (Tech.) 2 (M.Sc. (Tech.) 1-2 is also possible in academic year 2018-2019)

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Antti Salminen
Researcher, D.Sc. (Tech.) Heidi Piili

**Aims:**

After having passed the course, the student will:
- know all of the different technologies of additive manufacturing (AM, aka 3D printing)
- be able to compare different AM processes and select suitable processes for different applications
- know the basics about product design for additive manufacturing
- be familiar with the possibilities of additive manufacturing in product development, prototyping and part manufacturing
- have the latest knowledge of additive manufacturing technologies and processes.

**Contents:**

Additive manufacturing (AM, aka 3D printing) processes, materials and equipment. Utilization of the potential of additive manufacturing in product design. Practical cases and applications. Future trends and potential of additive manufacturing. First-hand demonstrations on how to design parts for additive manufacturing. Practical demonstrations on manufacturing of parts with AM processes. Economic aspects of additive manufacturing.

**Teaching Methods:**

Lectures 28 h, periods 3-4. Tutorials 14 h, periods 3-4. Individual work 88 h. Total workload 130 h.
The course is suitable for distance learning.

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

No

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

Yes

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

No

**Assessment:**

Grade 0-5, written project report 80 %, seminar 20 %. Volunteer Moodle exam 20%.

**Course Materials:**

Gibson, I., Rosen, D. W., Stucker, B.: Additive Manufacturing Technologies. Other study material will be listed in Moodle.

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

max 5

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

max 5

### BK30A1201: Laser Materials Processing, 5 cr

**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:** Antti Salminen, Ilkka Poutiainen

**Note:**

Replaces the course BK10A2300 Laser Materials Processing JEDI

**Year:**

M.Sc. (Tech.) 2 (M.Sc. (Tech.) 1-2 is also possible in academic year 2018-2019)

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Antti Salminen

**Aims:**

After having passed the course module the student is able:
- to compare laser materials processing processes and knows different processes special features
- identify what are the theoretical basis affecting in different processes and how they affect the possible applications based on them
- to know how to select and optimize proper process and processing procedure for different materials
- understanding how processing parameters affect the quality of the process / part
- to define what kind of lasers and laser systems can be applied in various processes and applications and how they could be applied

- is able to develop processes for different applications
- is able to work as expert to develop laser based processes for industrial applications

**Contents:**

- laser beam material interaction, transmission, reflection, absorption
- the features of different materials and laser beams affecting on phenomena
- the effect of laser based heating, melting, vaporization and ablation on material
- behavior of molten material and heat transfer mechanisms.
- formation of keyhole and phenomena connected
- knowledge on existing ways to process material with laser beam and the effect of laser beam material interaction on that
- knowledge on most common laser processes like laser welding, laser hybrid welding, cutting, marking, drilling, engraving, micro processing additive manufacturing and surface treatment and the lasers and laser systems used for carrying them out
- practical cases, applications will be combined to theory

**Teaching Methods:**

Lectures 28 h, 3rd and 4th period. Guided team working 3x2 h. Design, execution and reporting of project work in team's 96 h. Total workload 130 h.
The course is suitable for distance learning.

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

No

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

No

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

Yes

**Assessment:**

0-5, written project work report 50 %, oral seminar presentation 30 %, and voluntary exam 20 %.

**Course Materials:**

Steen W., Laser Material Processing. Ion, J., Laser Processing of Engineering Materials.
Course material in Moodle.

**Prerequisites:**

BK20A1300 Laser Based Manufacturing for Design passed or equal level of understanding shown with oral exam.

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

Yes, 1-3

**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.

### BK30A1301: Laser Based Manufacturing for Design, 5 cr

**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:** Ilkka Poutiainen, Matti Manninen, Joonas Pekkarinen, Antti Salminen

**Note:**

Replaces the course BK10A2201 Laser Based Manufacturing for Design JEDI

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Antti Salminen

**Aims:**

After having passed the course, the student will:
- understand how laser beams and systems are used in materials processing
- realize how these processes can be utilized to full in product development of a company
- be able to compare and generalize the special features gained with creative use of different laser based processes and the impact and utilization of the special features of these processes on product design
- understand what kind of properties can be gained with use of laser based processes and how does this effect on design flow of a product
- understand how the real total cost analysis and sustainability studies can be carried out and how they compete with conventional manufacturing technologies
- Realizes what kind of quality can be reached and how these technologies can be used for increasing energy efficiency and save material.

**Contents:**

The possibilities and limitations of laser processing on the product design. The utilization of laser based processes into design routines and philosophies, together with mechanical properties in comparison with conventional manufacturing technologies. Practical case examples. Economic aspects of laser materials processing. The features of most common laser based processes i.e. various different versions and applications of e.g. laser marking, cutting, welding and surface treatment processes.

**Teaching Methods:**

Lectures 28 h. Guided group working in teams (5x2h), 10 h. Design, execution and reporting of project work in teams 92 h. Total workload 130 h.
The course is suitable for distance learning.

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

No

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

No

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

No

**Assessment:**

Grade 0-5, written report 70 %, seminar 30 %. Voluntary learning diary.

**Course Materials:**

Course material in Moodle.

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

max 5

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

max 5

**BK30A1400: Individual Project Work of Laser Technology, 5 cr**

**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:** Antti Salminen, Joonas Pekkarinen

**Note:**

This is a self-study course so it is recommended that student full fills the prerequisites

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Antti Salminen, D.Sc. (Tech.) Heidi Piili, D.Sc. (Tech.) Ilkka Poutiainen

**Aims:**

After having passed the course module the student:
- apply comprehensively the learned skills of previous courses for laser based processes, systems and products
- understand how to perform research project in field of laser engineering / processing
- apply theoretical knowledge in practical R&D work
- have skills to collect existing data and use it for determining solutions
- know how to design and run experiments in field of laser processing
- select and design a laser system for industrial case.
- knows how to select right laser process and optimize the process for different materials
- is able to develop processes for different applications

**Contents:**

During the course student will become familiar with:
- basic phenomena of laser - material interaction in specific case i.e. transmission, reflection, absorption
- the features affecting on performing the experimental work to define the limitations and potential of ways to apply laser for manufacturing
- the effect of potential of laser in design and how to apply that into product and its manufacturing.
- reporting the tests carried out in an efficient effective way both in writing and orally.
- principles how to design and run a research project
- principles in writing scientific peer review publication

**Teaching Methods:**

Lectures 2 h. Guiding discussion with supervisor 15 h. Design, execution and reporting of project work 113 h. Total workload 130 h.
The course is suitable for distance learning.

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

No

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

No

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

No

**Assessment:**

Project plan 15 %, Written report 55 %, Oral presentation 30 %

**Course Materials:**

Steen W., Laser Material Processing.
Ion, J., Laser Processing of Engineering Materials. Course material in Moodle.

**Prerequisites:**

BK30A1301 Laser Based Manufacturing for Design or BK30A1201 Laser Materials Processing passed or equivalent understanding shown in oral exam.

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

No

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

No

## KoDSaManu: Modern Manufacturing, 20 - 30 cr

**Validity:** 01.08.2016 -

**Form of study:**

**Type:** Study module

**Unit:** LUT School of Energy Systems

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

**Aims:**
After completing this minor subject the student will be able to:
- calculate manufacturing process parameter to metallic products to achieve successfully production in technically manner but also economically wise
- design total manufacturing order and overall process to achieve efficient production rate with old and new machines
- create total manufacturing chain from original distributor to end user
- listen, discuss, understand and negotiate with different people with different organizational level
- find and create new production solutions for rapidly changing world

After the studies, students:
- have a theoretical or practical capability to work international environment.
- will understand the importance of the production for the national economy.
- have a theoretical or practical understanding of overall manufacturing and supply chain process to understand deeply different workers role in production.
- have a theoretical or practical understanding of a queque, mathematical distribution and simulation theory used in job shops.
- have a theoretical or practical understanding of a normally used manufacturing process.

*Obligatory Studies 25 ECTS cr*

### BK50A4000: Production Processes in Modern Job Shops, 5 cr

**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, Juho Ratava

**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 12 h. Independent work like assignments and learning diary 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, Lecture assignments 60 %, learning diary 40 %.

**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):**

max 5

### BK50A4100: Manufacturing Systems and Scheduling, 5 cr

**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:**

Reseacrher, 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
4. is able to make optimization for most common manufacturing environments.

**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 40 %, individual assigments 60 %.

**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 cr**

**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 socond year, next time in period 1. and 2. in year 2018-2019.

**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. is able to act as a product manager in a manufacturing plant
2. is able to analyze production capacity and to make improvement for production
3. is able to take responsibility for the daily operations of a production plant
4. is able to respond plant investments

**Contents:**

The course lectures will discuss the meaning of an overall function of a manufacturing flow. The course focuses to the strategy and methods of the production. Student will prepare and present during lectures, key factors and most common issues of production. In assignment, the students will plan and design factory lay-out commonly used in metal industry and present product flowin subcontracting network.

**Teaching Methods:**

Lectures 24 h, Group assignment and 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, lecture activity 40 %, assignment and individual work 60 %.

**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 cr

**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 next time during the academic year 2019-2020.

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

Yes, 2019-2020.

**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, Activity during lectures and exercises 20 %, individual work 80 %.

**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 cr

**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:**

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 plan, design and in some cases built industrial systems. Students will present their Project Work results to a 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):**

max 5

**Description and DL of the company assignment:**

During this particular course, industrial manufacturing related problems could be solved, as an engineering student assignments. Industrial cases could relate to an assembly, processes, automation, product flow, subcontracting or storage. Students can practice production related skill with simulation and optimization software.
Contact:
Mika Lohtander. mika.lohtander@lut.fi, +358 400 579 455

## KoDSaSusta: Sustainability, 20 - 30 cr

**Validity:** 01.08.2016 -

**Form of study:**

**Type:** Study module

**Unit:** LUT School of Energy Systems

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

**Aims:**
After completing this minor subject the student will be able to:
- understand the different sustainability aspects, sustainability challenges and their importance for a business
- recognize sustainability challenges related to different products
- apply life cycle assessment for evaluating environmental impacts of products and for searching environmentally best solutions

*Obligatory Studies 24-27 ECTS cr*

### BH60A2101: Advanced Course in Life Cycle Assessment, 7 cr

**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.
In order to take the course, the student should have own laptor computer with Windows

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

Finnish and English

**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
6. apply theories to find and develop the most sustainable product, process or system design.

**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):**

No

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

Yes

**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):**

max 10

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

max 5

### BJ02A4051: Development of New Sustainable Products and Solutions, 5 cr

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

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Katriina Mielonen

**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 28 h, self studies 42 h, project work 40 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):**

Yes

**Assessment:**

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

**Course Materials:**

Lecture material will be distributed via Moodle.

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

max 5

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

max 5

### CS30A1691: Social Sustainability, 6 cr

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

**Year:**

B.Sc. (Tech.) 3

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Helinä Melkas
Rakhshanda Khan, PhD, Senior Researcher
Satu Pekkarinen, PhD, Senior Researcher
Suvi Konsti-Laakso, M.Sc., Researcher
Suvi-Jonna Martikainen, MA, Researcher

**Aims:**

After completion of the course, students will be able to
- explain and analyze the significance and meaning of social sustainability in development of business, organization and product and service processes
- discuss both theoretical and practice-based viewpoints as well as the kinds of tools and methods that enable social sustainability to become part of business, management and product and service development
- determine and compare appropriate situations for applying these methods
- differentiate between elements for critical thinking concerning social sustainability.

**Contents:**

Core content: social sustainability at different levels (global, societal and organizational), social innovation, frugal innovation, social enterprise, end-user involvement, employee involvement. 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 60 h, presentation of case exercises in a closing seminar 10 h, personal learning diary 21 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).

**Prerequisites:**

None.

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

max 15

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

max 5

### CT10A7004: Sustainability and IT, 6 cr

**Validity:** 01.08.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Jari Porras

**Note:**

This course is meant only for the fulltime students of the software engineering programme.

**Year:**

M. Sc. 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**Aims:**

At the end of this course students will be able to:
1. Identify various sustainable development challenges in the surrounding society
2. Demonstrate the critical thinking and argumentation skills in the discussions of sustainable development challenges
3. Identify the possibilities of IT and especially software engineering in the sustainable development challenges
4. Apply IT and especially software engineering for sustainable development challenges

**Contents:**

The course emphasizes the role and impact of IT field and especially software engineering in the sustainable development. The topic is covered through selected books and scientific articles. Students may be divided into small groups that will each study the topic.

**Teaching Methods:**

This course follows flipped classroom approach. Introductory lectures are used for introducing the lecture material and dividing students into smaller groups.
Lectures 2 h, Mandatory classroom discussions 8 h, Homeworks 16 h, Reading assignments 24h, Period 3.
Lectures 6h, Mandatory classroom discussions 8h, Homeworks 16 h, Reading assignments 24 h, Project work 52 h, Period 4
Total 156 h.

**Assessment:**

0-5 continuous evaluation (no exam)
Presentation(s) 10%
Discussions 20%
Individual homeworks (x2) 20%
Group based homeworks (x2) 20%
Project 30%

**Course Materials:**

Murugesan S. & Gangadharan G.R.: Harnessing Green IT - Principles and practices, Wiley, 2012, 433 p
Tomlinson B.: Greening through IT - Information Technology for Environmental Sustainability, MIT Press, 2010, 221 p
A set of yearly changing scientific articles that will be announces at the moodle pages of the course.

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

This course is meant only for the full time students of the software engineering programme

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

max 10

*Students, who haven't done BH60A0001 Ympäristötekniikan perusteet in their earlier studies, are required to do Introduction to Sustainability.*

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

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

**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

**Contents:**

The idea is to learn and understand 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.

**Suitability for doctoral studies (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. Examination 60 %, assignment 40 %.

**Course Materials:**

Will be announced during lectures. Moodle.

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

max 5

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

max 5