# Catalogue report

**LUT School of Engineering Science**

# Master's Programme in Computational Engineering and Technical Physics

## Master’s Programme in Computational Engineering and Technical Physics 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 Computational Engineering and Technical Physics**

After the completion of the MSc programme in Computational Engineering and Technical Physics the student will obtain sufficient mathematical and computational skills for industry and other research and development tasks.

The students will

- be able to apply scientific methods to work
- master the advanced knowledge and skills involving major subject
- be able to work as experts, developers and researchers
- understand the fundamentals of minor subject

In addition, *Technomathematics* graduates will

- be able to describe systems and processes in the form of mathematical models
- possess symbolic data analysis and numerical analysis skills for mathematical equations and expressions
- be able to apply numerous applied mathematics techniques
- be able to apply statistical theory to study and describe the uncertainty of models and observations
- be able to use computational software to simulate and visualise models

In addition, *Technical Physics* graduates will

- have an advanced knowledge of physics
- be familiar with the scientific literature and research in the field
- be able to collaborate internationally with physics researchers
- master empirical research principles and laboratory practices
- be able to apply advanced measurement techniques
- be familiar with modern physics and material science
- have a knowledge of the application of physics in industry and other sectors of society

In addition, *Computer Vision and Pattern Recognition* graduates will

- be able to analyse challenging information processing problems and solve them algorithmically
- have strong programming skills to implement information technology solutions
- be able to apply intelligent information processing methods to solve information processing problems
- be able to choose and apply methods of computer vision, machine learning and artificial intelligence
- understand the importance of science in mathematical modelling and the application of methods

**Degree Structure**

The Master's degree (120 ECTS) consists of core studies, specialisation studies in Technomathematics, Technical Physics or Computer Vision and Pattern Recognition, minor studies and free elective studies. The Master's Thesis and Seminar is included in the specialisation studies.

This MSc in Computational Engineering and Technical Physics is also available as a Double Degree Programme for the students of our partner universities. The Double Degree Programme has a separate degree structure of its own with the exception of technomathematics. Students specialising in technomathematics make their personal study plans otherwise than in weboodi.

See Uni-portal:
Computational Engineering and Techical Physics

# Degree structures

**Degree Structure**

The Master's degree (120 ECTS) consists of core studies, specialisation studies in Technomathematics, Technical Physics or Computer Vision and Pattern Recognition, 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). The students of Computational Engineering and Technical Physics have recommendations on how to choose the minor:

- TiDSOsedt Software Engineering and Digital Transformation minor (extensive)
- TuSOEntr Entrepreneurship or
- TUSOMbanMafy Business Analytics for students in Computational Engineering

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 (BM10A0100 Work Internship in Master's Degree, 2-10 ECTS) may be included upon application, too.

The MSc in Computational Engineering and Technical Physics is also available as a Double Degree Programme for the students of our partner universities. The Double Degree Programme has a separate degree structure of its own with the exception of technomathematics. Students specialising in technomathematics make their personal study plans otherwise than in weboodi.

See the degree structure for details.

See the degree structure for details.

# Master's Programme in Computational Engineering and Technical Physics 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

## Core Studies (min 7 cr)

LaDCore: Core Studies, 5 - 30 cr
- *Obligatory Studies 7-12 ECTS cr*
  - BM10A0500: Research Methods, 3 cr
  - BM20A3401: Design of Experiments, 4 cr
- *Only for students who have no Matlab programming courses in earlier studies*
  - BM20A5001: Principles of Technical Computing, 4 cr
- *Only for students coming outside of LUT*
  - BM10A1200: Introduction to M.Sc. Studies in Computational Engineering and Technical Physics, 1 cr

## Specialisation Studies (min 70 cr)

Choose one specialization studies from the following.

Aim of studies in technomathematics is to learn mathematical methods to model and analyse real world problems arising from wide range of application fields, for example industry and environmental processes and economics.

Studies in technical physics will focus on materials physics, nanophysics, semiconductors, superconductors, spintronics and optical measurement technologies.

In computer vision and pattern recognition the student will get familiar with methods in computer vision and pattern recognition and how to implement them in industrial applications. The studies concentrate in intelligent and learning methods in computing. Data analytics, feature detection and classification are on the background of the practical applications

### Technical Physics

FyDMa100: Technical Physics, 65 - 74 cr
- *Obligatory Studies 74 ECTS cr*
  - BM10A0000: Master's Thesis and Seminar, 30 cr
  - BM30A0500: Applied Optics, 6 cr
  - BM30A0601: Optoelectronics, 6 cr
  - BM30A1500: Advanced Topics in Material Science, 6 cr
  - BM30A1600: Microelectronics, 6 cr
  - BM30A1701: Physics of Semiconductor Devices, 6 cr
  - BM30A2200: Semiconductor and Superconductor Physics, 6 cr
  - BM30A2500: Nanophysics, 6 cr
  - BL50A0600: Electromagnetic Compatibility in Power Electronics, 2 cr

### Computer Vision and Pattern Recognition

MaDCompu: Computer Vision and Pattern Recognition, 50 - 70 cr

*Specialisation Studies in Computer Vision and Pattern Recognition consists of obligatory studies (63 ECTS cr) and alternative studies (11 ECTS cr.*

BM10A0000: Master's Thesis and Seminar, 30 cr
BM20A6100: Advanced Data Analysis and Machine Learning, 6 cr
BM40A1400: GPGPU Computing, 6 cr
BM40A0701: Pattern Recognition, 6 cr
BM40A1002: Seminar on Computer Vision and Pattern Recognition, 3 cr
BM40A1201: Digital Imaging and Image Preprocessing, 6 cr

*Exchangeable courses, choose one of the following courses:*

BM40A0801: Machine Vision and Digital Image Analysis, 6 cr
BM40A0901: Computer Vision, 6 cr

*Alternative Studies. Choose at least 11 ECTS cr from following studies:*

BL40A1100: Embedded System Programming, 4 cr
BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 cr
BM20A3001: Statistical Analysis in Modelling, 5 cr
BM20A6200: Inverse Problems and Normed Spaces, 6 cr
BM30A0500: Applied Optics, 6 cr
BM30A0601: Optoelectronics, 6 cr
CS38A0060: Fuzzy sets and fuzzy logic, 6 cr
CS38A0070: Fuzzy data analysis, 6 cr

**Technomathematics**

MaDMa100: Technomathematics, 70 - 76 cr

*Specialisation studies in Technomathematics consists of obligatory studies (64 ECTS cr) and alternative studies (10 ECTS cr).*

BM10A0000: Master's Thesis and Seminar, 30 cr
BM20A3001: Statistical Analysis in Modelling, 5 cr
BM20A4000: Case Study Seminar, 5 cr
BM20A6100: Advanced Data Analysis and Machine Learning, 6 cr
BM20A6200: Inverse Problems and Normed Spaces, 6 cr
BM20A6500: Simulation and System Dynamics, 6 cr
CS38A0020: Optimization in business and industry, 6 cr

*Alternative studies. Choose at least 10 ECTS cr from following studies.*

BJ02A2011: Modelling of Unit Operations, 5 cr
BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 cr
BM20A4701: Modelling with Partial Differential Equations, 4 cr
BM20A5100: Scientific Computing and Numerics for PDEs, 6 cr
BM40A1400: GPGPU Computing, 6 cr
CS38A0060: Fuzzy sets and fuzzy logic, 6 cr
CS38A0070: Fuzzy data analysis, 6 cr

## Minor Studies (min 20 cr)

Students may choose any minor studies taught at LUT if the required prerequisites are fulfilled. Recommeded minor studies are minor studies in Software Engineering and Digital Transformation minor (extensive) (TiDSOsedt), Entrepreneurship (TuSOEntr) or Business Analytics for students in Computational Engineering (TUSOMbanMafy)

## 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 may include an internship that improves professional skills to free elective studies. An internship may be worth a maximum of 10 ECTS credits. More information: BM10A0100 Work Internship in Master’s Degree. Students are recommended to study language studies and courses in Finnish language.

# Master's Programme for Double Degree Students / Major in Technical Physics 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

## Core Studies

## Specialisation Studies (min 70 cr)

FyDMa200: Technical Physics, 66 cr
- *Specialisation studies in Technical Physics consists of obligatory studies (66 ECTS cr) and alternative studies (4 ECTS cr*
  - BM10A0000: Master's Thesis and Seminar, 30 cr
  - BM30A0500: Applied Optics, 6 cr
  - BM30A0601: Optoelectronics, 6 cr
  - BM30A1500: Advanced Topics in Material Science, 6 cr
  - BM30A1600: Microelectronics, 6 cr
  - BM30A2200: Semiconductor and Superconductor Physics, 6 cr
  - BM30A2500: Nanophysics, 6 cr
- *Choose min. 4 ECTS cr from following studies.*
  - BM20A5001: Principles of Technical Computing, 4 cr
  - BL40A1101: Embedded System Programming, 5 cr

## Credit transfer

## Free Elective Studies

Possible extra courses, students are recommended to study BM10A1200 Introduction to M.Sc. Studies in Computational Engineering and Technical Physics and at least one course of Finnish.

# Master's Programme for Double Degree Students / Major in Computer Vision and Pattern Recognition 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

## Cores Studies (min 0 cr)

## Specialisation Studies (min 70 cr)

MaDDCompu: Computer Vision and Pattern Recognition, 50 - 70 cr

*Specialisation studies in Computer Vision and Pattern Recognition consists of obligatory studies (57 ECTS cr) and alternative studies (13 ECTS cr*

BM10A0000: Master's Thesis and Seminar, 30 cr
BM40A0701: Pattern Recognition, 6 cr
BM40A1002: Seminar on Computer Vision and Pattern Recognition, 3 cr
BM40A1201: Digital Imaging and Image Preprocessing, 6 cr
BM40A1400: GPGPU Computing, 6 cr

*Exchangeable courses, choose one of the following courses*

BM40A0801: Machine Vision and Digital Image Analysis, 6 cr
BM40A0901: Computer Vision, 6 cr

*Choose min. 13 ECTS cr from following studies.*

BL40A1601: Embedded System Design, 6 cr
BM10A0500: Research Methods, 3 cr
BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 cr
BM20A3001: Statistical Analysis in Modelling, 5 cr
BM20A3401: Design of Experiments, 4 cr
BM20A4701: Modelling with Partial Differential Equations, 4 cr
BM20A6100: Advanced Data Analysis and Machine Learning, 6 cr
BM20A6200: Inverse Problems and Normed Spaces, 6 cr
BM30A0500: Applied Optics, 6 cr
BM30A0601: Optoelectronics, 6 cr
CS38A0060: Fuzzy sets and fuzzy logic, 6 cr
CS38A0070: Fuzzy data analysis, 6 cr

### Credit Transfer

### Free Elective Studies

Possible extra courses, students are recommended to study BM10A1200 Introduction to M.Sc. Studies in Computational Engineering and Technical Physics and at least one course of Finnish.

# 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).

The students of Computational Engineering and Technical Physics have recommendations on how to choose the minor:

TiDSOsedt Software Engineering and Digital Transformation minor (extensive)
TuSOEntr Entrepreneurship or
TUSOMbanMafy Business Analytics for students in Computational Engineering

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

Mechanical Engineering:
KoDSaKote Konetekniikka (in Finnish)
KoDSaManu Modern Manufacturing
KoDSaLaser Advanced Digital Laser Based Photonic Production
KoDSaMate Advanced Materials Engineering

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

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

Computer Science:
TikSOTite Tietotekniikka (in Finnish)

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

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".

TUSOMbanMafy: Business Analytics for students in Computational Engineering, 24 - 36 cr
- *Choose 24 cr from the following*
  - A210A0350: Real Options and Managerial Decision Making, 6 cr
  - A220A0000: Financial Econometrics, 6 cr
  - A220A0550: Advanced Decision-making, 6 cr
  - A220A0752: Analytics for Business, 6 cr
  - BM20A6500: Simulation and System Dynamics, 6 cr
  - CS38A0040: Marketing analytics, 6 cr
  - CS38A0050: Big data in business and industry, 6 cr
  - CS38A0020: Optimization in business and industry, 6 cr

TuSOEntr: Entrepreneurship, minor, 20 - 35 cr
- *Obligatory course 6 cr*
  - CS34A0302: Entrepreneurship Theory, 6 cr
- *Elective studies*
  - CS30A1372: Creative Design and Problem Solving, 6 cr
  - CS30A1691: Social Sustainability, 6 cr
  - CS34A0352: Leading business growth, 6 cr
  - CS34A0401: Strategic Entrepreneurship in an Age of Uncertainty, 6 cr
  - CS34A0551: Business Idea Development, 6 cr
  - CS34A0712: Business Governance and Entrepreneurial Renewal, 6 cr
  - CS34A0721: Entrepreneurship, ownership and family firms, 6 cr

CS34A0733: New Venture Creation, 6 cr
TiDSOsedt: Software Engineering and Digital Transformation minor, 24 - 30 cr
*Obligatory courses 12 cr*
CT60A5500: Quality Assurance in Software Development, 6 cr
CT70A2000: Requirements Engineering, 6 cr
*Elective courses, choose 12 cr*
CT30A8922: User Experience Design, 6 cr
CT60A5103: Software Engineering Models and Modeling, 6 cr
CT60A5400: Fundamentals of Game Development, 6 cr
CT60A7322: Software Business Development, 3 cr
CT70A4000: Business Process Modelling, 6 cr
CT70A5000: Impact and Benefits of Digitalization, 6 cr
CT70A7000: Digital Business Platforms, 6 cr

# Course descriptions

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

### LaDCore: Core Studies, 5 - 30 cr

**Validity:** 01.01.2016 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Engineering Science

No course descriptions.

*Obligatory Studies 7-12 ECTS cr*

#### BM10A0500: Research Methods, 3 cr

**Validity:** 01.08.2014 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Arto Kaarna

**Year:**
M.Sc. (Tech.) 1
**Period:**
1-2
**Teaching Language:**
English
**Teacher(s) in Charge:**
Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student is able to describe concepts and methods in research. Student is able to identify requirements for scientific reporting and is able to evaluate the structure and contents of a scientific report. Student is able to design a research process and to prepare a research plan.

**Contents:**

Categorization of science, scientific work. Philosophies behind research. Research process, designing research, research process, research questions and hypothesis. Qualitative and quantitative research
methods. Data collection, information retrieval, literature review. Reporting scientific work.

**Teaching Methods:**

Lectures and exercises 14h, seminars 4h, 1st period. Practical assignments 35 h, 1st and 2nd period. Self-study 22 h, exam 3 h. Total 78 h. Moodle is used in this course.

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 60 %, practical assignments 40 %.

**Course Materials:**

Creswell, J.W.: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th edition, SAGE, 2014. Hirsjärvi, S., Remes, P., Sajavaara, P.: Tutki ja kirjoita, 15. painos, Tammi, 2015. Research reports.

**Prerequisites:**

B.Sc. studies finished.

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

max 5

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

max 5

## BM20A3401: Design of Experiments, 4 cr

**Validity:** 01.08.2008 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Heikki Haario, Maaret Paakkunainen, Marko Laine, Satu-Pia Reinikainen

**Note:**

Suitable also for doctoral studies.

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Heikki Haario

**Aims:**

After the course, the student is expected to master the basic skills for effective experimentation, together with regression analysis of data:
- understanding of the importance of designed experiments
- ability to apply the basic experimental plans, and regression techniques to analyse the results
- skills to optimize an engineering process using design of experiments and data analysis.

**Contents:**

Importance of experimental design, minimization of prediction uncertainty of regression models. Basic factorial designs: 2N, Central Composite designs for regression analysis. The Taguchi principles. Experimental optimisation of engineering processes.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 21 h, experimental work in laboratory 26 h, preparation for examination and the examination 22 h, 4th period. Total 104 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

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

**Course Materials:**

Box, G., Hunter, S., Hunter, W. G.: Statistics for Experimenters, Wiley 2005, 2nd Edition.

**Prerequisites:**

First year university calculus, BM20A1401 Tilastomatematiikka I/basic statistics. Basic (Matlab) skills for technical computing with PC.

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

No

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

max 15

*Only for students who have no Matlab programming courses in earlier studies*

**BM20A5001: Principles of Technical Computing, 4 cr**

**Validity:** 01.08.2014 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Matylda Jablonska-Sabuka

**Year:**

B.Sc. (Tech.) 2., M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Matylda Jablonska-Sabuka

**Aims:**

Students get a good understanding of Matlab syntax and programming, gain fluency in principles of technical computing and are able to apply the skills to basic mathematical and engineering problems (the skills are applicable in big part to Octave and R programming, too).

**Contents:**

Working with various data structures (multidimensional arrays, cell arrays, etc.) and variable types (numeric, logical, textual, etc.), Matlab symbolic functionality, conditional statements (if-else, switch-case), loops (for and while), using built-in functions, handling external data, 2-D and 3-D plotting, writing user-defined functions, optimization of code speed, style and efficiency.

**Teaching Methods:**

Lectures 12 h, computer class exercises 24 h, independent study 30 h, preparation for exam 34 h, 1st period. Total 100 h. EXAM-tentti.

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

No

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

No

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

Yes

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Lecture material available in Moodle, based partly on textbook: Gilat, A.: An Introduction to Matlab with Applications.

**Prerequisites:**

Basic university calculus required. Recommended first year university calculus necessarily including matrix calculus.

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

max 10

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

max 5

*Only for students coming outside of LUT*

### BM10A1200: Introduction to M.Sc. Studies in Computational Engineering and Technical Physics, 1 cr

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Arto Kaarna, Marja Talikka

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna
Information Specialist M.Sc. (Tech.) Marja Talikka
Study Councellor, Johanna Kosunen

**Aims:**

The course provides information on studying at LUT in the specific degree programme. The course supports the student to organize and schedule her/his M.Sc. studies. In practical level, three main subjects are addressed:
A) The course provides the student with basic knowledge of studying at LUT in general and particularly in his/her degree programme. The course supports the student to plan and complete a personal study plan and to follow the progress of his/her studies according to the personal study plan.
B) Student will learn how to find electronic material from the Academic Library services, collections and databases. Students will learn to use needed digital services and different distance learning applications.
C) Student will get familiar with the information security issues in general and specifically related to studies at LUT.

**Contents:**

The Orientation Days activities. Practical study-related information, degree requirements. Planning of Master's studies. Preparation of the electronic personal study plan at the ePSP workshop. Getting familiar with the support in monitoring the progress of the studies. Use of digital services in studies. The Academic Library collections and databases. Information security training.

**Teaching Methods:**

Participation in the Orientation Days activities. Library introduction lectures, library use, information sources, information retrieval, and assignments. Assignments on general information about Master Studies. Using Moodle.  ePSP workshop, meetings with the Academic Director and Study Councellor. Independent study. Information security training. Total workload 26 h, 1. period.

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

No

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

No

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

No

**Assessment:**

Pass/Fail. Active participation, assignments. ePSP, assignment on information retrieval, and assignment on information security training completed.

**Course Materials:**

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

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

No

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

No

## FyDMa100: Technical Physics, 65 - 74 cr

**Validity:** 01.08.2009 -
**Form of study:** Major studies
**Type:** Study module
**Unit:** LUT School of Engineering Science

No course descriptions.

*Obligatory Studies 74 ECTS cr*

### BM10A0000: Master's Thesis and Seminar, 30 cr

**Validity:** 01.08.2010 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student has general knowledge about a specific field of engineering and applied science in modern society and is able to apply scientific knowledge and methods in the field of the study. The student is able to work independently, prepare a research plan, complete the designed research, and operate in a disciplined way. The student is able to apply the principles of scientific writing in reporting.

**Contents:**

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. The thesis is a research or an implementation project. A report is prepared following the instructions for the Master’s thesis. The report contains description of the problem and the context, the used methods,
describes the actual analysis and actions in the implementation, provides the results and evaluates the outcomes and conclusions.

**Teaching Methods:**

The student works independently and keeps contact with the supervisor informing and discussing the progress of the work. The thesis work is presented in a seminar with other thesis students and their instructors. The student gives a short presentation on the results of his/her project. The presentations are discussed and reviewed. Research work 300 h, independent study 200 h, report preparation 200 h.

**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 %.

**Course Materials:**

Final thesis instructions, scientific reports related to the topic of the thesis.

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

No

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

No

### BM30A0500: Applied Optics, 6 cr

**Validity:** 01.08.2007 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Erik Vartiainen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Erik Vartiainen

**Aims:**

After the course a student:
1. knows the basic properties of waves and wave motion,
2. understands the material polarization phenomenon as the ultimate source of light,
3. knows the basic properties and physics of laser action,
4. knows the ideas and applications of ultrafast optics,
5. knows the basic physics and applications of nonlinear optics,
6. knows the Fresnel-equations, and understand accordingly the physics of light reflection and refraction,
7. knows the basics of light polarization, the corresponding applications and the Jones matrix formulation,
8. understands the meaning of spatial and temporal coherence of light, and their implications for the technical applications, such as FTIR spectroscopy,
9. knows the ABCD-matrix formulation for geometrical optics,
10. knows the basics of laser imaging: one- and two-photon confocal microscopy, spectral imaging, and fluorescence nanoscopy,
11. understands the physics of producing slow and fast light, and knows their applications,
12. understands diffraction of light, and its applications.

**Contents:**

1. Wave motion and wave equations,
2. Maxwell equations and electromagnetic spectrum,
3. Lasers,
4. Ultrafast lasers,
5. Fresnell equations,
6. Polarization and optical activity,
7. Geometrical optics,
8. Coherence,
9. Interference and diffraction,
10. Nonlinear optics,
11. Optical microscopy and nanoscopy,
12. Slow and fast light, THz-optics,
13. Attosecond optics,
14. Coherent control.

**Teaching Methods:**

Lectures 42 h, exercises 14 h, homework 70 h, preparation for the exam 26 h and exam 4 h. total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

1. Eugene Hecht, Optics, 4th edition (Addison-Wesley, 2002). 2. G. R. Fowles, Introduction to Modern Optics, 2nd edition, (Holt, Rinehart and Winston, New York, 1976). 3. R. W. Boyd, Nonlinear Optics (Academic Press, San Diego, 1992). 4. Y. R. Shen, The Princples of Nonlinear Optics (Wiley, New York, 1984).

**Prerequisites:**

Students are recommended to have completed a basic course in physics.

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

15–

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

max 15

### BM30A0601: Optoelectronics, 6 cr

**Validity:** 01.08.2009 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Erkki Lähderanta, Ekaterina Soboleva, Bernardo Barbiellini

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Bernardo Barbiellini
Junior Researcher, M.Sc.(Tech.) Ekaterina Soboleva

**Aims:**

Students get a good understanding of the basics of optoelectronics and photonics and are able to deal with the following topics: optical data communication, construction of wave guides using total internal reflection and working principles of light emitting diodes and photodetectors.

**Contents:**

Wave nature of light, dielectric waveguides and optical fibers, working principals of light emitting diodes, LASERs and photovoltaic devices. Computation tasks to consolidate knowledge.

**Teaching Methods:**

Lectures 28 h, exercises 14 h, preparation for exam 114 h, 1st period. Examination.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Kasap, S. O.: Optoelectronics and Photonics P. Silfsten & E. Vartiainen: Optoelektroniikka,

**Prerequisites:**

Basic knowledge about optics.

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

max 5

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

max 5

### BM30A1500: Advanced Topics in Material Science, 6 cr

**Validity:** 01.08.2007 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Erkki Lähderanta

**Year:**

M.Sc. (Tech.) 1

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Erkki Lähderanta

**Aims:**

The aim of the course is to introduce students to selected topics of advanced Material Science: Nanophysics, Semiconductors, Superconductors, Magnetism, Ferroelectrics

**Contents:**

Nanophysics, applied superconductivity, ferroelectrics, magnetism, applied semiconductors and other advanced topics in material science connected to nanophysics.

**Teaching Methods:**

Lectures 30 h, homework 126 h (5 essays á 25 h 12 min), 2nd period. Total work load 156 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:**

Pass/Fail. Written assignment 100 %.

**Course Materials:**

Lecture notes to be given at lectures.

**Prerequisites:**

BM30A2200 Semiconductor and Superconductor Physics

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

max 5

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

max 5

### BM30A1600: Microelectronics, 6 cr

**Validity:** 01.08.2008 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Erkki Lähderanta, Bernardo Barbiellini, Ekaterina Soboleva

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Bernardo Barbiellini
Junior Researcher, M.Sc.(Tech.) Ekaterina Soboleva

**Aims:**

Studentsget a good understanding of microelectronics basics and main integrated circuit(IC) components, students gain fluency to the most important variables and functions relatedto the IC components, and are able to apply their skills to analog IC design.

**Contents:**

Considering the basic components (PN junctions, metal-oxide-semiconductor, bipolar junction transistors, MOSFET, diodes, and amplifiers) of integrated circuit and their operation principles. Computation tasks and simulation to facilitate understanding.

**Teaching Methods:**

Lectures 28 h, exercises and tutorials 28 h, assignment 40 h, preparation for exam 60 h. Assignment and its presentation. Written examination.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %. Satisfactorily completed assignment required.

**Course Materials:**

Roger T. Howe, Charles G. Sodini: Microelectronics An Integrated Approach.

**Prerequisites:**

Recommended BL40A1711 Johdanto digitaalielektroniikkaan and BL50A1400 Analogiaelektroniikka.

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

max 5

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

max 5

### BM30A1701: Physics of Semiconductor Devices, 6 cr

**Validity:** 01.08.2013 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Tuure Tuuva

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Tuure Tuuva

**Aims:**

Student will acquire an in-depth knowledge of semiconductor diode, CCD, MOSFET, LED and photodiode and their operation.

**Contents:**

Structure, operation and physics of semiconductor devices.

**Teaching Methods:**

Special assignment 102 h, seminars 28 h, 1st-2nd period. 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:**

Pass/fail, seminar presentation 100 %.

**Course Materials:**

Sze, Physics of Semiconductor Devices.

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

No

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

max 5

### BM30A2200: Semiconductor and Superconductor Physics, 6 cr

**Validity:** 01.08.2009 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Egor Fadeev, Erkki Lähderanta

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Erkki Lähderanta
Research Assistant, M.Sc. (Tech.) Egor Fadeev

**Aims:**

The course gives the student the skills to understand the basic behaviour of semiconductors and superconductors.

**Contents:**

Classical conductor, introduction to quantum mechanics, free-electron model of metals, energy bands, doped semiconductors, spintronics, basic properties of superconductivity, London equations, thermodynamics of the superconducting transition, the intermediate state, coherence length, current in superconductor, thin films, BCS-theory, type-II superconductors, high-Tc superconductors.

**Teaching Methods:**

Lectures 49 h, exercises 28 h, preparing for exercises 48 h, preparing for the exam 31 h. Total work load 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Lecture handouts.
Juha Sinkkonen: Puolijohdeteknologian perusteet.
A. C. Rose-Innes and E. H. Rhoderick: Introduction to Superconductivity, 2nd edition (Pergamon).

**Prerequisites:**

A knowledge of the fundamentals of material physics, a knowledge of the electric and physical properties of materials.

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

max 5

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

max 5

### BM30A2500: Nanophysics, 6 cr

**Validity:** 01.08.2014 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Anton Komlev, Igor Rozhanskiy, Pavel Geydt

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Junior Researcher, M.Sc. (Tech.) Pavel Geydt
Ph.D. Igor Rozhanskiy

**Aims:**

The objective of the course is to make information about the rapidly evolving areas of nanoscale science and technology available to a wide range of students. Upon completion of the course, students will clarify the principal difference between physical phenomena in macro-scale and nano-scale. Students will be able to:
- develop their understanding of bio-, physical and chemical systems,
- characterize the systems related with Materials science and Metrology,
- recognize the difference in prevailing forces in different size scales,
- explain many practical observations and anomalies found in their experimental research activity,
- apply this combined knowledge in practice.
After taking the course, students should become capable to operate safely with nano-systems, considering their hazardous aspects. The course helps to systematize the fragmented information about nano- related phenomena and knowledge from physical and chemical disciplines studied before.

**Contents:**

Nanoethics, Forces in the Nanoworld, Scaling Laws, Nanomaterials and Nanocomposites, Nanomechanics, Nanothermodynamics, Nanofluidics, Nanochemistry, Tribology, Nanooptics of Metals and Semiconductors, Nanoelectronics, Spintronics, Nanomagnetism, Nanocarbon, Nanolithography.

**Teaching Methods:**

Lectures 42 h, exercises 28 h; preparing for exercises 36 h, preparing for the presentation 8 h, preparing for laboratory works 6 h, preparing for the examination 40 h; 1st-2nd period. Total workload for student 160 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

Grade 0-5; evaluation 0-100 points, examination 50 %, exercises 25 %, presentation 15 %, laboratory works 10 %.

**Course Materials:**

Lecture handouts

**Prerequisites:**

B.Sc. (Tech) studies.

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

max 5

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

max 5

## BL50A0600: Electromagnetic Compatibility in Power Electronics, 2 cr

**Validity:** 01.08.2007 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Energy Systems

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

**Teachers:** Pertti Silventoinen, Juhamatti Korhonen

**Note:**

The course is suitable for distance learning.

**Year:**

M.Sc. (Tech.) 2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Juhamatti Korhonen

**Aims:**

Upon completion of the course the student will be able to:
1. describe the coupling mechanisms of electromagnetic interference in power electronics,
2. describe the most significant sources of electromagnetic emissions in power electronic systems,
3. provide suitable filter solutions for common-mode filtering, differential-mode filtering, du/dt filtering and harmonics filtering.

**Contents:**

Power electronics as an interference source, network harmonics, reflection phenomena of cables, conductive RF interference, interference radiation of power electronics, filtering techniques of conductive interference.

**Teaching Methods:**

14 h of lectures, 2st period. Moodle examination, weekly quizzes. Independent work 38 h. Online course. Total workload 52 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, Moodle examination 70 %, weekly quizzes 30 %.

**Course Materials:**

To be announced in class.

**Prerequisites:**

Recommended: Basic knowledge of electromagnetism and electromagnetic fields.

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

15–

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

max 10

## MaDCompu: Computer Vision and Pattern Recognition, 50 - 70 cr

**Validity:** 01.08.2018 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F

No course descriptions.

*Specialisation Studies in Computer Vision and Pattern Recognition consists of obligatory studies (63 ECTS cr) and alternative studies (11 ECTS cr.*

### BM10A0000: Master's Thesis and Seminar, 30 cr

**Validity:** 01.08.2010 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student has general knowledge about a specific field of engineering and applied science in modern society and is able to apply scientific knowledge and methods in the field of the study. The student is able to work independently, prepare a research plan, complete the designed research, and operate in a disciplined way. The student is able to apply the principles of scientific writing in reporting.

**Contents:**

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. The thesis is a research or an implementation project. A report is prepared following the instructions for the Master’s thesis. The report contains description of the problem and the context, the used methods,
describes the actual analysis and actions in the implementation, provides the results and evaluates the outcomes and conclusions.

**Teaching Methods:**

The student works independently and keeps contact with the supervisor informing and discussing the progress of the work. The thesis work is presented in a seminar with other thesis students and their instructors. The student gives a short presentation on the results of his/her project. The presentations are discussed and reviewed. Research work 300 h, independent study 200 h, report preparation 200 h.

**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 %.

**Course Materials:**

Final thesis instructions, scientific reports related to the topic of the thesis.

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

No

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

No

### BM20A6100: Advanced Data Analysis and Machine Learning, 6 cr

**Validity:** 01.08.2015 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Lasse Lensu, Heikki Haario

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Heikki Haario, Professor, D.Sc. (Tech.) Lasse Lensu

**Aims:**

The student can pre-process, visualise and analyse multivariate synthetic and real-world data. The student is able to understand and use state-of-the-art regression methods, graphical models and deep learning. The student can use selected methods to solve a practical assignment, analyse the results and report the findings.

**Contents:**

Characteristics of data sources, and data pre-processing, dimensionality reduction and outlier detection. Principal component and other advanced regression methods. Graphical models and Bayesian networks. Deep learning and convolutional neural networks. Case-based topics on advanced data analysis by visiting lecturers.

**Teaching Methods:**

Preparation for lectures 7 h, lectures 14 h, preparation for exercise 21 h, exercises 14 h, 1st period. Preparation for lectures 7 h, lectures 14 h, preparation for exercise 21 h, exercises 14 h, practical assignment 36 h, 2nd period. Self-study 5 h. Exam 3 h. Total amount 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 50 %, exercises 25 %, practical assignment 25 %.

**Course Materials:**

Lecture notes in Moodle. Other literature will be announced when the course starts.

**Prerequisites:**

Recommended: BM20A1901 Statistics II, BM20A2701 Numerical Methods II, BM20A3001 Statistical Analysis in Modelling, BM40A0700 Pattern Recognition or equivalent knowledge.

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

No

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

max 5

### BM40A1400: GPGPU Computing, 6 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:** Arto Kaarna, Aleksandr Bibov

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

Intensive week 43, periods 2 and 3.

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, D.Sc. (Tech.) Alexander Bibov.

**Aims:**

The student is able to reorganize computational tasks in order to best fit a given GPU architecture. The student is able to implement inter-operability between a GPU-boosted code and MATLAB/Python environment.

**Contents:**

GPGPU (General Purpose Graphics Processing Unit) programming architecture, solving problems using GPGPU. CUDA-implementations and interface to GPGPU hardware. Parallel algorithms, hybrid application design for CPU/GPGPU. Introduction to visualization of computed data. Practical implementations for artificial toy-cases and real engineering applications.

**Teaching Methods:**

Lectures 20 h, exercises 15 h, pre-assignment 24 h, intensive week 43. Seminar 4 h, post-assignment and seminar preparation, 93 h, periods 2 and 3. Totally 156 h.

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

No

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

No

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

No

**Assessment:**

0-5, report and seminar presentation on the assignment.

**Course Materials:**

Popular GPU-accelerated Applications, http://www.nvidia.com/docs/IO/123576/nv-applications-catalog-lowres.pdf. Other materials will be announced at lectures.

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

max 5

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

max 5

### BM40A0701: Pattern Recognition, 6 cr

**Validity:** 01.01.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Lasse Lensu

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Lasse Lensu

**Aims:**

After passing the course, students understand pattern recognition problems and know the common approaches including machine learning methods to solve them. The students are able to select an appropriate pattern recognition method and implement a working solution for a specific problem. The students can analyse the performance and quality of a pattern recognition system.

**Contents:**

Introduction to pattern recognition, supervised and unsupervised machine learning. Feature processing, selection and system evaluation. Statistical pattern recognition and Bayesian inference. Linear and non-linear classifiers such as the perceptron, artificial neural networks and support vector machines. Context-dependent and reinforcement learning. Unsupervised pattern recognition and method-independent learning.

**Teaching Methods:**

Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 21 h, 1st period. Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 21 h, practical assignment 40 h, 2nd period. Self-study 4 h. Total amount 156 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. Homework and exercises 30%, exercise quizzes (or exam) 40%, practical assignment 30%.

**Course Materials:**

Duda, R.O., Hart, P.E., Stork, D.G.: Pattern Classification, Wiley, 2001. Theodoridis, S., Koutroumbas, K.: Pattern Recognition, Academic Press, 2003.

**Prerequisites:**

Recommended BM20A4301 Johdatus tekniseen laskentaan, BM20A5001 Principles of Technical Computing, BM20A5800 Funktiot, lineaarialgebra ja vektorit, BM20A5810 Differentiaalilaskenta ja sovellukset, BM20A5820 Integraalilaskenta ja sovellukset, BM20A5840 Usean muuttujan funktiot ja sarjat, CT60A0210 Käytännön ohjelmointi, BM20A1401 Tilastomatematiikka I, BM20A1501 Numeeriset menetelmät I, BM20A1601 Matriisilaskenta, BM40A0501 Johdatus laskennalliseen älykkyyteen, or equivalent knowledge.

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

max 5

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

max 5

### BM40A1002: Seminar on Computer Vision and Pattern Recognition, 3 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Note:**

Replaces the course BM40A1001 Seminar on Intelligent Computing

**Year:**

M.Sc. (Tech.) 2

**Period:**

2-3

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**Aims:**

After the course a student is expected to be able to explain the basic principles of scientific work and its reporting both in the scientific forums and general media, to understand the principles of the academic thesis and possibilities of funding and different relevant work places, to write a seminar report about intelligent computing in the form of the academic thesis, to give the corresponding oral seminar presentation, and to act as an opponent.

**Contents:**

The first part (lectures in the 2nd period) provides the skills defined in the aims of the course, including the skills to prepare and to give the seminar presentation in the second part (3rd period). Independent preparation of a written seminar on a given intelligent computing topic.

**Teaching Methods:**

Lectures 8 h, 2nd period. Seminars 8 h, 3rd period. Preparing a written and oral seminar presentation, including self-study of relevant literature, and acting as an opponent, 62 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, written seminar report 100 %. Seminar presentation. Active participation to all seminar sessions. Acting as an opponent.

**Course Materials:**

Material published on the course web page.

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

No

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

No

### BM40A1201: Digital Imaging and Image Preprocessing, 6 cr

**Validity:** 01.01.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Tuure Tuuva, Erik Vartiainen, Lasse Lensu

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, Professor, Ph.D. Tuure Tuuva, Associate Professor, Ph.D. Erik Vartiainen.

**Aims:**

A student knows how radiation interacts with matter, how images can be captured and the image formation modelled, and how preprocessed images can be used for measurement purposes. The student is able to characterise imaging and the factors affecting it, and affect image quality in practice.

**Contents:**

Electromagnetic radiation and light interaction with matter, sources of radiation and illumination techniques, imaging sensors and manufacturing technologies, spectroscopy, imaging optics, sensor and image acquisition modelling and characterisation, digital image encoding and characteristics, image preprocessing techniques, and image-based measurement.

**Teaching Methods:**

Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 14 h, 1. period.
Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 14 h, practical assignment 40 h, 2. period.
Self-study 18 h. Total amount 156 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. Homework and exercises 25 %, exercise quizzes (or exam) 50 %, practical assignment 25 %.

**Course Materials:**

Kasap, S.O.: Optoelectronics and Photonics, Prentice-Hall, 2000. Gonzales, R.C., Woods, R.E.: Digital image processing, Prentice-Hall, 2002. Jain, A.K.: Fundamentals of digital image processing, Prentice-Hall, 1989.

**Prerequisites:**

Recommended BM20A4301 Johdatus tekniseen laskentaan, BM20A5001 Principles of Technical Computing, BM40A0502 Johdatus laskennalliseen älykkyyteen ja koneoppimiseen, or equivalent knowledge.

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

max 5

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

max 5

*Exchangeable courses, choose one of the following courses:*

**BM40A0801: Machine Vision and Digital Image Analysis, 6 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:** Heikki Kälviäinen

**Note:**

The course will be lectured every other year, next during the academic year 2019-2020.

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

Yes, next realization year 2019-2020

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**Aims:**

After the course a student is expected to be able to explain the fundamental steps of image processing and analysis, to introduce and compare machine vision applications, to plan a solution to a given object recognition problem, and to implement practical solutions for machine vision problems using Matlab or other suitable programming language.

**Contents:**

Digital image processing: digital image, image transforms, image enhancement, image compression. Image analysis: segmentation, representation and description, recognition and interpretation. Hardware, software and applications.

**Teaching Methods:**

Lectures and seminars 21 h, exercises 14 h, 3rd period. Lectures and seminars 21 h, exercises 14 h, 4th period. Preparation for the seminar presentations and acting as an opponent, homework, and practical assignment 47 h, self-studying of taught matters and relevant literature and preparation for the exam 36 h, 3rd and 4th period. Exam 3 h. Total amount 156 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):**

Yes

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

No

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

No

**Assessment:**

0-5, exam 50 %, exercises 50 %. Seminar presentation. Acting as an opponent. Practical assignment.

**Course Materials:**

References and material published on the course web page.

**Prerequisites:**

Recommended BM40A0701 Pattern Recognition, BM40A0901 Computer Vision, BM40A1201 Digital Imaging and Image Preprocessing,BM40A0502 Johdatus laskennalliseen älykkyyteen ja koneoppimiseen

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

max 5

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

No

**BM40A0901: Computer Vision, 6 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:** Arto Kaarna

**Note:**

The course will be lectured every other year, next during the academic year 2018-2019.

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

Yes, 2018-2019.

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

A student knows the theoretical basis of geometric and dynamic computer vision, and is able to apply the knowledge to solve practical problems in computer vision. A student is able to explain basic approaches and applications for image processing and feature extraction for single images and video sequences. Student is able to implement simple application in computer vision.

**Contents:**

Computer vision for 3D scenes. Imaging and camera calibration. Image preprocessing. Coordinate frames and geometrical primitives. Single and multi-view geometry. Pose estimation. Dynamic vision and tracking. Structure from motion. Computer vision for robotics.

**Teaching Methods:**

Lectures 14 h, exercises 12 h, exercise preparation 12 h, 3rd period.
Lectures 14 h, exercises 14 h, exercise preparation 14 h, seminar 3h, practical assignment and seminar preparation 42h, 4th period.
Independent study 28h, exam 3 h. Total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5:
0-2, exam, exercises, practical assignment if the grade from the exam is 0, 1 or 2.
3-5, exam (60 %), exercises (40 %), practical assignment if the grade from the exam is 3, 4, or 5.

**Course Materials:**

Emanuele Trucco, Alessandro Verri: Introductory Techniques for 3-D Computer Vision. Prentice Hall, 1998. E. R. Davies: Computer and Machine Vision, Fourth Edition: Theory, Algorithms, Practicalities, 4th Edition. Elsevier, 2012. Richard Hartley, Andrew Zisserman: Multiple View Geometry in Computer Vision, 2nd Edition. Cambridge University Press, 2004. David A. Forsyth, Jean Ponce: Computer Vision: A Modern Approach, 2nd Edition. Prentice Hall, 2011.

**Prerequisites:**

BM20A6700 Matematiikka I
BM20A6800 Matematiikka II
BM20A6800 Matematiikka II
CT60A0200 Ohjelmoinnin perusteet.
Recommended
BM20A1401 Tilastomatematiikka I,
BM20A1501 Numeeriset menetelmät I,
BM20A1601 Matriisilaskenta,
BM20A5500 Differentiaaliyhtälöt ja dynaamiset systeemit
BM40A0501 Johdatus laskennalliseen älykkyyteen or equivalent knowledge.

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

max 5

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

max 5

*Alternative Studies. Choose at least 11 ECTS cr from following studies:*

### BL40A1100: Embedded System Programming, 4 cr

**Validity:** 01.08.2007 - 31.12.2017
**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:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate professor, D.Dc. (Tech.) Tuomo Lindh

**Aims:**

Upon completion of the course the student will be able to: 1. apply C language and its structures to embedded system programming, 2. form complex data types such as structures, unions and buffers and use these in order to maintain information of different entities (e.g. processing units), 3. control the registers of a micro controller using C-language, 4. use different PUs of a micro controller.

**Contents:**

Design tools, C-language in embedded system programming, utilization of a micro controller environment (registers, timers, buses, A/D conversion etc.). Typical data structures, typical program structures in real-time applications.

**Teaching Methods:**

14 h of lectures, 14 h of tutorials, 1st period. 14 h of lectures, 14 h of tutorials, 2nd period. Assignment. Written examination. Total workload 104 h.

**Assessment:**

0-5, assignment 1 50 %, examination 50 %. Satisfactorily completed assignment required.

**Course Materials:**

Wolf, W.: Computers as components: principles of embedded computing system design. Lecture notes.

**Prerequisites:**

Basics of C language.

**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.

### BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 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:** Erkki Lähderanta, Jouni Sampo, Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, Professor, Ph.D. Erkki Lähderanta, University Lecturer, D. Sc. (Tech.) Jouni Sampo.

**Aims:**

The student is able to employ theoretical and operational skills in some specific area of applied mathematics, computing, and technical physics. The student is able to select, apply, and analyze methods to modeling problems in mathematics, science and engineering. Entrepreneurial learning methods are applied.

**Contents:**

The course consists of literature review, working on exercises and completing practical projects. Materials will be chosen and agreed individually according to the focus of the study module, students' interests, and research in the laboratories. The course with the same title can be included in the study programme twice when two distinct areas are covered.

**Teaching Methods:**

Self-study of learning materials, exercises, project assignment and reporting, seminar presentation, total 80-160 h, 1st-4th period.

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

No

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

No

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

No

**Assessment:**

Pass/Fail, report and seminar presentation 100 %.

**Course Materials:**

Learning materials will be agreed with each student separately depending on the task(s).

**Prerequisites:**

Recommended: BSc. in Computational Engineering and Technical Physics, first year studies in the specialization of the M.Sc. studies.

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

No

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

No

### BM20A3001: Statistical Analysis in Modelling, 5 cr

**Validity:** 01.08.2008 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Heikki Haario

**Note:**

Suitable also for doctoral studies

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-Doctoral Researcher, D.Sc. (Tech.) Virpi Junttila

**Aims:**

Introduction to modern computational methods of estimating reliability of modeling and simulation results. After the course, the student is able to estimate parameters of nonlinear models by measured data and to create posterior distributions for parameters and model predictions by MCMC (Markov chain Monte Carlo) methods.

**Contents:**

Introduction to the methods of estimating reliability of modelling. Errors and uncertainty in experimental data. Uncertainty in model parameters and prediction results. Bayesian approach for parameter estimation and inverse problems, various Monte Carlo (MCMC) methods for nonlinear models.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 35 h, practical assignment 38 h, preparation for examination and the examination 22 h, 2nd period. Total 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, examination 100 %.

**Course Materials:**

To be given at the lectures.

**Prerequisites:**

First year university calculus, BM20A1401 Tilastomatematiikka I. Recommended BM20A6500 Simulation and System Dynamics.

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

No

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

max 15

### BM20A6200: Inverse Problems and Normed Spaces, 6 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:** Jouni Sampo

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

University lecturer, D.Sc. (Tech.) Jouni Sampo

**Aims:**

The student knows the concepts of function spaces and related basic terminology of functional analysis. Student understand and is able to use classical methods for solving linear inverse problems like of estimation of signal from incomplete or corrupted measurements.

**Contents:**

Vector spaces, bases and linear operators. Linear subspaces and projections. Norms, metric and convergence. Various function spaces, Banach spaces, Lp-spaces, Hilbert spaces. Formulation of inverse problems with additive noise. Ill-posedness and inverse crimes. Truncated singular value decomposition for inverse problems, Tikhonov and total variation regularization.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, independent study and homework 40 h, 1st period. Lectures 21 h, exercises 14 h, independent study and homework 43 h, 2nd period. Exam 3h. Total 156 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 100 %

**Course Materials:**

Study material will be informed/distributed through the Moodle portal.

**Prerequisites:**

Basic Matlab skills are required (in 2nd period). BM20A1601 Matrix calculus is recommended.

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

max 5

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

max 15

**BM30A0500: Applied Optics, 6 cr**

**Validity:** 01.08.2007 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Erik Vartiainen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Erik Vartiainen

**Aims:**

After the course a student:
1. knows the basic properties of waves and wave motion,
2. understands the material polarization phenomenon as the ultimate source of light,
3. knows the basic properties and physics of laser action,
4. knows the ideas and applications of ultrafast optics,
5. knows the basic physics and applications of nonlinear optics,
6. knows the Fresnel-equations, and understand accordingly the physics of light reflection and refraction,
7. knows the basics of light polarization, the corresponding applications and the Jones matrix

formulation,
8. understands the meaning of spatial and temporal coherence of light, and their implications for the technical applications, such as FTIR spectroscopy,
9. knows the ABCD-matrix formulation for geometrical optics,
10. knows the basics of laser imaging: one- and two-photon confocal microscopy, spectral imaging, and fluorescence nanoscopy,
11. understands the physics of producing slow and fast light, and knows their applications,
12. understands diffraction of light, and its applications.

**Contents:**

1. Wave motion and wave equations,
2. Maxwell equations and electromagnetic spectrum,
3. Lasers,
4. Ultrafast lasers,
5. Fresnell equations,
6. Polarization and optical activity,
7. Geometrical optics,
8. Coherence,
9. Interference and diffraction,
10. Nonlinear optics,
11. Optical microscopy and nanoscopy,
12. Slow and fast light, THz-optics,
13. Attosecond optics,
14. Coherent control.

**Teaching Methods:**

Lectures 42 h, exercises 14 h, homework 70 h, preparation for the exam 26 h and exam 4 h. total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

1. Eugene Hecht, Optics, 4th edition (Addison-Wesley, 2002). 2. G. R. Fowles, Introduction to Modern Optics, 2nd edition, (Holt, Rinehart and Winston, New York, 1976). 3. R. W. Boyd, Nonlinear Optics (Academic Press, San Diego, 1992). 4. Y. R. Shen, The Princples of Nonlinear Optics (Wiley, New York, 1984).

**Prerequisites:**

Students are recommended to have completed a basic course in physics.

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

15–

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

max 15

**BM30A0601: Optoelectronics, 6 cr**

**Validity:** 01.08.2009 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Erkki Lähderanta, Ekaterina Soboleva, Bernardo Barbiellini

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Bernardo Barbiellini
Junior Researcher, M.Sc.(Tech.) Ekaterina Soboleva

**Aims:**

Students get a good understanding of the basics of optoelectronics and photonics and are able to deal with the following topics: optical data communication, construction of wave guides using total internal reflection and working principles of light emitting diodes and photodetectors.

**Contents:**

Wave nature of light, dielectric waveguides and optical fibers, working principals of light emitting diodes, LASERs and photovoltaic devices. Computation tasks to consolidate knowledge.

**Teaching Methods:**

Lectures 28 h, exercises 14 h, preparation for exam 114 h, 1st period. Examination.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Kasap, S. O.: Optoelectronics and Photonics P. Silfsten & E. Vartiainen: Optoelektroniikka,

**Prerequisites:**

Basic knowledge about optics.

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

max 5

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

max 5

**CS38A0060: Fuzzy sets and fuzzy logic, 6 cr**

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Pasi Luukka

**Year:**

M.Sc. (Tech) 2.

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Pasi Luukka, D.Sc. (Tech.), Professor

**Aims:**

By the end of the course student will be able to

- understand basic mathematical concepts related to fuzzy set theory and fuzzy logic
- model uncertain concepts using fuzzy set theory
- construct fuzzy models
- deduce meaningful information from fuzzy models

**Contents:**

The course consists of basics of fuzzy set theory, some algebras of fuzzy sets, fuzzy quantities, logical aspects of fuzzy sets, operations of fuzzy sets, fuzzy relations, fuzzy compositional calculus, aggregation operators, possibility theory, fuzzy inference systems.

**Teaching Methods:**

Lectures 14 h, tutorials 7 h, exercises 14 h, 1st period. Lectures 14 h, tutorials 7 h, exercises 14 h, 2nd period. Independent study 90 h. Written examination. Total workload 160 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Klir, G., Yuan, B.: Fuzzy Sets and Fuzzy Logic. Theory and Applications, Prentice Hall, 1995.
Fullér, R.: Introduction to Neuro-Fuzzy Systems, Physica-Verlag, 2000.

**Prerequisites:**

Bachelor level mathematics courses:
BM20A6700 Matematiikka I, osa A , BM20A6800 Matematiikka II, osa A, BM20A6900 Matematiikka III
Experience in programming or using mathematical software required:
BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of Technical Computing

**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 10

**CS38A0070: Fuzzy data analysis, 6 cr**

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Pasi Luukka

**Year:**

M.Sc. (Tech.) 2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Pasi Luukka

**Aims:**

In the end of the course the student is expected to be able to

- understand theoretical aspects of data analysis
- understand basic mathematics from fuzzy set theory related to data analysis
- apply fuzzy set theory based models in data analysis
- analyze and interpret results from the models
- apply fuzzy principal component analysis, fuzzy clustering and classification methods to data analysis problems

**Contents:**

Fuzzy sets and relations. Uncertainty measures. Qualitative and quantitative analysis of fuzzy data. Principles of individual multi-person, multi-criteria decision making, feature selection, fuzzy principal component analysis, fuzzy clustering and classification, fuzzy regression analysis.

**Teaching Methods:**

Lectures 28 h, exercises 28 h. Practical assignment. Independent study 100 h. Total work load 156 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:**

No

**Assessment:**

0-5, examination 100 %. Practical assignment.

**Course Materials:**

Bandemer, H., Näther, W.: Fuzzy Data Analysis, Kluwer Academic Publ., 1992.

**Prerequisites:**

CS38A0060 Fuzzy sets and fuzzy logic

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

No

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

Yes, max 10

## MaDMa100: Technomathematics, 70 - 76 cr

**Validity:** 01.08.2009 -
**Form of study:** Major studies
**Type:** Study module
**Unit:** LUT School of Engineering Science

No course descriptions.

*Specialisation studies in Technomathematics consists of obligatory studies (64 ECTS cr) and alternative studies (10 ECTS cr).*

### BM10A0000: Master's Thesis and Seminar, 30 cr

**Validity:** 01.08.2010 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student has general knowledge about a specific field of engineering and applied science in modern society and is able to apply scientific knowledge and methods in the field of the study. The student is able to work independently, prepare a research plan, complete the designed research, and operate in a disciplined way. The student is able to apply the principles of scientific writing in reporting.

**Contents:**

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. The thesis is a research or an implementation project. A report is prepared following the instructions for the Master’s thesis. The report contains description of the problem and the context, the used methods,
describes the actual analysis and actions in the implementation, provides the results and evaluates the outcomes and conclusions.

**Teaching Methods:**

The student works independently and keeps contact with the supervisor informing and discussing the progress of the work. The thesis work is presented in a seminar with other thesis students and their instructors. The student gives a short presentation on the results of his/her project. The presentations are discussed and reviewed. Research work 300 h, independent study 200 h, report preparation 200 h.

**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 %.

**Course Materials:**

Final thesis instructions, scientific reports related to the topic of the thesis.

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

No

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

No

### BM20A3001: Statistical Analysis in Modelling, 5 cr

**Validity:** 01.08.2008 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Heikki Haario

**Note:**

Suitable also for doctoral studies

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-Doctoral Researcher, D.Sc. (Tech.) Virpi Junttila

**Aims:**

Introduction to modern computational methods of estimating reliability of modeling and simulation results. After the course, the student is able to estimate parameters of nonlinear models by measured data and to create posterior distributions for parameters and model predictions by MCMC (Markov chain Monte Carlo) methods.

**Contents:**

Introduction to the methods of estimating reliability of modelling. Errors and uncertainty in experimental data. Uncertainty in model parameters and prediction results. Bayesian approach for parameter estimation and inverse problems, various Monte Carlo (MCMC) methods for nonlinear models.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 35 h, practical assignment 38 h, preparation for examination and the examination 22 h, 2nd period. Total 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, examination 100 %.

**Course Materials:**

To be given at the lectures.

**Prerequisites:**

First year university calculus, BM20A1401 Tilastomatematiikka I. Recommended BM20A6500 Simulation and System Dynamics.

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

No

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

max 15

### BM20A4000: Case Study Seminar, 5 cr

**Validity:** 01.08.2007 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Tuomo Kauranne, Heikki Haario, Virpi Junttila

**Note:**

Suitable also for doctoral studies. The seminar is compulsory for Master students in Applied Mathematics and regular attendance is required.

**Year:**

M.Sc. (Tech.) 1 or Doctoral studies

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Tuomo Kauranne, Professor, Ph.D. Heikki Haario

**Aims:**

The course gives an introduction to independent scientific work by presenting seminar works from different fields of applied mathematics. After the course, the student is able to prepare and give scientific presentations.

**Contents:**

The course works in a seminar form. Each student receives a project work topic and presents the problem as well as the work plan in the beginning. For example, the topics cover modelling problems from different engineering fields, together with numerical solutions. Solution methods for the project work problems are discussed during the course. At conclusion, the participants present their project works. The project work typically is an introduction to the diploma work topic of the student. Guest lectures are also given during the course.

**Teaching Methods:**

Lectures 42 h, exercises 14 h, homework 38 h, preparation of the presentation 36 h, 1st-4th period. Total 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:**

Pass/fail. To pass the course student must attend every week and present his/her project work at least twice during the four periods.

**Course Materials:**

Seminar presentations and other material in Moodle.

**Prerequisites:**

First year university calculus. Recommended BM20A1501 Numeeriset menetelmät I, BM20A1601 Matriisilaskenta, BJ02A2010 Modelling of Unit Operations

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

max 10

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

max 10

### BM20A6100: Advanced Data Analysis and Machine Learning, 6 cr

**Validity:** 01.08.2015 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Lasse Lensu, Heikki Haario

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Heikki Haario, Professor, D.Sc. (Tech.) Lasse Lensu

**Aims:**

The student can pre-process, visualise and analyse multivariate synthetic and real-world data. The student is able to understand and use state-of-the-art regression methods, graphical models and deep learning. The student can use selected methods to solve a practical assignment, analyse the results and report the findings.

**Contents:**

Characteristics of data sources, and data pre-processing, dimensionality reduction and outlier detection. Principal component and other advanced regression methods. Graphical models and Bayesian networks. Deep learning and convolutional neural networks. Case-based topics on advanced data analysis by visiting lecturers.

**Teaching Methods:**

Preparation for lectures 7 h, lectures 14 h, preparation for exercise 21 h, exercises 14 h, 1st period. Preparation for lectures 7 h, lectures 14 h, preparation for exercise 21 h, exercises 14 h, practical assignment 36 h, 2nd period. Self-study 5 h. Exam 3 h. Total amount 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 50 %, exercises 25 %, practical assignment 25 %.

**Course Materials:**

Lecture notes in Moodle. Other literature will be announced when the course starts.

**Prerequisites:**

Recommended: BM20A1901 Statistics II, BM20A2701 Numerical Methods II, BM20A3001 Statistical Analysis in Modelling, BM40A0700 Pattern Recognition or equivalent knowledge.

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

No

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

max 5

### BM20A6200: Inverse Problems and Normed Spaces, 6 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:** Jouni Sampo

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

University lecturer, D.Sc. (Tech.) Jouni Sampo

**Aims:**

The student knows the concepts of function spaces and related basic terminology of functional analysis. Student understand and is able to use classical methods for solving linear inverse problems like of estimation of signal from incomplete or corrupted measurements.

**Contents:**

Vector spaces, bases and linear operators. Linear subspaces and projections. Norms, metric and convergence. Various function spaces, Banach spaces, Lp-spaces, Hilbert spaces. Formulation of inverse problems with additive noise. Ill-posedness and inverse crimes. Truncated singular value decomposition for inverse problems, Tikhonov and total variation regularization.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, independent study and homework 40 h, 1st period. Lectures 21 h, exercises 14 h, independent study and homework 43 h, 2nd period. Exam 3h. Total 156 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 100 %

**Course Materials:**

Study material will be informed/distributed through the Moodle portal.

**Prerequisites:**

Basic Matlab skills are required (in 2nd period). BM20A1601 Matrix calculus is recommended.

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

max 5

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

max 15

### BM20A6500: Simulation and System Dynamics, 6 cr

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Virpi Junttila, Azzurra Morreale

**Year:**

M.Sc. (Tech.) 1

**Period:**

2-3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-Doctoral Researcher, D.Sc. (Tech.) Virpi Junttila
Post-Doctoral Researcher, Ph.D. Azzurra Morreale

**Aims:**

The course gives an introduction to the concepts of discrete and continuous simulation models and methods together with numerical examples. After the course, the student is able to create and use different simulation models to solve practical problems. Among the discrete-event based models, the student is able to model basic queuing, server, scheduling and storage size problems. Also, the student is able to create basic operations and model dynamic systems with Simulink and use Simulink to solve different simulation problems.

**Contents:**

Basic concepts of discrete and continuous systems. Model-based design, basic modeling work-flow, basic simulation work-flow, running the simulations and interpreting the results. Random numbers, discrete event generation by random numbers. Statistical and empirical distributions for event generation. Building numerical simulation examples with Matlab and Simulink. Modeling dynamics systems and simulation models for dynamic systems with Simulink.
Application examples: queuing systems, storage size optimization, profitability analysis, supply chain management, investment analysis

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 21 h, 2nd period. Lectures 21 h, exercises 14 h, homework 21 h, 3rd period. Practical assignment 22 h, preparation for examination and the examination 22 h, 2nd-3rd period. Total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 80 %, homework and practical assignment 20 %.

**Course Materials:**

Course material is given in the course homepage.

**Prerequisites:**

Recommended BM20A1401 Tilastomatematiikka I and BM20A5001 Principles of Technical Computing.

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

No

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

max 15

### CS38A0020: Optimization in business and industry, 6 cr

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Sirkku Parviainen, Pasi Luukka

**Year:**

M.Sc. 1.

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Pasi Luukka, D.Sc. (Tech.), Associate Professor
Sirkku Parviainen, Lic.Phil., Lecturer

**Aims:**

By the end of the course student will be able to
- select/ employ mathematical models for various optimization problems
- use optimization software
- interpret information from optimization results
- understand the basic principles of different optimization algorithms for linear, mixed-integer linear, and nonlinear optimization

**Contents:**

Formulation of optimization models. Linear programming and mixed-integer linear programming, nonlinear optimization algorithms.
Solving optimization problems using Matlab Optimization Toolbox. Business and industry oriented practical examples, i.e. factory, warehouse, sales allocation models etc.

**Teaching Methods:**

Lectures 28 h, exercises 28 h, 4th period. Independent study 74 h, practical assignment 30 h. Written examination. Total work load 160 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %

**Course Materials:**

Taha, H.A.: Operations Research an introduction, 8th edition, Pearson/Prentice-Hall, 2007.
Hillier, F.S., Lieberman, G.J.: Introduction to Operations Research, 8th edition, McGraw-Hill, 2004.

**Prerequisites:**

Experience in programming or using mathematical software required.
BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of Technical Computing

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

2

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

Yes, max 15

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

Yes, max 10

*Alternative studies. Choose at least 10 ECTS cr from following studies.*

### BJ02A2011: Modelling of Unit Operations, 5 cr

**Validity:** 01.01.2017 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Tuomo Kauranne, Dipal Shah

**Year:**

M.Sc. (Tech.) 1, M.Sc. (Tech.) 2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate professor, Ph.D. Tuomo Kauranne

**Aims:**

After completing the module the student - can describe steady-state and transient unit operations with mathematical models - can validate models and estimate parameters from experimental data - can apply phenomenon based models in process development and design
tasks, such as sizing, optimization, and scale-up - can use mathematical and simulation software.

**Contents:**

Modeling and parameter estimation in Matlab, for Chemical Engineering and Applied Mathematics in general. The course presents kinetic models for processes that feature chemical reactions, temperature dependence, CSTR and batch reactors with and without cooling, plug flow and pipeline reactors.

**Teaching Methods:**

Lectures 24 h, exercises 14 h, 2nd period. Home assignments 70 h, self-study 22 h. Home assignments passed, no exam.
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. Half of the grade is decided by the share of exercises completed by the student, the other half by the quality of the work and reports produced from home assignments.

**Course Materials:**

In Moodle.

**Prerequisites:**

Either the Finnish course Johdatus tekniseen lasekntaan or Principles of Technical Computing, or corresponding skills in MATLAB programming.

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

max 10

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

max 10

### BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 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:** Erkki Lähderanta, Jouni Sampo, Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, Professor, Ph.D. Erkki Lähderanta, University Lecturer, D. Sc. (Tech.) Jouni Sampo.

**Aims:**

The student is able to employ theoretical and operational skills in some specific area of applied mathematics, computing, and technical physics. The student is able to select, apply, and analyze methods to modeling problems in mathematics, science and engineering. Entrepreneurial learning methods are applied.

**Contents:**

The course consists of literature review, working on exercises and completing practical projects. Materials will be chosen and agreed individually according to the focus of the study module, students' interests, and research in the laboratories. The course with the same title can be included in the study programme twice when two distinct areas are covered.

**Teaching Methods:**

Self-study of learning materials, exercises, project assignment and reporting, seminar presentation, total 80-160 h, 1st-4th period.

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

No

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

No

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

No

**Assessment:**

Pass/Fail, report and seminar presentation 100 %.

**Course Materials:**

Learning materials will be agreed with each student separately depending on the task(s).

**Prerequisites:**

Recommended: BSc. in Computational Engineering and Technical Physics, first year studies in the specialization of the M.Sc. studies.

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

No

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

No

### BM20A4701: Modelling with Partial Differential Equations, 4 cr

**Validity:** 01.08.2011 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Tuomo Kauranne

**Note:**

The course has no contact teaching. Students wishing to take this course should contact the teacher by email and she will obtain course material in return mail. Exam time and form to be agreed separately by email.

**Year:**

M.Sc. (Tech.) 1-2 or Doctoral studies

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Tuomo Kauranne

**Aims:**

The student is able to formulate PDE-models, knows fundaments of theory, basic model types and most common numerical schemes, and is able to perform numerical solution using mathematical software tools. The student familiar with a number of application areas. He/she is able to analyze PDE models in multiphysical phenomena, examples are acoustics, solidification and free-boundary computations, crystal growth and impedance tomography.

**Contents:**

Introduction to PDE:s, basics of finite element method, multiphysics and modeling, examples.

**Teaching Methods:**

Supervised self study course: supervision 5 h, self study 55 h, exam and preparation 10 h, 2nd period. Total workload 70 h. The course is available in Finnish language as web-course http://hlab.ee.tut.fi/mallinnus/kurssit.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 100 %

**Course Materials:**

Endre Suli: Lecture notes on finite element methods for partial differential equations, chapters 1-3 and 5.

**Prerequisites:**

Good command of calculus. Knowledge of functional analysis recommended but not compulsory.

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

max 15

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

max 15

### BM20A5100: Scientific Computing and Numerics for PDEs, 6 cr

**Validity:** 01.08.2011 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Ashvinkumar Chaudhari

**Note:**

The course will be lectured every other year, next during the academic year 2019-2020. Suitable also for doctoral studies.

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

Yes, 2019-2020

**Year:**

M.Sc.(Tech.) 2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Postdoctoral Researcher, D.Sc. (Tech.) Ashvinkumar Chaudhari

**Aims:**

The student knows basic equations of heat transfer, fluid flows and turbulence.The student is able to solve ordinary and partial differential equations usingthe finite difference/volume method, and is able to work with CFD simulationsoftware, such as OpenFOAM.

**Contents:**

Governing equations for fluid flow and heat transfer. Finite difference andvolume methods in heat transfer and fluid dynamics. Analytical solutions ofsimplified (linearized) flow problems. Numericalsolutions of steady state as well as time-dependent (i.e. non-linear) flow /heattransfer problems. CFD simulations for industrial flow problems.

**Teaching Methods:**

Lectures 14 h; Computer exercises (CFD software learning) 14 h; Mathematical exercises14 h, Self-study 40 h, Project assignment 40 h, Exam and preparation 10 h, 4thperiod. Total 132 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, project work 50 %, exam 50 %.

**Course Materials:**

Lecture notes

**Prerequisites:**

BM20A2701 Numerical Methods II
BM20A5500 Differentiaaliyhtälöt ja dynaamiset systeemit
BM20A4100 Vektorianalyysi teknillisessä laskennassa.

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

max 5

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

max 15

### BM40A1400: GPGPU Computing, 6 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:** Arto Kaarna, Aleksandr Bibov

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

Intensive week 43, periods 2 and 3.

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, D.Sc. (Tech.) Alexander Bibov.

**Aims:**

The student is able to reorganize computational tasks in order to best fit a given GPU architecture. The student is able to implement inter-operability between a GPU-boosted code and MATLAB/Python environment.

**Contents:**

GPGPU (General Purpose Graphics Processing Unit) programming architecture, solving problems using GPGPU. CUDA-implementations and interface to GPGPU hardware. Parallel algorithms, hybrid application design for CPU/GPGPU. Introduction to visualization of computed data. Practical implementations for artificial toy-cases and real engineering applications.

**Teaching Methods:**

Lectures 20 h, exercises 15 h, pre-assignment 24 h, intensive week 43. Seminar 4 h, post-assignment and seminar preparation, 93 h, periods 2 and 3. Totally 156 h.

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

No

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

No

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

No

**Assessment:**

0-5, report and seminar presentation on the assignment.

**Course Materials:**

Popular GPU-accelerated Applications, http://www.nvidia.com/docs/IO/123576/nv-applications-catalog-lowres.pdf. Other materials will be announced at lectures.

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

max 5

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

max 5

### CS38A0060: Fuzzy sets and fuzzy logic, 6 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Pasi Luukka

**Year:**

M.Sc. (Tech) 2.

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Pasi Luukka, D.Sc. (Tech.), Professor

**Aims:**

By the end of the course student will be able to

- understand basic mathematical concepts related to fuzzy set theory and fuzzy logic
- model uncertain concepts using fuzzy set theory
- construct fuzzy models
- deduce meaningful information from fuzzy models

**Contents:**

The course consists of basics of fuzzy set theory, some algebras of fuzzy sets, fuzzy quantities, logical aspects of fuzzy sets, operations of fuzzy sets, fuzzy relations, fuzzy compositional calculus, aggregation operators, possibility theory, fuzzy inference systems.

**Teaching Methods:**

Lectures 14 h, tutorials 7 h, exercises 14 h, 1st period. Lectures 14 h, tutorials 7 h, exercises 14 h, 2nd period. Independent study 90 h. Written examination. Total workload 160 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Klir, G., Yuan, B.: Fuzzy Sets and Fuzzy Logic. Theory and Applications, Prentice Hall, 1995.
Fullér, R.: Introduction to Neuro-Fuzzy Systems, Physica-Verlag, 2000.

**Prerequisites:**

Bachelor level mathematics courses:
BM20A6700 Matematiikka I, osa A , BM20A6800 Matematiikka II, osa A, BM20A6900 Matematiikka III
Experience in programming or using mathematical software required:
BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of Technical Computing

**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 10

### CS38A0070: Fuzzy data analysis, 6 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Pasi Luukka

**Year:**

M.Sc. (Tech.) 2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Pasi Luukka

**Aims:**

In the end of the course the student is expected to be able to

- understand theoretical aspects of data analysis
- understand basic mathematics from fuzzy set theory related to data analysis
- apply fuzzy set theory based models in data analysis
- analyze and interpret results from the models
- apply fuzzy principal component analysis, fuzzy clustering and classification methods to data analysis problems

**Contents:**

Fuzzy sets and relations. Uncertainty measures. Qualitative and quantitative analysis of fuzzy data. Principles of individual multi-person, multi-criteria decision making, feature selection, fuzzy principal component analysis, fuzzy clustering and classification, fuzzy regression analysis.

**Teaching Methods:**

Lectures 28 h, exercises 28 h. Practical assignment. Independent study 100 h. Total work load 156 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:**

No

**Assessment:**

0-5, examination 100 %. Practical assignment.

**Course Materials:**

Bandemer, H., Näther, W.: Fuzzy Data Analysis, Kluwer Academic Publ., 1992.

**Prerequisites:**

CS38A0060 Fuzzy sets and fuzzy logic

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

No

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

Yes, max 10

## FyDMa200: Technical Physics, 66 cr

**Validity:** 01.08.2011 -
**Form of study:** Major studies
**Type:** Study module
**Unit:** LUT School of Engineering Science

No course descriptions.

*Specialisation studies in Technical Physics consists of obligatory studies (66 ECTS cr) and alternative studies (4 ECTS cr*

### BM10A0000: Master's Thesis and Seminar, 30 cr

**Validity:** 01.08.2010 -
**Form of study:** Basic studies
**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student has general knowledge about a specific field of engineering and applied science in modern society and is able to apply scientific knowledge and methods in the field of the study. The student is able to work independently, prepare a research plan, complete the designed research, and operate in a disciplined way. The student is able to apply the principles of scientific writing in reporting.

**Contents:**

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. The thesis is a research or an implementation project. A report is prepared following the instructions for the Master's thesis. The report contains description of the problem and the context, the used methods,
describes the actual analysis and actions in the implementation, provides the results and evaluates the outcomes and conclusions.

**Teaching Methods:**

The student works independently and keeps contact with the supervisor informing and discussing the progress of the work. The thesis work is presented in a seminar with other thesis students and their instructors. The student gives a short presentation on the results of his/her project. The presentations are discussed and reviewed. Research work 300 h, independent study 200 h, report preparation 200 h.

**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 %.

**Course Materials:**

Final thesis instructions, scientific reports related to the topic of the thesis.

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

No

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

No

### BM30A0500: Applied Optics, 6 cr

**Validity:** 01.08.2007 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Erik Vartiainen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Erik Vartiainen

**Aims:**

After the course a student:
1. knows the basic properties of waves and wave motion,
2. understands the material polarization phenomenon as the ultimate source of light,
3. knows the basic properties and physics of laser action,
4. knows the ideas and applications of ultrafast optics,
5. knows the basic physics and applications of nonlinear optics,
6. knows the Fresnel-equations, and understand accordingly the physics of light reflection and refraction,
7. knows the basics of light polarization, the corresponding applications and the Jones matrix formulation,
8. understands the meaning of spatial and temporal coherence of light, and their implications for the technical applications, such as FTIR spectroscopy,
9. knows the ABCD-matrix formulation for geometrical optics,
10. knows the basics of laser imaging: one- and two-photon confocal microscopy, spectral imaging, and fluorescence nanoscopy,
11. understands the physics of producing slow and fast light, and knows their applications,
12. understands diffraction of light, and its applications.

**Contents:**

1. Wave motion and wave equations,
2. Maxwell equations and electromagnetic spectrum,
3. Lasers,
4. Ultrafast lasers,
5. Fresnell equations,
6. Polarization and optical activity,
7. Geometrical optics,
8. Coherence,
9. Interference and diffraction,
10. Nonlinear optics,
11. Optical microscopy and nanoscopy,
12. Slow and fast light, THz-optics,
13. Attosecond optics,
14. Coherent control.

**Teaching Methods:**

Lectures 42 h, exercises 14 h, homework 70 h, preparation for the exam 26 h and exam 4 h. total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

1. Eugene Hecht, Optics, 4th edition (Addison-Wesley, 2002). 2. G. R. Fowles, Introduction to Modern Optics, 2nd edition, (Holt, Rinehart and Winston, New York, 1976). 3. R. W. Boyd, Nonlinear Optics (Academic Press, San Diego, 1992). 4. Y. R. Shen, The Princples of Nonlinear Optics (Wiley, New York, 1984).

**Prerequisites:**

Students are recommended to have completed a basic course in physics.

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

15–

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

max 15

### BM30A0601: Optoelectronics, 6 cr

**Validity:** 01.08.2009 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Erkki Lähderanta, Ekaterina Soboleva, Bernardo Barbiellini

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Bernardo Barbiellini
Junior Researcher, M.Sc.(Tech.) Ekaterina Soboleva

**Aims:**

Students get a good understanding of the basics of optoelectronics and photonics and are able to deal with the following topics: optical data communication, construction of wave guides using total internal reflection and working principles of light emitting diodes and photodetectors.

**Contents:**

Wave nature of light, dielectric waveguides and optical fibers, working principals of light emitting diodes, LASERs and photovoltaic devices. Computation tasks to consolidate knowledge.

**Teaching Methods:**

Lectures 28 h, exercises 14 h, preparation for exam 114 h, 1st period. Examination.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Kasap, S. O.: Optoelectronics and Photonics P. Silfsten & E. Vartiainen: Optoelektroniikka,

**Prerequisites:**

Basic knowledge about optics.

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

max 5

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

max 5

### BM30A1500: Advanced Topics in Material Science, 6 cr

**Validity:** 01.08.2007 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Erkki Lähderanta

**Year:**

M.Sc. (Tech.) 1

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Erkki Lähderanta

**Aims:**

The aim of the course is to introduce students to selected topics of advanced Material Science: Nanophysics, Semiconductors, Superconductors, Magnetism, Ferroelectrics

**Contents:**

Nanophysics, applied superconductivity, ferroelectrics, magnetism, applied semiconductors and other advanced topics in material science connected to nanophysics.

**Teaching Methods:**

Lectures 30 h, homework 126 h (5 essays á 25 h 12 min), 2nd period. Total work load 156 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:**

Pass/Fail. Written assignment 100 %.

**Course Materials:**

Lecture notes to be given at lectures.

**Prerequisites:**

BM30A2200 Semiconductor and Superconductor Physics

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

max 5

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

max 5

### BM30A1600: Microelectronics, 6 cr

**Validity:** 01.08.2008 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Erkki Lähderanta, Bernardo Barbiellini, Ekaterina Soboleva

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Bernardo Barbiellini
Junior Researcher, M.Sc.(Tech.) Ekaterina Soboleva

**Aims:**

Studentsget a good understanding of microelectronics basics and main integrated circuit(IC) components, students gain fluency to the most important variables and functions relatedto the IC components, and are able to apply their skills to analog IC design.

**Contents:**

Considering the basic components (PN junctions, metal-oxide-semiconductor, bipolar junction transistors, MOSFET, diodes, and amplifiers) of integrated circuit and their operation principles. Computation tasks and simulation to facilitate understanding.

**Teaching Methods:**

Lectures 28 h, exercises and tutorials 28 h, assignment 40 h, preparation for exam 60 h. Assignment and its presentation. Written examination.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %. Satisfactorily completed assignment required.

**Course Materials:**

Roger T. Howe, Charles G. Sodini: Microelectronics An Integrated Approach.

**Prerequisites:**

Recommended BL40A1711 Johdanto digitaalielektroniikkaan and BL50A1400 Analogiaelektroniikka.

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

max 5

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

max 5

### BM30A2200: Semiconductor and Superconductor Physics, 6 cr

**Validity:** 01.08.2009 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Egor Fadeev, Erkki Lähderanta

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Erkki Lähderanta
Research Assistant, M.Sc. (Tech.) Egor Fadeev

**Aims:**

The course gives the student the skills to understand the basic behaviour of semiconductors and superconductors.

**Contents:**

Classical conductor, introduction to quantum mechanics, free-electron model of metals, energy bands, doped semiconductors, spintronics, basic properties of superconductivity, London equations, thermodynamics of the superconducting transition, the intermediate state, coherence length, current in superconductor, thin films, BCS-theory, type-II superconductors, high-Tc superconductors.

**Teaching Methods:**

Lectures 49 h, exercises 28 h, preparing for exercises 48 h, preparing for the exam 31 h. Total work load 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Lecture handouts.
Juha Sinkkonen: Puolijohdeteknologian perusteet.
A. C. Rose-Innes and E. H. Rhoderick: Introduction to Superconductivity, 2nd edition (Pergamon).

**Prerequisites:**

A knowledge of the fundamentals of material physics, a knowledge of the electric and physical properties of materials.

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

max 5

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

max 5

### BM30A2500: Nanophysics, 6 cr

**Validity:** 01.08.2014 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Anton Komlev, Igor Rozhanskiy, Pavel Geydt

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Junior Researcher, M.Sc. (Tech.) Pavel Geydt
Ph.D. Igor Rozhanskiy

**Aims:**

The objective of the course is to make information about the rapidly evolving areas of nanoscale science and technology available to a wide range of students. Upon completion of the course, students will clarify the principal difference between physical phenomena in macro-scale and nano-scale. Students will be able to:
- develop their understanding of bio-, physical and chemical systems,
- characterize the systems related with Materials science and Metrology,
- recognize the difference in prevailing forces in different size scales,
- explain many practical observations and anomalies found in their experimental research activity,
- apply this combined knowledge in practice.

After taking the course, students should become capable to operate safely with nano-systems, considering their hazardous aspects. The course helps to systematize the fragmented information about nano- related phenomena and knowledge from physical and chemical disciplines studied before.

**Contents:**

Nanoethics, Forces in the Nanoworld, Scaling Laws, Nanomaterials and Nanocomposites, Nanomechanics, Nanothermodynamics, Nanofluidics, Nanochemistry, Tribology, Nanooptics of Metals and Semiconductors, Nanoelectronics, Spintronics, Nanomagnetism, Nanocarbon, Nanolithography.

**Teaching Methods:**

Lectures 42 h, exercises 28 h; preparing for exercises 36 h, preparing for the presentation 8 h, preparing for laboratory works 6 h, preparing for the examination 40 h; 1st-2nd period. Total workload for student 160 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

Grade 0-5; evaluation 0-100 points, examination 50 %, exercises 25 %, presentation 15 %, laboratory works 10 %.

**Course Materials:**

Lecture handouts

**Prerequisites:**

B.Sc. (Tech) studies.

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

max 5

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

max 5

*Choose min. 4 ECTS cr from following studies.*

**BM20A5001: Principles of Technical Computing, 4 cr**

**Validity:** 01.08.2014 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Matylda Jablonska-Sabuka

**Year:**

B.Sc. (Tech.) 2., M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Matylda Jablonska-Sabuka

**Aims:**

Students get a good understanding of Matlab syntax and programming, gain fluency in principles of technical computing and are able to apply the skills to basic mathematical and engineering problems (the skills are applicable in big part to Octave and R programming, too).

**Contents:**

Working with various data structures (multidimensional arrays, cell arrays, etc.) and variable types (numeric, logical, textual, etc.), Matlab symbolic functionality, conditional statements (if-else, switch-case), loops (for and while), using built-in functions, handling external data, 2-D and 3-D plotting, writing user-defined functions, optimization of code speed, style and efficiency.

**Teaching Methods:**

Lectures 12 h, computer class exercises 24 h, independent study 30 h, preparation for exam 34 h, 1st period. Total 100 h. EXAM-tentti.

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

No

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

No

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

Yes

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Lecture material available in Moodle, based partly on textbook: Gilat, A.: An Introduction to Matlab with Applications.

**Prerequisites:**

Basic university calculus required. Recommended first year university calculus necessarily including matrix calculus.

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

max 10

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

max 5

### BL40A1101: Embedded System Programming, 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:** Jouni Vuojolainen, Teemu Sillanpää, Tuomo Lindh

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate professor, D.Sc. (Tech.) Tuomo Lindh

**Aims:**

Upon completion of the course the student will be able to: 1. apply C language and its structures to embedded system programming, 2. form complex data types such as structures, unions and buffers and use these in order to maintain information of different entities (e.g.
processing units), 3. control the registers of a micro controller using C-language, 4. use different PUs of a micro controller, 5. Take into use a real time operation system.

**Contents:**

Design tools, C-language in embedded system programming, utilization of a micro controller environment (registers, timers, buses, A/D conversion etc.). Typical data structures, typical program structures in real-time applications.

**Teaching Methods:**

14 h of lectures, 14 h of tutorials, 1st period. 14 h of lectures, 14 h of tutorials, 2nd period. Assignment. Written examination.
Total workload 130 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, assignment 1 50 %, examination 50 %.

**Course Materials:**

Wolf, W.: Computers as components: principles of embedded computing system design.
Lecture notes.

**Prerequisites:**

Basics of C language.

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

No

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

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

## MaDDCompu: Computer Vision and Pattern Recognition, 50 - 70 cr

**Validity:** 01.08.2018 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F

No course descriptions.

*Specialisation studies in Computer Vision and Pattern Recognition consists of obligatory studies (57 ECTS cr) and alternative studies (13 ECTS cr*

**BM10A0000: Master's Thesis and Seminar, 30 cr**

**Validity:** 01.08.2010 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student has general knowledge about a specific field of engineering and applied science in modern society and is able to apply scientific knowledge and methods in the field of the study. The student is able to work independently, prepare a research plan, complete the designed research, and operate in a disciplined way. The student is able to apply the principles of scientific writing in reporting.

**Contents:**

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. The thesis is a research or an implementation project. A report is prepared following the instructions for the Master’s thesis. The report contains description of the problem and the context, the used methods,
describes the actual analysis and actions in the implementation, provides the results and evaluates the outcomes and conclusions.

**Teaching Methods:**

The student works independently and keeps contact with the supervisor informing and discussing the progress of the work. The thesis work is presented in a seminar with other thesis students and their instructors. The student gives a short presentation on the results of his/her project. The presentations are discussed and reviewed. Research work 300 h, independent study 200 h, report preparation 200 h.

**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 %.

**Course Materials:**

Final thesis instructions, scientific reports related to the topic of the thesis.

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

No

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

No

### BM40A0701: Pattern Recognition, 6 cr

**Validity:** 01.01.2016 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Lasse Lensu

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Lasse Lensu

**Aims:**

After passing the course, students understand pattern recognition problems and know the common approaches including machine learning methods to solve them. The students are able to select an appropriate pattern recognition method and implement a working solution for a specific problem. The students can analyse the performance and quality of a pattern recognition system.

**Contents:**

Introduction to pattern recognition, supervised and unsupervised machine learning. Feature processing, selection and system evaluation. Statistical pattern recognition and Bayesian inference. Linear and non-linear classifiers such as the perceptron, artificial neural networks and support vector machines. Context-dependent and reinforcement learning. Unsupervised pattern recognition and method-independent learning.

**Teaching Methods:**

Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 21 h, 1st period.
Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 21 h, practical assignment 40 h, 2nd period. Self-study 4 h. Total amount 156 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. Homework and exercises 30%, exercise quizzes (or exam) 40%, practical assignment 30%.

**Course Materials:**

Duda, R.O., Hart, P.E., Stork, D.G.: Pattern Classification, Wiley, 2001. Theodoridis, S., Koutroumbas, K.: Pattern Recognition, Academic Press, 2003.

**Prerequisites:**

Recommended BM20A4301 Johdatus tekniseen laskentaan, BM20A5001 Principles of Technical Computing, BM20A5800 Funktiot, lineaarialgebra ja vektorit, BM20A5810 Differentiaalilaskenta ja sovellukset, BM20A5820 Integraalilaskenta ja sovellukset, BM20A5840 Usean muuttujan funktiot ja sarjat, CT60A0210 Käytännön ohjelmointi, BM20A1401 Tilastomatematiikka I, BM20A1501 Numeeriset menetelmät I, BM20A1601 Matriisilaskenta, BM40A0501 Johdatus laskennalliseen älykkyyteen, or equivalent knowledge.

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

max 5

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

max 5

### BM40A1002: Seminar on Computer Vision and Pattern Recognition, 3 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Note:**

Replaces the course BM40A1001 Seminar on Intelligent Computing

**Year:**

M.Sc. (Tech.) 2

**Period:**

2-3

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**Aims:**

After the course a student is expected to be able to explain the basic principles of scientific work and its reporting both in the scientific forums and general media, to understand the principles of the academic thesis and possibilities of funding and different relevant work places, to write a seminar report about intelligent computing in the form of the academic thesis, to give the corresponding oral seminar presentation, and to act as an opponent.

**Contents:**

The first part (lectures in the 2nd period) provides the skills defined in the aims of the course, including the skills to prepare and to give the seminar presentation in the second part (3rd period). Independent preparation of a written seminar on a given intelligent computing topic.

**Teaching Methods:**

Lectures 8 h, 2nd period. Seminars 8 h, 3rd period. Preparing a written and oral seminar presentation, including self-study of relevant literature, and acting as an opponent, 62 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, written seminar report 100 %. Seminar presentation. Active participation to all seminar sessions. Acting as an opponent.

**Course Materials:**

Material published on the course web page.

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

No

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

No

### BM40A1201: Digital Imaging and Image Preprocessing, 6 cr

**Validity:** 01.01.2016 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Tuure Tuuva, Erik Vartiainen, Lasse Lensu

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, Professor, Ph.D. Tuure Tuuva, Associate Professor, Ph.D. Erik Vartiainen.

**Aims:**

A student knows how radiation interacts with matter, how images can be captured and the image formation modelled, and how preprocessed images can be used for measurement purposes. The student is able to characterise imaging and the factors affecting it, and affect image quality in practice.

**Contents:**

Electromagnetic radiation and light interaction with matter, sources of radiation and illumination techniques, imaging sensors and manufacturing technologies, spectroscopy, imaging optics, sensor and image acquisition modelling and characterisation, digital image encoding and characteristics, image preprocessing techniques, and image-based measurement.

**Teaching Methods:**

Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 14 h, 1. period.
Lectures 14 h, lecture preparation 7 h, exercises 14 h, exercise preparation 14 h, practical assignment 40 h, 2. period.
Self-study 18 h. Total amount 156 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. Homework and exercises 25 %, exercise quizzes (or exam) 50 %, practical assignment 25 %.

**Course Materials:**

Kasap, S.O.: Optoelectronics and Photonics, Prentice-Hall, 2000. Gonzales, R.C., Woods, R.E.: Digital image processing, Prentice-Hall, 2002. Jain, A.K.: Fundamentals of digital image processing, Prentice-Hall, 1989.

**Prerequisites:**

Recommended BM20A4301 Johdatus tekniseen laskentaan, BM20A5001 Principles of Technical Computing, BM40A0502 Johdatus laskennalliseen älykkyyteen ja koneoppimiseen, or equivalent knowledge.

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

max 5

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

max 5

### BM40A1400: GPGPU Computing, 6 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:** Arto Kaarna, Aleksandr Bibov

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

Intensive week 43, periods 2 and 3.

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, D.Sc. (Tech.) Alexander Bibov.

**Aims:**

The student is able to reorganize computational tasks in order to best fit a given GPU architecture. The student is able to implement inter-operability between a GPU-boosted code and MATLAB/Python environment.

**Contents:**

GPGPU (General Purpose Graphics Processing Unit) programming architecture, solving problems using GPGPU. CUDA-implementations and interface to GPGPU hardware. Parallel algorithms, hybrid application design for CPU/GPGPU. Introduction to visualization of computed data. Practical implementations for artificial toy-cases and real engineering applications.

**Teaching Methods:**

Lectures 20 h, exercises 15 h, pre-assignment 24 h, intensive week 43. Seminar 4 h, post-assignment and seminar preparation, 93 h, periods 2 and 3. Totally 156 h.

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

No

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

No

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

No

**Assessment:**

0-5, report and seminar presentation on the assignment.

**Course Materials:**

Popular GPU-accelerated Applications, http://www.nvidia.com/docs/IO/123576/nv-applications-catalog-lowres.pdf. Other materials will be announced at lectures.

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

max 5

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

max 5

*Exchangeable courses, choose one of the following courses*

**BM40A0801: Machine Vision and Digital Image Analysis, 6 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:** Heikki Kälviäinen

**Note:**

The course will be lectured every other year, next during the academic year 2019-2020.

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

Yes, next realization year 2019-2020

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

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

**Aims:**

After the course a student is expected to be able to explain the fundamental steps of image processing and analysis, to introduce and compare machine vision applications, to plan a solution to a given object recognition problem, and to implement practical solutions for machine vision problems using Matlab or other suitable programming language.

**Contents:**

Digital image processing: digital image, image transforms, image enhancement, image compression. Image analysis: segmentation, representation and description, recognition and interpretation. Hardware, software and applications.

**Teaching Methods:**

Lectures and seminars 21 h, exercises 14 h, 3rd period. Lectures and seminars 21 h, exercises 14 h, 4th period. Preparation for the seminar presentations and acting as an opponent, homework, and practical assignment 47 h, self-studying of taught matters and relevant literature and preparation for the exam 36 h, 3rd and 4th period. Exam 3 h. Total amount 156 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):**

Yes

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

No

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

No

**Assessment:**

0-5, exam 50 %, exercises 50 %. Seminar presentation. Acting as an opponent. Practical assignment.

**Course Materials:**

References and material published on the course web page.

**Prerequisites:**

Recommended BM40A0701 Pattern Recognition, BM40A0901 Computer Vision, BM40A1201 Digital Imaging and Image Preprocessing,BM40A0502 Johdatus laskennalliseen älykkyyteen ja koneoppimiseen

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

max 5

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

No

### BM40A0901: Computer Vision, 6 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:** Arto Kaarna

**Note:**

The course will be lectured every other year, next during the academic year 2018-2019.

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

Yes, 2018-2019.

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

A student knows the theoretical basis of geometric and dynamic computer vision, and is able to apply the knowledge to solve practical problems in computer vision. A student is able to explain basic approaches and applications for image processing and feature extraction for single images and video sequences. Student is able to implement simple application in computer vision.

**Contents:**

Computer vision for 3D scenes. Imaging and camera calibration. Image preprocessing. Coordinate frames and geometrical primitives. Single and multi-view geometry. Pose estimation. Dynamic vision and tracking. Structure from motion. Computer vision for robotics.

**Teaching Methods:**

Lectures 14 h, exercises 12 h, exercise preparation 12 h, 3rd period.
Lectures 14 h, exercises 14 h, exercise preparation 14 h, seminar 3h, practical assignment and seminar preparation 42h, 4th period.
Independent study 28h, exam 3 h. Total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5:
0-2, exam, exercises, practical assignment if the grade from the exam is 0, 1 or 2.
3-5, exam (60 %), exercises (40 %), practical assignment if the grade from the exam is 3, 4, or 5.

**Course Materials:**

Emanuele Trucco, Alessandro Verri: Introductory Techniques for 3-D Computer Vision. Prentice Hall, 1998. E. R. Davies: Computer and Machine Vision, Fourth Edition: Theory, Algorithms, Practicalities, 4th Edition. Elsevier, 2012. Richard Hartley, Andrew Zisserman: Multiple View Geometry in Computer Vision, 2nd Edition. Cambridge University Press, 2004. David A. Forsyth, Jean Ponce: Computer Vision: A Modern Approach, 2nd Edition. Prentice Hall, 2011.

**Prerequisites:**

BM20A6700 Matematiikka I
BM20A6800 Matematiikka II
BM20A6800 Matematiikka II
CT60A0200 Ohjelmoinnin perusteet.
Recommended
BM20A1401 Tilastomatematiikka I,
BM20A1501 Numeeriset menetelmät I,
BM20A1601 Matriisilaskenta,
BM20A5500 Differentiaaliyhtälöt ja dynaamiset systeemit
BM40A0501 Johdatus laskennalliseen älykkyyteen or equivalent knowledge.

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

max 5

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

max 5

*Choose min. 13 ECTS cr from following studies.*

**BL40A1601: Embedded System Design, 6 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:** Jero Ahola, Juhamatti Korhonen

**Year:**

M.Sc. (Tech.) 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Juhamatti Korhonen

**Aims:**

Upon completion of the course the student will be able to program with VHDL hardware design language and design and implement digital systems by using programmable logic circuits.

**Contents:**

Circuit design of digital electronics with programmable logic circuits. Principles of digital circuit design, system level synthesis, hardware design languages.

**Teaching Methods:**

Lectures 14 h, exercises, 14 h, 3rd period. Lectures 14 h, exercises, 14 h, assignment, 4th period. Examination.
Total workload 156 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 25 %, assignment 1 25 %, assignment 2 50 %.

**Course Materials:**

To be announced in class.

**Prerequisites:**

Basics of digital design and digital electronics, basics of programming.

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

Yes, 15

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

Max. 15

### BM10A0500: Research Methods, 3 cr

**Validity:** 01.08.2014 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Arto Kaarna

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna

**Aims:**

Student is able to describe concepts and methods in research. Student is able to identify requirements for scientific reporting and is able to evaluate the structure and contents of a scientific report. Student is able to design a research process and to prepare a research plan.

**Contents:**

Categorization of science, scientific work. Philosophies behind research. Research process, designing research, research process, research questions and hypothesis. Qualitative and quantitative research
methods. Data collection, information retrieval, literature review. Reporting scientific work.

**Teaching Methods:**

Lectures and exercises 14h, seminars 4h, 1st period. Practical assignments 35 h, 1st and 2nd period. Self-study 22 h, exam 3 h. Total 78 h. Moodle is used in this course.

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 60 %, practical assignments 40 %.

**Course Materials:**

Creswell, J.W.: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th edition, SAGE, 2014. Hirsjärvi, S., Remes, P., Sajavaara, P.: Tutki ja kirjoita, 15. painos, Tammi, 2015. Research reports.

**Prerequisites:**

B.Sc. studies finished.

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

max 5

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

max 5

### BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 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:** Erkki Lähderanta, Jouni Sampo, Arto Kaarna

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, D.Sc. (Tech.) Arto Kaarna, Professor, Ph.D. Erkki Lähderanta, University Lecturer, D. Sc. (Tech.) Jouni Sampo.

**Aims:**

The student is able to employ theoretical and operational skills in some specific area of applied mathematics, computing, and technical physics. The student is able to select, apply, and analyze methods to modeling problems in mathematics, science and engineering. Entrepreneurial learning methods are applied.

**Contents:**

The course consists of literature review, working on exercises and completing practical projects. Materials will be chosen and agreed individually according to the focus of the study module, students' interests, and research in the laboratories. The course with the same title can be included in the study programme twice when two distinct areas are covered.

**Teaching Methods:**

Self-study of learning materials, exercises, project assignment and reporting, seminar presentation, total 80-160 h, 1st-4th period.

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

No

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

No

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

No

**Assessment:**

Pass/Fail, report and seminar presentation 100 %.

**Course Materials:**

Learning materials will be agreed with each student separately depending on the task(s).

**Prerequisites:**

Recommended: BSc. in Computational Engineering and Technical Physics, first year studies in the specialization of the M.Sc. studies.

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

No

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

No

### BM20A3001: Statistical Analysis in Modelling, 5 cr

**Validity:** 01.08.2008 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Heikki Haario

**Note:**

Suitable also for doctoral studies

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-Doctoral Researcher, D.Sc. (Tech.) Virpi Junttila

**Aims:**

Introduction to modern computational methods of estimating reliability of modeling and simulation results. After the course, the student is able to estimate parameters of nonlinear models by measured data and to create posterior distributions for parameters and model predictions by MCMC (Markov chain Monte Carlo) methods.

**Contents:**

Introduction to the methods of estimating reliability of modelling. Errors and uncertainty in experimental data. Uncertainty in model parameters and prediction results. Bayesian approach for parameter estimation and inverse problems, various Monte Carlo (MCMC) methods for nonlinear models.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 35 h, practical assignment 38 h, preparation for examination and the examination 22 h, 2nd period. Total 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, examination 100 %.

**Course Materials:**

To be given at the lectures.

**Prerequisites:**

First year university calculus, BM20A1401 Tilastomatematiikka I. Recommended BM20A6500 Simulation and System Dynamics.

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

No

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

max 15

### BM20A3401: Design of Experiments, 4 cr

**Validity:** 01.08.2008 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Heikki Haario, Maaret Paakkunainen, Marko Laine, Satu-Pia Reinikainen

**Note:**

Suitable also for doctoral studies.

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Heikki Haario

**Aims:**

After the course, the student is expected to master the basic skills for effective experimentation, together with regression analysis of data:
- understanding of the importance of designed experiments
- ability to apply the basic experimental plans, and regression techniques to analyse the results
- skills to optimize an engineering process using design of experiments and data analysis.

**Contents:**

Importance of experimental design, minimization of prediction uncertainty of regression models. Basic factorial designs: 2N, Central Composite designs for regression analysis. The Taguchi principles. Experimental optimisation of engineering processes.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 21 h, experimental work in laboratory 26 h, preparation for examination and the examination 22 h, 4th period. Total 104 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

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

**Course Materials:**

Box, G., Hunter, S., Hunter, W. G.: Statistics for Experimenters, Wiley 2005, 2nd Edition.

**Prerequisites:**

First year university calculus, BM20A1401 Tilastomatematiikka I/basic statistics. Basic (Matlab) skills for technical computing with PC.

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

No

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

max 15

### BM20A4701: Modelling with Partial Differential Equations, 4 cr

**Validity:** 01.08.2011 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Tuomo Kauranne

**Note:**

The course has no contact teaching. Students wishing to take this course should contact the teacher by email and she will obtain course material in return mail. Exam time and form to be agreed separately by email.

**Year:**

M.Sc. (Tech.) 1-2 or Doctoral studies

**Period:**

1-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Tuomo Kauranne

**Aims:**

The student is able to formulate PDE-models, knows fundaments of theory, basic model types and most common numerical schemes, and is able to perform numerical solution using mathematical software tools. The student familiar with a number of application areas. He/she is able to analyze PDE models in multiphysical phenomena, examples are acoustics, solidification and free-boundary computations, crystal growth and impedance tomography.

**Contents:**

Introduction to PDE:s, basics of finite element method, multiphysics and modeling, examples.

**Teaching Methods:**

Supervised self study course: supervision 5 h, self study 55 h, exam and preparation 10 h, 2nd period. Total workload 70 h. The course is available in Finnish language as web-course http://hlab.ee.tut.fi/mallinnus/kurssit.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 100 %

**Course Materials:**

Endre Suli: Lecture notes on finite element methods for partial differential equations, chapters 1-3 and 5.

**Prerequisites:**

Good command of calculus. Knowledge of functional analysis recommended but not compulsory.

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

max 15

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

max 15

### BM20A6100: Advanced Data Analysis and Machine Learning, 6 cr

**Validity:** 01.08.2015 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Lasse Lensu, Heikki Haario

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Heikki Haario, Professor, D.Sc. (Tech.) Lasse Lensu

**Aims:**

The student can pre-process, visualise and analyse multivariate synthetic and real-world data. The student is able to understand and use state-of-the-art regression methods, graphical models and deep learning. The student can use selected methods to solve a practical assignment, analyse the results and report the findings.

**Contents:**

Characteristics of data sources, and data pre-processing, dimensionality reduction and outlier detection. Principal component and other advanced regression methods. Graphical models and Bayesian networks. Deep learning and convolutional neural networks. Case-based topics on advanced data analysis by visiting lecturers.

**Teaching Methods:**

Preparation for lectures 7 h, lectures 14 h, preparation for exercise 21 h, exercises 14 h, 1st period. Preparation for lectures 7 h, lectures 14 h, preparation for exercise 21 h, exercises 14 h, practical assignment 36 h, 2nd period. Self-study 5 h. Exam 3 h. Total amount 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 50 %, exercises 25 %, practical assignment 25 %.

**Course Materials:**

Lecture notes in Moodle. Other literature will be announced when the course starts.

**Prerequisites:**

Recommended: BM20A1901 Statistics II, BM20A2701 Numerical Methods II, BM20A3001 Statistical Analysis in Modelling, BM40A0700 Pattern Recognition or equivalent knowledge.

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

No

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

max 5

### BM20A6200: Inverse Problems and Normed Spaces, 6 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:** Jouni Sampo

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

University lecturer, D.Sc. (Tech.) Jouni Sampo

**Aims:**

The student knows the concepts of function spaces and related basic terminology of functional analysis. Student understand and is able to use classical methods for solving linear inverse problems like of estimation of signal from incomplete or corrupted measurements.

**Contents:**

Vector spaces, bases and linear operators. Linear subspaces and projections. Norms, metric and convergence. Various function spaces, Banach spaces, Lp-spaces, Hilbert spaces. Formulation of inverse problems with additive noise. Ill-posedness and inverse crimes. Truncated singular value decomposition for inverse problems, Tikhonov and total variation regularization.

**Teaching Methods:**

Lectures 21 h, exercises 14 h, independent study and homework 40 h, 1st period. Lectures 21 h, exercises 14 h, independent study and homework 43 h, 2nd period. Exam 3h. Total 156 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, exam 100 %

**Course Materials:**

Study material will be informed/distributed through the Moodle portal.

**Prerequisites:**

Basic Matlab skills are required (in 2nd period). BM20A1601 Matrix calculus is recommended.

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

max 5

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

max 15

### BM30A0500: Applied Optics, 6 cr

**Validity:** 01.08.2007 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Engineering Science
**Grading:** Study modules 0-5,P/F
**Teachers:** Erik Vartiainen

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Associate Professor, Ph.D. Erik Vartiainen

**Aims:**

After the course a student:
1. knows the basic properties of waves and wave motion,
2. understands the material polarization phenomenon as the ultimate source of light,
3. knows the basic properties and physics of laser action,
4. knows the ideas and applications of ultrafast optics,
5. knows the basic physics and applications of nonlinear optics,
6. knows the Fresnel-equations, and understand accordingly the physics of light reflection and refraction,
7. knows the basics of light polarization, the corresponding applications and the Jones matrix formulation,
8. understands the meaning of spatial and temporal coherence of light, and their implications for the technical applications, such as FTIR spectroscopy,
9. knows the ABCD-matrix formulation for geometrical optics,
10. knows the basics of laser imaging: one- and two-photon confocal microscopy, spectral imaging, and fluorescence nanoscopy,
11. understands the physics of producing slow and fast light, and knows their applications,
12. understands diffraction of light, and its applications.

**Contents:**

1. Wave motion and wave equations,
2. Maxwell equations and electromagnetic spectrum,
3. Lasers,
4. Ultrafast lasers,
5. Fresnell equations,
6. Polarization and optical activity,
7. Geometrical optics,
8. Coherence,
9. Interference and diffraction,
10. Nonlinear optics,
11. Optical microscopy and nanoscopy,
12. Slow and fast light, THz-optics,
13. Attosecond optics,
14. Coherent control.

**Teaching Methods:**

Lectures 42 h, exercises 14 h, homework 70 h, preparation for the exam 26 h and exam 4 h. total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

1. Eugene Hecht, Optics, 4th edition (Addison-Wesley, 2002). 2. G. R. Fowles, Introduction to Modern Optics, 2nd edition, (Holt, Rinehart and Winston, New York, 1976). 3. R. W. Boyd, Nonlinear Optics (Academic Press, San Diego, 1992). 4. Y. R. Shen, The Princples of Nonlinear Optics (Wiley, New York, 1984).

**Prerequisites:**

Students are recommended to have completed a basic course in physics.

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

15–

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

max 15

### BM30A0601: Optoelectronics, 6 cr

**Validity:** 01.08.2009 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Erkki Lähderanta, Ekaterina Soboleva, Bernardo Barbiellini

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Bernardo Barbiellini
Junior Researcher, M.Sc.(Tech.) Ekaterina Soboleva

**Aims:**

Students get a good understanding of the basics of optoelectronics and photonics and are able to deal with the following topics: optical data communication, construction of wave guides using total internal reflection and working principles of light emitting diodes and photodetectors.

**Contents:**

Wave nature of light, dielectric waveguides and optical fibers, working principals of light emitting diodes, LASERs and photovoltaic devices. Computation tasks to consolidate knowledge.

**Teaching Methods:**

Lectures 28 h, exercises 14 h, preparation for exam 114 h, 1st period. Examination.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Kasap, S. O.: Optoelectronics and Photonics P. Silfsten & E. Vartiainen: Optoelektroniikka,

**Prerequisites:**

Basic knowledge about optics.

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

max 5

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

max 5

### CS38A0060: Fuzzy sets and fuzzy logic, 6 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Pasi Luukka

**Year:**

M.Sc. (Tech) 2.

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Pasi Luukka, D.Sc. (Tech.), Professor

**Aims:**

By the end of the course student will be able to

- understand basic mathematical concepts related to fuzzy set theory and fuzzy logic
- model uncertain concepts using fuzzy set theory
- construct fuzzy models
- deduce meaningful information from fuzzy models

**Contents:**

The course consists of basics of fuzzy set theory, some algebras of fuzzy sets, fuzzy quantities, logical aspects of fuzzy sets, operations of fuzzy sets, fuzzy relations, fuzzy compositional calculus, aggregation operators, possibility theory, fuzzy inference systems.

**Teaching Methods:**

Lectures 14 h, tutorials 7 h, exercises 14 h, 1st period. Lectures 14 h, tutorials 7 h, exercises 14 h, 2nd period. Independent study 90 h. Written examination. Total workload 160 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %.

**Course Materials:**

Klir, G., Yuan, B.: Fuzzy Sets and Fuzzy Logic. Theory and Applications, Prentice Hall, 1995.
Fullér, R.: Introduction to Neuro-Fuzzy Systems, Physica-Verlag, 2000.

**Prerequisites:**

Bachelor level mathematics courses:
BM20A6700 Matematiikka I, osa A , BM20A6800 Matematiikka II, osa A, BM20A6900 Matematiikka III
Experience in programming or using mathematical software required:
BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of Technical Computing

**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 10

### CS38A0070: Fuzzy data analysis, 6 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Pasi Luukka

**Year:**

M.Sc. (Tech.) 2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Pasi Luukka

**Aims:**

In the end of the course the student is expected to be able to

- understand theoretical aspects of data analysis
- understand basic mathematics from fuzzy set theory related to data analysis
- apply fuzzy set theory based models in data analysis
- analyze and interpret results from the models
- apply fuzzy principal component analysis, fuzzy clustering and classification methods to data analysis problems

**Contents:**

Fuzzy sets and relations. Uncertainty measures. Qualitative and quantitative analysis of fuzzy data. Principles of individual multi-person, multi-criteria decision making, feature selection, fuzzy principal component analysis, fuzzy clustering and classification, fuzzy regression analysis.

**Teaching Methods:**

Lectures 28 h, exercises 28 h. Practical assignment. Independent study 100 h. Total work load 156 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:**

No

**Assessment:**

0-5, examination 100 %. Practical assignment.

**Course Materials:**

Bandemer, H., Näther, W.: Fuzzy Data Analysis, Kluwer Academic Publ., 1992.

**Prerequisites:**

CS38A0060 Fuzzy sets and fuzzy logic

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

No

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

Yes, max 10

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

## TUSOMbanMafy: Business Analytics for students in Computational Engineering, 24 - 36 cr

**Validity:** 01.08.2018 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F

No course descriptions.

*Choose 24 cr from the following*

### A210A0350: Real Options and Managerial Decision Making, 6 cr

**Validity:** 01.08.2011 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Mariia Kozlova, Mikael Collan, Azzurra Morreale

**Year:**

M.Sc. (Econ. & Bus. Adm.) 2

**Period:**

3 (intensive week 9)

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Econ. & Bus. Adm.) Mikael Collan
Post-doc researcher D.Eng. Azzurra Morreale

Post-doc researcher, D.Sc. (Econ. & Bus. Adm.) Mariia Kozlova

**Aims:**

The aim of the course is to give students know-how about how to use the real options approach as a part of decision making in companies and how to apply real options thinking in valuation and analysis in the presence of uncertainty. After the course the students:
- know the mathematical foundations of real options and the connections between the real options approach and financial theory
- know the research tradition of real options and are able to evaluate the limits of the approach
- understand and analyze the role of uncertainty and risk in decision making
- apply the real options approach in managerial decision situations, where suitable
- know the main model types used in real option valuation
- ability to perform real option valuation with the fuzzy pay-off method or with Monte Carlo Simulation and to construct a tool for RO valuation with one of these methods

**Contents:**

Core content: real options vs. financial options, modeling the real options and the limits of modeling, the usability of real options in strategic decision making
Additional content :the use of mathematical tools applied in the real options context
Special content: how to use the real options approach in managerial decision making situations exemplified by means of different real cases, project of constructing a simple real option valuation tool with excel or with matlab

**Teaching Methods:**

Lectures and exercises 18 h, independent reading assignments (articles) and preparation for lectures 46h. Written exam and preparation for the exam 93 h. Peer project evaluation 2h. Total workload for the student 160 h. Extra curricular project.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

Grade 0-5, evaluation 0-100 points, written exam 80%, course project 20%,

**Course Materials:**

Collan, M., 2012, The Pay-Off Method: Re-Inventing Investment Analysis – With numerical application examples from different industries, CreateSpace, Charleston, SC, USA (ISBN 978-14-782-3842-3) Lecture slides, Assigned reading, collection of articles. Materials will be available in Moodle (except for the course book)

**Prerequisites:**

For master´s program students only

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

Yes. 100, priority for MSF and MBAN students.

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

15–

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

No

**A220A0000: Financial Econometrics, 6 cr**

**Validity:** 01.08.2011 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Jan Stoklasa

**Note:**

Additional requirements for doctoral students: read Mikosch, T., Kreiß, J., Davis, R. A., & Andersen, T. G. (2009). Handbook of Financial Time Series. Springer eBooks – selected part(s) after consulting with the teacher in charge, term paper will be written by the student on the selected advanced topic.

If the course enrollment is more than the course maximum, then students are accepted in the following order: students from the MSF and MBAN programmes, other master´s programme students, other students.

**Year:**

M.Sc. (Econ. & Bus. Adm.) 2

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Jan Stoklasa

**Aims:**

At the end of this course a student is expected to have a concise overall understanding of the mechanisms behind the econometrics models covered in the course so that he/she:
- Is able to describe the main ideas of the models and methods and assess the appropriateness of their use in specific application cases, incl. the testing of assumptions of the models
- Is capable of formulating the main questions of his/her empirical research in terms of the econometrics models and their parameters
- Is able to select appropriate methods for the given practical application in financial data analysis and construct appropriate econometrics models and assess their quality
- Is able to design econometrics models for financial data prediction (in case of time series)
- Is able to interpret the outputs of the econometrics models in the context of financial data analysis
- Is able to use the methods and their outputs to explain phenomena in financial data and to assess hypothesis concerning financial data
- Is able to utilize the models in financial theory building and assessment as well as in time series analysis and prediction and financial data analysis in general.
- Is able to implement the designed econometrics models in MATLAB using its econometrics package.

The models covered in this course include for example:
Classical linear regression models, univariate time series models, ARMA processes, multivariate time series models, models for simultaneous equations systems, vector autoregressive (VAR) model, ARCH and GARCH-type models.

**Contents:**

This course deepens students' knowledge on empirical research methods in financial econometrics. The focus is on the empirical techniques used most often in the analysis of financial markets and how they are applied to actual market data.The course is designed to give advanced-level (Master) knowledge of financial econometrics – that is to provide sufficient insight in the financial econometrics models and hypothesis testing and practical experience with building models for financial econometrics in MATLAB. The course covers four different areas in econometrics: 1) univariate and multivariate statistical analyses, 2) time series models, 3) modeling volatility and correlation, 4) modeling long-run relationships in financial markets. The students will use MATLAB econometrics package to run analyses.

**Teaching Methods:**

Lectures & exercises: 36 h, period 1. Preparation for lectures and exam: 64 h, period 1. home assignments: 60 h, period 1. Total workload: 160 h.

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

Yes

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

No

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

No

**Assessment:**

Grade 0-5, on the basis the exam (50%) and home assignments (50%). Students are required to achieve 50 percent of the maximum points in both.

**Course Materials:**

1. Brooks, Chris: Introductory econometrics for finance. Cambridge, 2002 or newer (Text book) 2. Handouts in class and all additional material required by the lecturer 3. MATLAB materials available on the mathworks www-site

**Prerequisites:**

Required: BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of technical computing Compulsory bachelor's level courses in finance and economics.

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

Yes, 80. If the course enrollment is more than the course maximum, then students are accepted in the following order: students from the MSF and MBAN programmes, other master´s programme students, other students.

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

No

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

No

### A220A0550: Advanced Decision-making, 6 cr

**Validity:** 01.08.2014 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Jan Stoklasa

**Note:**

If the course enrollment is more than the course maximum, then students are accepted in the following order: students from the MBAN and MSF programmes, other master´s programme students, other students.

**Year:**

M.Sc. (Econ. & Bus. Adm.) 2

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Tech.) Jan Stoklasa

**Aims:**

The students learn principles of some modern methods for multiple criteria decision-making, decision analysis, and about systems for supporting decision-making. Students learn about the history of decision-support and operational research and understand that there is a constant evolution in decision support methods. Students are able to understand the benefits of modern decision-support methods in real world business situations. Students can put some models and analysis methods into use with MATLAB or Excel, where applicable and solve real-life decision-making problems using the methods.

**Contents:**

Core content: This course covers the main topics of multiple criteria decision making under certainty, uncertainty and risk. The topics discussed during the course therefore include: principles of decision making under certainty, uncertainty, risk and ignorance, multiple criteria decision-making (MCDM) and evaluation methods (TOPSIS, AHP), the use evaluations of absolute and relative type, efficiency assessment models (DEA), game theory (non-cooperative games of two players, cooperative games of two players with/without transferable gains, games against nature), validation of decision support systems and models and sensitivity analysis. MATLAB and Excel are used to build the models and solve assignments, to showcase the practical application of the presented methods. Additional content: The history of operational research is summarized. Additionally, fuzzy logic in decision-making is also covered, along with topics such as decision-support systems (DSS), expert systems and optimization. Special content: The course also introduces students to the basics of multiple expert decision-making and reaching consensus, Delphi method.

**Teaching Methods:**

Lectures and exercises approximately 24 h, reading materials and preparation for the lectures (60 h) & the exam (76 h). Course work, which will reduce the number of hours needed for lecture & test preparation. Total workload for the student 160 h.

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

Yes

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

No

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

No

**Assessment:**

Grade 0-5, based on a written exam. Bonus points can be awarded for homework assignments.

**Course Materials:**

Lecture materials, Assigned reading and assigned course books MATLAB / Octavia materials available on the mathworks www-site Mengov, G.: Decision Science: A Human-Oriented Perspective, Springer, 2015. Srinivasan, R.: Strategic Business Decisions - A Quantitative Approach, Springer, 2014. San Cristóbal, J. R.: Multi Criteria Analysis in the Renewable Energy Industry, Springer, 2012.

**Prerequisites:**

Required: BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of technical computing Suggested: Information Systems in Corporate Management and Decision-Making

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

Yes, 80. If the course enrollment is more than the course maximum, then students are accepted in the following order: students from the MBAN and MSF programmes, other master´s programme students, other students.

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

No

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

No

**A220A0752: Analytics for Business, 6 cr**

**Validity:** 01.01.2017 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Azzurra Morreale

**Year:**

M.Sc. (Econ. & Bus. Adm.) 1-2

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post- doctoral researcher, Azzurra Morreale

**Aims:**

This course enables to learn a significant understanding of data science: the fundamental concepts and principles that underlie techniques for extracting useful knowledge from data. These concepts underlie the analysis of data-centered business problems, the creation and evaluation of data science solutions, and the evaluation of general data science strategies, and proposals. Through several practical examples, at the end of the course the student will acquire a broad range of techniques and practical skills to independently plan and create analysis tools able to finding anomalies, patterns and correlations within large data sets to predict outcomes. Students will be also able to put some models and analysis methods into use with MATLAB and EXCEL.

**Contents:**

Core content: Data understanding and data preparation, supervised learning (decision-trees, linear regressions, logistic regression, super vector machine), unsupervised learning (clustering methods)
Additional content: neural networks (self-organizing map)
Special content: Performance measure and overfitting: (Roc curve, area under Roc (Auc), confusion matrix, cross-validation)

**Teaching Methods:**

Lectures and exercises 35 h, reading materials and preparation for the exam (75 h). Course work (50 h). Total workload for the student 160 h.

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

No

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

Yes

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

No

**Assessment:**

During the course the will be several single assignments (50%), where the illustrated methods are applied to new data and a group assignment (50%), where in a seminal paper, at the end of the course, the group will work on a real case study.

**Course Materials:**

Lecture materials, Assigned reading, Course book
Data Science for Business : What you need to know about data mining and data-analytic thinking, by Foster Provost, Tom Fawcett, 2013- available as an eBook in the library database
Moro S., Cortez. P. and Rita P. (2014). A Data-Driven Approach to Predict the Success of Bank Telemarketing. Decision Support System, 22-31.
Collan M., Ekulnd T., Back. (2007). Using the Self-Organizing Map to Visualize and Explore Socio-Economic

Development. EBS Review.
Huysmans J, Baesens B, Vanthienen J, van Gestel T (2006). Failure prediction with self organizing maps. Exp Syst Appl 30:479–487

**Prerequisites:**

Principles of technical computing course (BM20A5001) or the same in Finnish. is required. Only for master degree students.

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

15–

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

No

### BM20A6500: Simulation and System Dynamics, 6 cr

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

**Unit:** LUT School of Engineering Science

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

**Teachers:** Virpi Junttila, Azzurra Morreale

**Year:**

M.Sc. (Tech.) 1

**Period:**

2-3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-Doctoral Researcher, D.Sc. (Tech.) Virpi Junttila
Post-Doctoral Researcher, Ph.D. Azzurra Morreale

**Aims:**

The course gives an introduction to the concepts of discrete and continuous simulation models and methods together with numerical examples. After the course, the student is able to create and use different simulation models to solve practical problems. Among the discrete-event based models, the student is able to model basic queuing, server, scheduling and storage size problems. Also, the student is able to create basic operations and model dynamic systems with Simulink and use Simulink to solve different simulation problems.

**Contents:**

Basic concepts of discrete and continuous systems. Model-based design, basic modeling work-flow, basic simulation work-flow, running the simulations and interpreting the results. Random numbers, discrete event generation by random numbers. Statistical and empirical distributions for event generation. Building numerical simulation examples with Matlab and Simulink. Modeling dynamics systems and simulation models for dynamic systems with Simulink.
Application examples: queuing systems, storage size optimization, profitability analysis, supply chain management, investment analysis

**Teaching Methods:**

Lectures 21 h, exercises 14 h, homework 21 h, 2nd period. Lectures 21 h, exercises 14 h, homework 21 h, 3rd period. Practical assignment 22 h, preparation for examination and the examination 22 h, 2nd-3rd period. Total 156 h.

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

Yes

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 80 %, homework and practical assignment 20 %.

**Course Materials:**

Course material is given in the course homepage.

**Prerequisites:**

Recommended BM20A1401 Tilastomatematiikka I and BM20A5001 Principles of Technical Computing.

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

No

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

max 15

### CS38A0040: Marketing analytics, 6 cr

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Jyrki Savolainen

**Note:**

If the course enrollment is more than the course maximum, then students are accepted in the following order: students from MBAN programme, students from MIMM programme, other master's programme students, other students.

**Year:**

M.Sc. (Tech) 1

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Jyrki Savolainen, D.Sc.(Econ. & Bus. Adm.), Post-doc researcher

**Aims:**

The aim of the course is to offer extensive knowledge on the use of various analytical techniques in marketing. The students will be introduced to the process of decision support in marketing using analytics in various typical problems. Through several practical examples, the course aims to provide the tools that focus on data understanding and preprocessing, modelling choices and implementation until the interpretation, visualization and utilization of the analysis in various marketing-related problems. The course will provide hands-on lectures to using the various methodologies with the selected software environments. After the course the students: have an understanding of the process of performing

marketing analytics, know how to collect, understand and preprocess data to be used in marketing problems, know the most important applications and can identify the appropriate tool for a specific problem, are capable of performing marketing analytics using software, understand the role of big data in marketing.

**Contents:**

Core content: role of data in modern marketing, traditional methods (clustering, forecasting, market-basket analysis), machine learning-based methods in marketing (recommendation systems, advertising on the web)
Additional content: social network analysis, sentiment analysis
Special content: use of the introduced methods with relevant software

**Teaching Methods:**

Lectures 20 h, computer room tutorials 10 hours, course assignments involving data analysis with software 75h. Written exam and preparation for the exam 55 h. Total workload for the student 160 h.

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

Yes

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

No

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

No

**Assessment:**

Course assignments (70% of the grade), written examination (30% of the grade), grading 0-5.

**Course Materials:**

The course will largely be based on the free online book (http://www.mmds.org/)
Leskovec-Rajaraman-Ullman: Mining of Massive Datasets
Additional material will be distributed during the course via Moodle.

**Prerequisites:**

The course will use an analytics capable software (to be announced later; Matlab or R, perhaps even Excel) - the students are expected to know how to use the software. Basic knowledge in statistics.

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

Yes. 50, priority to MBAN students (Masters program in business analytics), then students from MIMM programme, other master's programme students, other students.

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

No

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

No

### CS38A0050: Big data in business and industry, 6 cr

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Jyrki Savolainen

**Year:**

M.Sc. (Tech.) 2

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Jyrki Savolainen, D.Sc., Post-Doctoral Researcher
(Jozsef Mezei, D.Sc., Research Fellow)

**Aims:**

The course discusses the most important new tools for understanding the potential impact of big data analytics on decision making and business performance. Through analyzing typical business decision problems from the perspective of data requirements, the course discusses the role of big data analytics in modern organizations. After the completion of the course, the students: know the most important technological requirements of performing big data analytics, understand the role of big data in transforming modern organizations through data driven decision making, understand the impact of data volume, variety, and velocity, understand how to create value with big data, become familiar with the techniques and tools for capturing, processing, and interpreting big data, know the most important methods to reduce big data sets by extracting the most important information, are familiar with several real-world scenarios of big data use from different business sectors, understand the role of big data in creating business value, know how to apply the discussed concepts and tools to business projects.

**Contents:**

Core content: big data technology, data and dimension reduction, role of data driven decision making in modern organizations.
Additional content: machine learning methods for big data analytics, network analysis
Special content: text analytics

**Teaching Methods:**

Lectures 20 h, computer room tutorials 10 hours, course assignments involving big data analysis (using relevant software) 75 h. Written exam and preparation for the exam 55 h. Total workload for the student 160 h.

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

Yes

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

No

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

No

**Assessment:**

Course assignments (70% of the grade), written examination (30% of the grade), grading 0-5.

**Course Materials:**

The following two books cover several topics introduced in the course:
Thomas Davenport, 2015: Big Data at Work
The rest to be annouced later.
Additional material will be distributed in the course.

**Prerequisites:**

The course will rely on using software, relevant knowledge of the used software required; TBA (Matlab or R)
Basic knowledge in statistics.

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

60

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

No

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

No

**CS38A0020: Optimization in business and industry, 6 cr**

**Validity:** 01.08.2017 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Sirkku Parviainen, Pasi Luukka

**Year:**

M.Sc. 1.

**Period:**

4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Pasi Luukka, D.Sc. (Tech.), Associate Professor
Sirkku Parviainen, Lic.Phil., Lecturer

**Aims:**

By the end of the course student will be able to
- select/ employ mathematical models for various optimization problems
- use optimization software
- interpret information from optimization results
- understand the basic principles of different optimization algorithms for linear, mixed-integer linear, and nonlinear optimization

**Contents:**

Formulation of optimization models. Linear programming and mixed-integer linear programming, nonlinear optimization algorithms.
Solving optimization problems using Matlab Optimization Toolbox. Business and industry oriented practical examples, i.e. factory, warehouse, sales allocation models etc.

**Teaching Methods:**

Lectures 28 h, exercises 28 h, 4th period. Independent study 74 h, practical assignment 30 h. Written examination. Total work load 160 h.

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

Yes

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

No

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

No

**Assessment:**

0-5, examination 100 %

**Course Materials:**

Taha, H.A.: Operations Research an introduction, 8th edition, Pearson/Prentice-Hall, 2007.
Hillier, F.S., Lieberman, G.J.: Introduction to Operations Research, 8th edition, McGraw-Hill, 2004.

**Prerequisites:**

Experience in programming or using mathematical software required.
BM20A4301 Johdatus tekniseen laskentaan or BM20A5001 Principles of Technical Computing

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

2

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

Yes, max 15

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

Yes, max 10

## TuSOEntr: Entrepreneurship, minor, 20 - 35 cr

**Validity:** 01.08.2016 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Business and Management

*Obligatory course 6 cr*

### CS34A0302: Entrepreneurship Theory, 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:** Timo Pihkala, Marita Rautiainen

**Note:**

Course is also a part of the Entrepreneurship minor subject.

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Econ. & Bus. Adm.) Timo Pihkala
D.Sc. (Econ. & Bus. Adm.) Marita Rautiainen

**Aims:**

The aim ofthis course is to give an overview of different forms of entrepreneurship, itsimportance for economies and the people involved. Besides studying anddiscussing a selection of academic articles, students will be actively involvedin the entrepreneurial process through practical cases. After the course, students should be able to:

- Prove evidence of a comprehensive knowledge of the concepts and theories used in the course
- Prove evidence of (research and case-based) empirical knowledge regarding the different topics covered by the course
- Be able to link theoretical knowledge with empirical insights and apply it to practical cases, in particular:
    - Be able to analyze a business case and critically assess the quality of entrepreneurial strategies and tactics based on theoretical and practical insights
    - Be able to find and evaluate relevant literature and empirical evidence to support the analysis of specific topics covered by the course
    - Be able to critically assess the validity of statements based on empirical research

**Contents:**

Basic concepts of entrepreneurship, entrepreneurship theory, entrepreneurial person and the latest theoretical directions.

**Teaching Methods:**

Independent studies 148 h, lectures 8 h, total 156 h.

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

Yes

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

Yes

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

No

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

Yes

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

No

**Assessment:**

0-5, Moodle-exams (50%) and written assignment (50%).

**Course Materials:**

Bridge, S., O´Neill, K. and Cromie, S. (2003): Understanding, Enterprise, Entrepreneurship and Small Business. (2nd ed.) Palgrave-MacMillan Shane, Scott: A general theory of entrepreneurship. The individual-opportunity nexus. Edward Elgar. Lecture materials

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

Yes, maximum 100. Priority is given to the student in Entrepreneurship masters program and students of entrepreneurship minor.

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

15–

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

15–

*Elective studies*

**CS30A1372: Creative Design and Problem Solving, 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:** Andrzej Kraslawski

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, Ph.D. Andrzej Kraslawski

**Aims:**

Learning outcomes: After fulfilling all requirements of the course, the students will be able to: 1. Understand the principles of creative problem solving 2. Know the basic methods of creative design 3. Work in team during the design process 4. Apply methods of creative design to products, processes, services and business methods

**Contents:**

The major subjects of the course are: Major Steps in Problem Solving Types of Problems Types of Design Concept of Creativity Survey of Intuitive and Structured Methods of Creativity Enhancement Types of Brainstorming Check lists Morphological analysis Synectics Case-based Reasoning Graphical Methods Evaluation of Ideas

**Teaching Methods:**

The course is organised as a combination of regular lectures and interactive problem-solving sessions and project works. The in-class problem-solving sessions will be based on the team work realised by the groups of 3-5 students. The 3-4 project works will be realised by the groups of 3-4 students during the out-of-class activities and it will be finished with the preparation of the project report. In-class teaching and problem-solving sessions 42 h, project works 88 h. Total workload 130 h.

Lectures, in class activity, period 1.
Project work, out-of - class activity, period 2.
Project work 88 hours

**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):**

No

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

No

**Assessment:**

Final grade 0-5. Evaluation: Generated solutions of the in class problems 40 %, project reports 30 %, written exam 30%. Obligatory presence during 80% of in-class activities.

**Course Materials:**

Course slides.

Tony Proctor
Creative problem solving for managers
Routledge, 3rd edition, 2009

H. Scott Fogler and Steven E. LeBlanc
Strategies for Creative Problem Solving
Prentice Hall, 3rd edition , 2013

David Silverstein, Philip Samuel, Neil DeCarlo
The Innovator's Toolkit: 50+ Techniques for Predictable and Sustainable Organic Growth
Wiley, 2009

Alexander Osterwalder and Yves Pigneur
Business Model Generation
Osterwalder and Pigneur, 2010

**Prerequisites:**

Basic courses of management. Basic knowledge of engineering disciplines (e.g. process or mechanical engineering).

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

Yes, 80

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

15–

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

**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

### CS34A0352: Leading business growth, 6 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Mikko Pynnönen

**Year:**

M.Sc. (Tech.) 1

**Period:**

1

**Teaching Language:**

English

**Teacher(s) in Charge:**

Mikko Pynnönen, D.Sc. (econ.), Professor

**Aims:**

The students become familiar with the basic concepts of entrepreneurial growth, growth strategies and the latest theoretical directions within entrepreneurship research. After the course, the students are able recognize different forms of growth, growth potential and routes for business development.

**Contents:**

Models, theories and approaches on entrepreneurial growth, growth strategy and SME development.

**Teaching Methods:**

Lectures 18h, 1st period.  Prior reading and assignments 106 h, essay writing, 30 h. In total 154 h.

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

No

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

No

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

No

**Assessment:**

0-5, Group assignments 50%, essay 50%.

**Course Materials:**

Cases and articles delivered during the course. Lecture materials.

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

max 5

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

max 5

### CS34A0401: Strategic Entrepreneurship in an Age of Uncertainty, 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:** Ekaterina Albats, Justyna Dabrowska, Marko Torkkeli

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Tech.) Marko Torkkeli

**Aims:**

Managing in a knowledge-based economy, Managing by Core Competences, Knowledge intensive firms, Uncertainty. Are they the latest buzz words or another passing managerial fad? Old wine in new bottles? Or perhaps, just perhaps, fundamental means of survival and success for modern day corporations? Given the amount of effort that has been devoted to the topic by both academics and practitioners, it appears worth taking a deep and dispassionate look at the role of entrepreneurial thinking in sustained competitive advantage. The goal is to learn as you go and effectively convert assumptions to knowledge at a low cost.
By the end of the course, students will be able to identify business opportunities and analyze them using different tools of uncertainty management. Students will be able to understand the main components of different pitches and be able to design and present a pitch.

**Contents:**

During the course students learn to develop and test a business idea following the feasibility analysis, discovery driven planning steps as well as using the uncertainty management tools of Attribute Mapping, Supply Chain Analysis, Differentiation, Quizzing and Market-Busters. The course does not teach business plan writing but rather focuses on opportunity recognition and feasibility assessment. Moreover, it adds the elements of lean startup as well as social entrepreneurship as possible avenues in dealing with entrepreneurial challenges.

Entrepreneurial thinking, uncertainty management, strategic entrepreneurship, discovery-driven planning.

**Teaching Methods:**

Lectures 20 h, Independent study 73 h, seminar work writing 63 h, Total 156 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. Based on assignment and in-class work, participation in the lectures required (possibility to substitute absence with literary work).

**Course Materials:**

Lectures and additional reading provided in the class. Book: McGrath Rita and MacMillan Ian, (2000). The Entrepreneurial Mindset. Harvard Business School Press.; McGrath Rita and MacMillan Ian, (2005). MarketBusters: 40 strategic moves that drive exceptional business growth. Harvard Business Press.

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

60, priority for GMIT students and others to whom this course is part of the major.

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

Yes, max 15

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

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

### CS34A0551: Business Idea Development, 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:** Timo Pihkala, Suvi Konsti-Laakso

**Year:**

M.Sc. (Tech.) 1

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Timo Pihkala, D.Sc. (Econ. & Bus. Adm.), Professor
Suvi Konsti-Laakso, M.Sc.(Tech.), Project researcher

**Aims:**

Student can explain and analyze key theoreticalapproaches associated to business idea development. The student learns toidentify, develop and assess future-oriented business opportunities and ideas.The student can use different systematical tools and techniques related tobusiness idea development.

**Contents:**

Fuzzy-front end of entrepreneurial process, opportunityrecognition, innovation, sources of business ideas, creativity and systematicgeneration of ideas

Supplementary content: innovation and creativity
Specific content: customer/user involvement

**Teaching Methods:**

12 h of lectures/seminars, learning diary and assignments 80 h. Written group assignment 64 h. In total 156 h.

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

No

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

No

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

No

**Assessment:**

Grades 0-5, Learning diary (60%) and group work and presentation (40)%.

**Course Materials:**

Study materials will be available in Moodle.

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

15–

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

15–

### CS34A0712: Business Governance and Entrepreneurial Renewal, 6 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Timo Pihkala, Tuuli Ikäheimonen

**Year:**

M.Sc. (Tech.) 1

**Period:**

2

**Teaching Language:**

English

**Teacher(s) in Charge:**

D.Sc. (Econ. & Bus. Adm.) Tuuli Ikäheimonen
Professor, D.Sc. (Econ. & Bus. Adm.) Timo Pihkala

**Aims:**

After completing the course the student:
- Knows the key theories in the field of governance, and understands thetheoretical starting points for

governance research
- Understands the overall governance system and its various actors, and therole of the actor in the governance system.
- Understands the relationships between governance actors, key stakeholders andbusiness environment
- Is able to analyze the company's characteristics, business and environmentand, basing on this, to provide suggestions for governance solutions that suitthe company's situation.
- Is able to identify the role and possibilities of the board of directors and itsindividual members in corporate renewal and business development.
- Is able to analyze the company boards and provide suggestions for their development

**Contents:**

Different types of businesses (e.g. SMEs, family businesses,start-ups). Owners and stakeholders influence on governance. The concept andcontent of ownership strategy. Governance mechanisms. Advisory boards, familycouncils, the board of directors, top management teams. The structure,processes and roles of the board of directors. Governance research, theoreticalbase and research objectives. Development of governance. The role of the boardand individual board members in company renewal and business development.

**Teaching Methods:**

Lectures 20 h, 2nd period. Independent study 71 h, Course assignments 65 h. Total workload 156 h.

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

No

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

Yes

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

No

**Assessment:**

0-5, course assignments 100%.

**Course Materials:**

Will be announced later.

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

15–

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

max 10

### CS34A0721: Entrepreneurship, ownership and family firms, 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:** Marita Rautiainen, Timo Pihkala

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. (Econ. & Bus. Adm.) Timo Pihkala
D.Sc. (Econ. & Bus. Adm.) Marita Rautiainen

**Aims:**

The courseintroduces the student with the phenomenon of entrepreneurship, ownership, andfamily firm. The course aims to enhance students' understanding of thecharacteristics, contributions, and issues surrounding family business. Throughcase studies, student research and guest speakers, we consider questions ofownership, succession, conflict resolution, sibling rivalry, compensation,attracting and retaining both family and nonfamily talent, estate planning, andfinancing the family owned enterprise. After the course, students should beable to define and understand the conceptual special characteristics and thecentral theories of these phenomena. In addition, students learn to applydifferent theories in the analysis of practical cases as well as aboutways to manage the transitional processes such as family business succession. Itcombines rigorous learning with practical group works. The course willappeal to those who are interested in starting up their own business, as wellas those interacting with small firms and family businesses as advisors,managers and policy-makers.

**Contents:**

Course explores the unique challenges and opportunities involved in managing a family firm. The course will address a wide variety of topics, including: the strengths and weaknesses of a family firm, the dynamics of family interactions, family business culture, conflict resolution in a family firm, transferring ownership of a family firm, planning for a family firm's growth and continuity, effective leadership and communication, and planning for succession.

**Teaching Methods:**

Lectures 20 h 3rd period. Prior reading and assignments 106 h. Preparation for lectures 30 h. In total 156 h.

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

No

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

Yes

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

No

**Assessment:**

Individual exercise 50 %, group exercise 30 % moodle exam 20 %

**Course Materials:**

1.Ernesto J. Poza (2010). Family Business, South-Western, Cengage Learning.
2.Materials indicated during lectures
3.Cases and articles delivered during the course.

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

Yes, maximum 80. Priority is given to the student in Entrepreneurship masters program and students of entrepreneurship minor.

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

15–

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

15–

### CS34A0733: New Venture Creation, 6 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Henri Hakala, Kirsi Snellman

**Note:**

Schedule: intensive lecturing at the beginning of the period, independent group work, business planin pitching competition at the end of the period

**Year:**

M.Sc. (Tech.) 1

**Period:**

3

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, D.Sc. Henri Hakala
Post-doctoral researcher, D.Sc, Kirsi Snellman

**Aims:**

The course targets on the entrepreneurial phenomenon and especially on start-up analysis. After the course the student is familiar with entrepreneurship theory that integrates creativity, resource-based characteristics and finance. In addition, the student will understand the start-up process, and is able to prepare a business plan.

**Contents:**

Entrepreneurship process, start-up theory, start-up strategies, financial analysis of the business concept, business plan and evaluation criteria.

**Teaching Methods:**

Lectures 8 h. Pitching competition 8 h, Online study and independent reading 76 h. Written assignment 70 h. In total 162 h.

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

No

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

No

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

No

**Assessment:**

Grades 0-5, evaluation 0-100 points. Assignments 100%. (pitching competition 30%, written business plan 70%)

**Course Materials:**

Kubr, T., Marchesi, H., Ilar, D., Kienhuis, H. (2013). Starting Up: achieving success with professional business planning. McKinsey.
Lecture/Moodle material

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

Yes, maximum 80. Priority is given to the student in Entrepreneurship masters program and students of entrepreneurship minor.

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

No

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

No

## TiDSOsedt: Software Engineering and Digital Transformation minor, 24 - 30 cr

**Validity:** 01.08.2018 -
**Form of study:**
**Type:** Study module
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F

**Aims:**
Software Engineering and Digital Transformation Minor Learning Objectives
1. Describe and adapt software engineering knowledge, best practices, and standards appropriate to engineering complex software systems.
2. Analyze a problem; identify and elicit functional, non-functional and sustainability requirements appropriate to its solution.
3. Recognize human, security, social, entrepreneur issues and responsibilities relevant to engineering software and digitalization of services.
4. Acknowledge life-long learning as a way to stay up to date in the profession.

*Obligatory courses 12 cr*

### CT60A5500: Quality Assurance in Software Development, 6 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Uolevi Nikula

**Year:**
M.Sc. (Tech.) 1
**Period:**
1-2
**Teaching Language:**
English
**Teacher(s) in Charge:**
Associate Professor, D.Sc. (Tech.) Uolevi Nikula

**Aims:**
After the course students are able to do the following activities in the key areas of software development based on the available research literature
1. name key activities and artifacts related to each area
2. develop standard documents for the given areas when relevant
3. describe typical problems occurring in each area
4. summarize typical ways to avoid the identified problems
In general the students have the knowledge to
5.plan and run a software project
6.assure the quality of software development
Students are able to
7.work collaboratively in a team

**Contents:**
Software economics, project management, process areas, tools, configuration and change management, teams, process assessment, improvement, and measurement.

**Teaching Methods:**

Lectures 14 h, exercises 14 h, assignments & self-study 14 h, team assignments 36 h, 1. period. Lectures 14 h, exercises 14 h, assignments & self-study 14 h, team assignments 36 h, 2. period. Total workload 156 h.

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

No

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

No

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

No

**Assessment:**

0 - 5. Weekly assignments 70 %, project 30%, no exam.

**Course Materials:**

Materials announced in the lectures. Basic reference is Robillard, Kruchten, and d'Astous: Software Engineering Process with the UPEDU, Addison-Wesley, 2002.

**Prerequisites:**

Software Engineering CT60A4002 or equivalent.

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

max 10

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

max 5

### CT70A2000: Requirements Engineering, 6 cr

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Sami Jantunen

**Year:**

M.Sc. 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

AssociateProfessor, D.Sc. (Tech.) Sami Jantunen

**Aims:**

At the end of this course students will be able to:
1. Perform requirements engineering in the context of the most common software development life cycles and processes
2. Develop effective functional and non-functional requirements that are complete, concise, correct, consistent, testable and unambiguous.
3. Select the appropriate requirements elicitation techniques to identify requirements

4. Effectively analyze requirements and prioritize accordingly.
5. Create a requirements specification to communicate requirements to a broad set of stakeholders
6. Manage change to requirements

**Contents:**

The focus of this course is in helping the student to choose and apply requirements engineering (RE) techniques to different types of software development situations. The course considers a variety of software development contexts such as bespoke software development, market-driven, and agile development and discusses how these contexts affect the choice of RE techniques. To this end, different RE-related techniques as well as different underlying principles and formats for documenting and maintaining requirements are covered.

**Teaching Methods:**

Lectures 14 h, homework 20 h, Period 1.
Lectures 14 h, homework 20 h, Period 2.
Individual studies, project assignments 88 h. Total 156 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, continuous evaluation (no Exam)
Assignments 50%, Weekly Mini-examinations 50%

**Course Materials:**

Elizabeth Hull, Ken Jackson, Jeremy Dick, Requirements Engineering. 2011. Springer, London. ISBN: 978-1-84996-405-0.
More material to be announced later.

**Prerequisites:**

No

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

No

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

No

*Elective courses, choose 12 cr*

**CT30A8922: User Experience Design, 6 cr**

**Validity:** 01.01.2018 -
**Form of study:** Basic studies
**Type:** Course
**Unit:** LUT School of Business and Management
**Grading:** Study modules 0-5,P/F
**Teachers:** Annika Wolff

**Note:**

NOTE: Can not be included in the same degree as CT30A8921 User and Design Research in Software Engineering.

**Year:**

M.Sc. 1

**Period:**

3-4

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-doctoral researcher, D.Sc Annika Wolff

**Aims:**

How do we design interactive technology, systems and services? Why do only a few of them make it to market and most fail? Why users are not able to master, learn and use them? What are the costs and benefits of user experience design? The course answers these questions while outlining the user research, user experience, user-centric design and design thinking approaches for software products, systems and services engineering. Through a mix of readings on human computer interaction (HCI) and design science research, user research investigations and a practical team-oriented design project in the living lab, students will acquire a solid practical and theoretical grounding in “user experience design methods and user interface design”.
The importance of human aspects in design and innovation is a key concern in software and information systems engineering and research. Design principles and methods can be used to increase the value of software products through the concept of open innovation. This course follows the work of open innovation and user-centric design and design thinking theories and principles that established the basis of innovation by design. It analyzes the concept of innovation by design, as it is applied to software and information system design, from the HCI (human-computer interaction), user experience and research perspective. Students will learn how to formulate a design as a problem space and how to use the UCD UXDT toolkit to create an innovative solution to solve the problem and conduct user testing. This course will teach students the design theories used in the interaction design, user-centered design (UCD) and user experience design thinking (UxDT) processes.
Via a design bootcamp in the CODER Living Lab, students will be able to:
[1]. Advocate and build-in support for interaction, user-centered and user experience design with stakeholders
[2]. Apply user research methods for identifying target users and their problem spaces
[3]. Use ideation techniques that go beyond brainstorming to propose innovative solutions, software products, services and systems
[4]. Conduct rapid prototyping to gather user feedback, inform design decisions and iteratively improve design solutions
[5]. Build and validate diverse forms of user interfaces including mobile, wearable, tangible and cyber physical user interfaces
[6]. Use usability testing and user acceptance methods to assess and validate proof of concept and prototypes
[7]. Integrate user experience design methods into the wider software development and innovation lifecycle.

**Contents:**

Design theories, principles and methods. Principles of design thinking. Human-centric design processes. User experience in design practices. Co-design in living lab. User research in design. Persona and customer profiling. Diary studies. HCI design patterns. Storytelling. Paper prototyping. Usability and sustainability testing. Controlled experiments. Design of innovative software products. Introduction to design research and science. Socio-technical systems design. Historical, cultural, and technical foundations of design in a range of discipline areas (software engineering, HCI, arts). In a group of 6 students are asked to develop a design concept and validate it in the design living lab. Students are requested to demonstrate their capacity to generate design ideas, innovative concepts, proposals or solutions independently and/or collaboratively in response to a set briefs and/or as a self-initiated activity or based on documented user experiences.

**Teaching Methods:**

Weekly Design bootcamp sessions 24h. Lecture preparation (mandatory readings from textbooks and video to watch from HCI labs) 24h. Practical large design bootcamp in a group of 6 students' 48h. User research in living lab 36h. Prototyping and presentation of the design portfolio in the class 28 h. Total 160h.
Students will complete many hands-on activities and interact with their fellow students and representatives of real users as they experience a completely different way of learning how to develop human-centric software and information systems, services, and socio-technical systems.

**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:**

Grade: 0-5
Design Portfolio 60%
Individual reflections on design methods included in the design portfolio 20%
Oral group presentation of the final design concept and portfolio 20%

**Course Materials:**

Specific mandatory readings from the following books will be discussed in class by the professor and the students. The following are also suitable background readings:
• Tim Brown. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation
• Terry Winograd (ed.): Bringing Design to Software. Addison-Wesley, 1996. Bill
• Buxton, Sketching User Experiences: Getting the Design Right and the Right Design, Morgan Kauffmann Series on Interactive Technologies, 2007. Mads, et al. (Eds).
• The Online Encyclopedia of Human Computer Interaction, 2nd Edition. Interaction Design Foundation.
Students are required to read some chapters from these two books, the second is the mandatory textbook:
• User Interface design and evaluation. D. Stone, C. Jarrett, M. Woodroffe. S. Minocha. Morgan Kauffmann Series in Interactive technologies. 2005.
• Interaction Design: Beyond Human-Computer Interaction, 4th Edition, Jenny Preece, Helen Sharp, and Yvonne Rogers. February 2015, Wiley.

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

36 max, places in the living lab

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

No

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

No

### CT60A5103: Software Engineering Models and Modeling, 6 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Antti Knutas

**Year:**

M.Sc. 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Post-doctoral researcher, D.Sc. Antti Knutas

**Aims:**

Software modeling (this course) is aimed at reducing the gap between problem and software implementation through the development and use of models, which describe complex systems at multiple levels of abstraction and from a variety of perspectives. A model is an abstraction (one aspect or entire system) of an existing or planned system. Models are created to serve particular purposes, for example, to present a human-understandable description of some aspect of a system or to predict its quality.
The course is focused at building a deep understanding of the concept of model and modeling while enabling the students to be able to:
1. Master the importance of conceptual modeling techniques in software engineering and the diverse types of models.
2. Explain the concepts of meta-models, platforms dependent and independent models, model-to-model transformations, automated code generation from models.
3. Understand and select the appropriate modeling method or methods for the software development project at hand and for the various types of software systems such as critical-safety systems, interactive consumer services, enterprise applications, hardware software, etc.
4. Manage, plan, analyze and contribute to various models to represent requirements, design, implementation and maintenance of large intensive software products, systems and services.
5. Understand how human, social and technical factors may have (both) positive and negative influence on the methods and practices of modelling in software engineering.
6. Identify the modeling challenges facing the software engineering research community as well as the avenues for further investigations.

**Contents:**

Modeling in Software Engineering Body of Knowledge (SWEBOK). Principles and foundations of software engineering. Formal methods. Prototyping techniques. Object-oriented modeling. Data-centric models. Model-driven architecture (MDA). Modeling techniques. Importance of modeling in software development projects and processes. Software engineering tools. Information, structure and behavioral modeling. Systematic literature review and large case studies on specific models and methods, their uses and abuses such as UML, use cases, user task models and prototypes, Z, B, and G Express. Systems Thinking

**Teaching Methods:**

Lectures/seminars on selected topics 24 h. Presentations 8h, weekly self-study 48 h (mandatory readings), scientific literature review and case studies 56 h, period 1-2. Research papers 20 h. Total 156 h.

The course is designed to be a forum for a scientific discussion and presentations by the professor, students and guests' researchers. Except an introductory lecture, the professor will be mainly acting as a senior project manager and a researcher will be advising students regarding literature review, reliable information sources on software engineering as well as how to select, review and present a case study on software engineering methods. The students will have to work in a team of 2-3; each team will make 2 presentations in the class; each student will have to contribute to the writing of a research paper that can be submitted to a conference or a workshop. Altogether, the presentations provide a systematic framework for selecting the appropriate methods for complex software systems development projects.

**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:**

Grade: 0-5
Project in groups (6 deliverable) 60%
Pictorial research paper 30%
Participation in class 10%

**Course Materials:**

There is no book that covers all the topics addressed in the course. A selection of readings from top journals will be used as basic readings; students are requested to make their own literature review from IEEE Transactions on Software Engineering, IEEE Software, ACM Transactions on Software Engineering Methodologies, Journal of Software and Systems (JSS), Communication of the ACM. The students are encouraged to walkthrough, one of the two following books as a basic introductory reading:
(1) R.S Pressman. Software Engineering: A Practitioner's Approach, 7/e, McGraw Hill, 2010
(2) J. Sommerville. Software Engineering. 9/e, Addison Wesley, 2011.

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

48.

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

max 5

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

No

### CT60A5400: Fundamentals of Game Development, 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:** Jussi Kasurinen

**Year:**

M.Sc. (Tech). 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Docent, D.Sc. (Tech.) Jussi Kasurinen

**Aims:**

Intended Course Learning Outcomes. At the end of this course students will be able to:
1. Conduct independent work in entertainment software engineering context.
2. Independently design and implement a small-scale game program with some industry-relevant platform.
3. Acquiring further knowledge concerning the taught game development tool.

4. Working as a productive member and as part of a team developing larger entertainment software product.

**Contents:**

Applied software engineering course. The objective for this course is for students to learn how to use their software engineering knowledge in an entertainment software engineering context. With the selected game development tools, student is capable to independently design and develop a small game program on some modern game engine platform, or work as a part of a team developing a larger game product.
List of Topics: lectures and project works:

- Games as software products
- Basics of processes and models applied in the entertainment software industry
- Basics of the game development tools
- Introduction to game engines and their functions
- Basics of 3D objects
- Introduction to game development-related programming problem.
- Basics of artificial intelligence in entertainment software engineering context.
- Basics of sound engineering
- Gamification and Serious games.

**Teaching Methods:**

Primary mode of work is assisted self-study. Lectures 8 h, Independent work and project assignments 148 h. Total 156 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. Continuous evaluation (no exam)
Project proposal and presentation 20%
Individual project assignments (x2) 60%
Peer review work on other project assignments 20%.

**Course Materials:**

Based on the yearly implementation; the taught game engine tutorials and other materials given during the course.

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

No

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

15–

### CT60A7322: Software Business Development, 3 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:** Marianne Kinnula

**Year:**

M.Sc. (Tech.) 1-2

**Period:**

Intensive week 20

**Teaching Language:**

English

**Teacher(s) in Charge:**

Docent, Ph.D. Marianne Kinnula

**Aims:**

After completing the course, the student has knowledge of how to 1. develop a software business idea over the whole life cycle of the business, 2. conduct market and business analyses, 3. identify sources for financing the business, and how to 4. select a suitable business model for the company.

**Contents:**

The course introduces the concepts of business idea, business plan, software business models and strategies, and the software value network. Case studies vary yearly.

**Teaching Methods:**

Lectures 6 h, workshops 12 h, seminar presentations 8 h, homeworks and project (pre, course, post) 52h. Total amount 78 h.

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

No

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

No

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

No

**Assessment:**

0-5, pre-task, project, essay.

**Course Materials:**

To be announced in course pages and in lectures.

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

Yes, 40.

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

max 5

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

max 5

### CT70A4000: Business Process Modelling, 6 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Ajantha Dahanayake

**Year:**

M.Sc. (Tech.) 1

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

Professor, PhD Ajantha Dahanayake

**Aims:**

1. Identify the principles of a business process modelling language and the dimensions of quality in a process model
2.Apply the process of process modelling (“method”) and the social aspects of process modelling
3.Use the modelling language to express and abstract from a realistic business process
4.Apply a method for modelling business processes in all its stages
5.Evaluate the model and the modelling process as a social process
6.Investigate a business and research question related to business process modeling

**Contents:**

Introduction of the concept and relevance of a business process, role modeling, dimensions of model quality and measurement, BPM and modeling methods, application to business process modeling and digital transformation, research issues.

**Teaching Methods:**

Lectures 14 h, homework work 20 h, 1. period.
Lectures 14 h, homework 20 h, 2. period.
Reading assignments, 2 hands on team project assignments 88 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. continuous evaluation.
Assessments 50%, Project 50%

**Course Materials:**

- Silver, Bruce: BPMN Method and Style, 2nd Edition, with BPMN Implementer's Guide: A structured approach for business process modelling and implementation using BPMN 2.0. Cody-Cassidy Press, 2011
- Weske, Mathias: Business Process Management: Concepts, Languages, Architectures. Springer, 2007

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

max 5

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

No

### CT70A5000: Impact and Benefits of Digitalization, 6 cr

**Validity:** 01.01.2018 -

**Form of study:** Basic studies

**Type:** Course

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

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

**Teachers:** Paula Savolainen

**Year:**

M.Sc (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

PhD Paula Savolainen

**Aims:**

The aim of the course is to give knowledge about different functions of an organization, which have to be considered when developing and following a digitalization strategy for the organization, and being able to assess the impact and benefits of digitalization.
After completing this course the student will be able to
1. Understand consequences of digitalization at macro level
2. Understand the ecosystem where the organization in question is operating and its' connections to the organization's business operations
3. Assess technologies from the viewpoint of the organization in question and how technologies enable new services / new ways of working for the organization
4. Develop an overall digitalization strategy or a project plan for an organization
5. Compile a perception of impacts for the organization in question and possibilities to achieve desired benefits
6. Evaluate research articles and write a reasoned opinion on the articles

**Contents:**

Drivers of digitalization; analysis of industry sectors, ecosystems, value networks and organizations; new business models; analysis of burning technologies; cost benefit analysis; from current state to unknown; impact of digitalization globally.

**Teaching Methods:**

Lectures 28 h, assignment given during the lectures (pair work) 10 h, self-study 10 h, reading and analyzing research articles (individual work) 30 h, project work (group work + report + presentation) 78 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. continuous evaluation
Assignment: report + presentation 40%
Project work: group work + report + presentation 60%.

**Course Materials:**

Reading package will be announced at the beginning of the course.

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

max 5

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

No

### CT70A7000: Digital Business Platforms, 6 cr

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

**Note:**

Not lectured in 2018-19, this course will start from academic year 2019-20.

**Year:**

M.Sc. (Tech.) 2

**Period:**

1-2

**Teaching Language:**

English

**Teacher(s) in Charge:**

D Sc. (Tech) Kari Heikkinen, Professor Ajantha Dahanayake

**Aims:**

At the end of the course students will be able to
1. Have expertise of the fundamental principles of key enabling pillars and platforms for digital business
2. Understanding how different platforms will add value to digital business
3. Understanding how data analytics will enhance value of heterogeneous data
4. Understand the role of stakeholders, technology trends and business challenges of software technology for being able to build a customer-centric culture and customer understanding
5. Master a digital business platform help to reengineer existing services, business processes and creating new digital services

**Contents:**

Introduction to pillars of and platforms for digital business: IoT (Internet of Things), 5G and CPS (Cyber Physical Systems), Data and Analytics (Big data), Ecosystems (Cloud evolution and Software as a service), strategies (Cybersecurity) and technologies (Distributed Ledgers, e.g. block chain), Information Systems, Customer experience and Business platforms.
In-depth discussion of platforms examples from different industries for demonstrating the variety of possible approaches towards organizing and managing platforms. Identifying the patterns of technology and transformation underlying current and future platforms of digital business. Overview of the different design steps and important decisions in the development of a digital platform or in its selection for business needs.

**Teaching Methods:**

Lectures 28 h, Case studies with in-depth discussions 70 h, Course work 28 h, Essay preparation 30 h. Total workload 156 h.

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

No

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

No

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

No

**Assessment:**

0-5. Continuous evaluation
Class participation, discussions and quizzes = 40%
Written Case studies (in groups) = 40%
Scientific paper on future vision of digital platforms individual) = 20%

**Course Materials:**

"Platform Revolution: How Networked Markets Are Transforming the Economy - And How toMake Them Work," by G. Parker,  M. Van Alstyne, S. Choudary, 2016.
Handouts during the class

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

Yes, 40, priority given to Digital Transformation students

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

No

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

No