Catalogue report

LUT School of Energy Systems

Master's Programme in Energy Systems

Master’s Programme in Energy Systems 2018-2019 (120 ECTS)

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 year , full-time studies of 60 ECTS per academic year.

Learning Outcomes of the Programme

Master’s Programme in Energy Systems, specialisation in Bio-Energy Systems or Nuclear Engineering
After completion of the M.Sc. programme in Energy Systems, the graduate will
• be able to analyse, plan and select energy conversion processes for different applications, taking into account the technical, economic, environmental and sociological aspects
• be able to design equipment and processes with respect to energy technology
• be able to apply and develop mathematical models for solving problems in energy technology
• be able to lead and organize both domestic and international projects
• be able to communicate and work in society, in industry as well as in the scientific and research community.

Degree Structure

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

The MSc in Energy Systems is also available as a Double Degree Programme for the students of our partner universities. The Double Degree Programme has separate degree structures of its own.

See Uni-portal:
https://uni.lut.fi/en/web/lut.fi-eng/energy-technology

Degree structures

Degree Structure

The Master's degree (120 ECTS) consists of core studies, specialisation studies, minor studies and elective studies.

The students choose to specialise either in Bio-energy Systems or in Nuclear Engineering. 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 (see specialisation in Nuclear Engineering for an exception to this rule).

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).

Electives 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 (BH10A1500 Work Internship in Master's Degree, 2-10 ECTS) may be included upon application, too.

The MSc in Energy Systems 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.

See the degree structures for details.

Master's Programme for Double Degree Students/Major in Bio-Energy Systems 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

Specialisation in Bio-Energy Systems (min 70 cr)

The extent of the specialisation in Bio-Energy Systems for double degree students is 70 ECTS.

EnDDBES: Specialisation in Bio-Energy Systems for double degree students, 70 cr
- *Obligatory specialisation studies of 56 ECTS.*
  - BH10A2000: Master's Thesis, 30 cr
  - BH40A1600: Turbomachinery in Renewable Energy, 5 cr
  - BH50A1200: Energy Systems Engineering, 6 cr
  - BH50A1400: Steam Boilers, 6 cr
  - BH50A1500: Bioenergy Technology Solutions, 6 cr
  - BH61A0600: Bioenergy, 3 cr
- *Selectable specialisation studies, choose enough to attain a total of 70 ECTS.*
  - BH30A0302: Nuclear Power Plant Engineering, 6 cr
  - BH40A1800: Steam Turbines, 3 cr
  - BH50A1701: District Heating, 4 cr
  - BH61A0201: Energy Economics, 5 cr
  - BH70A0101: Advanced Modelling Tools for Transport Phenomena, 5 cr
  - BH70A0200: Advanced Topics in Modelling of Energy Systems, 6 cr
  - BL20A1500: Energy Scenarios, 6 cr
  - BL20A1400: Renewable Energy Technology, 6 cr
  - BL20A0401: Electricity Market, 5 cr

Credit transfer from studies at home university (max 50 cr)

A max. of 50 ECTS of credit transfer from studies at home university can be added here. The decision on the credit transfers is made by the student's degree programme at LUT. Contact study counselling for detailed instructions.

Electives

No elective studies are required, as the M.Sc. degree consists of specialisation studies (a min. of 70 ECTS) and credit transfer of 50 ECTS.

Master's Programme for Double Degree Students/Major in Nuclear Engineering 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

Specialisation in Nuclear Engineering (min 70 cr)

The extent of the specialisation in Nuclear Engineering for double degree students is 70 ECTS.

ENDDNE: Specialisation in Nuclear Engineering for double degree students, 70 cr
- *Obligatory specialisation studies of 62 ECTS.*
  - BH10A2000: Master's Thesis, 30 cr
  - BH30A0201: Nuclear Reactor Design, 6 cr
  - BH30A0302: Nuclear Power Plant Engineering, 6 cr
  - BH30A2001: Computational Nuclear Thermal Hydraulics, 3 cr
  - BH30A1701: Nuclear Reactor Physics Methods, 3 cr
  - BH30A1801: Nuclear Reactor Physics Analyses, 3 cr
  - BH30A1901: Theoretical Nuclear Thermal Hydraulics, 3 cr
  - BH30A2104: Nuclear Reactor Dynamics, 2 cr
  - BH30A2200: Experimental Nuclear Thermal Hydraulics, 3 cr
  - BH40A1800: Steam Turbines, 3 cr
- *Selectable specialisation studies, choose enough to attain a total of 70 ECTS.*
  - BH30A0701: Reliability Engineering, 4 cr
  - BH40A1500: Turbulence Models, 4 cr
  - BH50A1200: Energy Systems Engineering, 6 cr
  - BH50A1400: Steam Boilers, 6 cr
  - BH61A0201: Energy Economics, 5 cr
  - BL20A0401: Electricity Market, 5 cr
  - BL20A1400: Renewable Energy Technology, 6 cr
  - BL20A1500: Energy Scenarios, 6 cr

Credit transfer from studies at home university (max 50 cr)

A max. of 50 ECTS of credit transfer from studies at home university can be added here. The decision on the credit transfers is made by the student's degree programme at LUT. Contact study counselling for detailed instructions.

Electives

No elective studies are required, as the M.Sc. degree consists of specialisation studies (a min. of 70 ECTS) and credit transfer of 50 ECTS.

Master's Programme in Energy Systems 2018-2019

Degree structure status: accepted

Academic year: 2018-19

Beginning date of the academic year: 01.08.2018

Core Studies (min 18 cr)

EnCoreES: Core Studies, Energy Systems, 18 cr
- *Obligatory core studies, 18 ECTS.*
  - BH40A1560: Fundamentals of Computational Fluid Dynamics, 6 cr
  - BH50A1300: Maintenance Management, 4 cr
  - BH60A4400: Introduction to Sustainability, 3 cr
  - BH60A4600: Introduction to M.Sc. Studies, 1 cr
  - BL20A0910: Technology and Society, 4 cr

Specialisation Studies (min 72 cr)

The minimum extent of specialisation studies is 72 ECTS.
Choose one of the following specialisations: Bio-Energy Systems or Nuclear Engineering.
If the total of specialisation studies exceeds 80 ECTS cr., no minor studies are required.

Bio-Energy Systems

EnDSBio: Specialisation in Bio-Energy Systems, 60 cr
- *Obligatory specialisation studies of 56 ECTS.*
  - BH10A2000: Master's Thesis, 30 cr
  - BH40A1600: Turbomachinery in Renewable Energy, 5 cr
  - BH50A1200: Energy Systems Engineering, 6 cr
  - BH50A1400: Steam Boilers, 6 cr
  - BH50A1500: Bioenergy Technology Solutions, 6 cr
  - BH61A0600: Bioenergy, 3 cr
- *Choose enough selectable courses to attain a min. of 72 ECTS in specialisation studies.*
  - BH30A0302: Nuclear Power Plant Engineering, 6 cr
  - BH40A1570: Advanced Computational Fluid Dynamics, 5 cr
  - BH40A1800: Steam Turbines, 3 cr
  - BH50A1701: District Heating, 4 cr
  - BH61A0201: Energy Economics, 5 cr
  - BH70A0101: Advanced Modelling Tools for Transport Phenomena, 5 cr
  - BH70A0200: Advanced Topics in Modelling of Energy Systems, 6 cr
  - BL20A0401: Electricity Market, 5 cr
  - BL20A1400: Renewable Energy Technology, 6 cr
  - BL20A1500: Energy Scenarios, 6 cr

Nuclear Engineering

EnDSNuclear: Specialisation in Nuclear Engineering, 60 cr
- *Master's Thesis and Diplomityö are alternative to each other.Students who have completed BSc at LUT, may do the thesis in Finnish. Students admitted directly to this MSc programme, write the thesis in English.*
  - BH10A1101: Master's Thesis, 30 cr
  - BH10A2000: Master's Thesis, 30 cr
- *Obligatory specialisation studies, including the thesis, of 62 ECTS.*
  - BH30A0201: Nuclear Reactor Design, 6 cr
  - BH30A0302: Nuclear Power Plant Engineering, 6 cr

BH30A1701: Nuclear Reactor Physics Methods, 3 cr
BH30A1801: Nuclear Reactor Physics Analyses, 3 cr
BH30A1901: Theoretical Nuclear Thermal Hydraulics, 3 cr
BH30A2001: Computational Nuclear Thermal Hydraulics, 3 cr
BH30A2104: Nuclear Reactor Dynamics, 2 cr
BH30A2200: Experimental Nuclear Thermal Hydraulics, 3 cr
BH40A1800: Steam Turbines, 3 cr

Choose enough courses to attain a min. of 72 ECTS in specialisation studies.

BH30A0600: Radiation Protection, 3 cr
BH30A0701: Reliability Engineering, 4 cr
BH40A1501: Turbulence Models, 4 cr
BH40A1570: Advanced Computational Fluid Dynamics, 5 cr
BH50A1200: Energy Systems Engineering, 6 cr
BH50A1400: Steam Boilers, 6 cr
BH61A0201: Energy Economics, 5 cr
BL20A0401: Electricity Market, 5 cr
BL20A1400: Renewable Energy Technology, 6 cr
BL20A1500: Energy Scenarios, 6 cr

Minor (min 20 cr)

The extent of the minor is a min. of 20 ECTS. Choose any minor offered by LUT (check the required prerequisites, if any) or do the minor during exchange abroad/in another Finnish university (upon application).

These minors are offered in English in the academic year 2018-2019:
SaDREE Renewable Energy and Energy Efficiency
KoDSaMate Advanced Materials Engineering
KoDSaManu Modern Manufacturing
YmDSaResp Environmental Responsibility
EnDMES Modelling of Energy Systems
MaDIntM300 Technomathematics
FyDInt300 Technical Physics
MaDSaCompu Computer Vision and Pattern Recognition
KeSOD400 Biobased Chemical Engineering (suitable for distance learning)
KeSOD500 Advanced Chemistry
TuSOEntr Entrepreneurship, minor
TiDSOsedt Software Engineering and Digital Transformation
KaSOIbm International Business and Management.

If the total of specialisation studies exceeds 80 ECTS cr., no minor studies are required.

Electives

Choose enough courses to attain a min. of 120 ECTS in the M.Sc. degree.
Electives 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 (BH10A1500 Work Internship in Master's Degree, 2-10 ECTS) may be included upon application, too.

Courses and study modules not included in degree structures

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 minors taught in English at LUT in the academic year 2018-2019 are:
(check if the courses included in the chosen minor have prerequisites)

SaDREE Renewable Energy and Energy Efficiency
KoDSaMate Advanced Materials Engineering
KoDSaManu Modern Manufacturing
YmDSaResp Environmental Responsibility
EnDMES Modelling of Energy Systems
MaDIntM300 Technomathematics
FyDInt300 Technical Physics
MaDSaCompu Computer Vision and Pattern Recognition
KeSOD400 Biobased Chemical Engineering
KeSOD500 Advanced Chemistry
TuSOEntr Entrepreneurship, minor
TiDSOsedt Software Engineering and Digital Transformation
KaSOIbm International Business and Management.

KeSoD500: Advanced Chemistry, 20 - 25 cr
- *Choose a min. of 20 ECTS*
  - BJ02A1012: Concepts of Analytical and Inorganic Chemistry, 5 cr
  - BJ02A1600: Biobased Materials and Advanced Organic Chemistry, 5 cr
  - BJ02A1031: Solution Chemistry, 5 cr
  - BJ02A4070: Principles of Thermal Gas-Liquid Processes, 5 cr
  - BJ03A1040: Advanced Materials in Adsorption and Ion Exchange, 5 cr

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

KeSoD400: Biobased Chemical Engineering, 20 - 30 cr
- *Choose a min. of 20 ECTS. This minor is suitable for distance learning.*
  - BJ02A1090: Environmental and Industrial Analytics, 5 cr
  - BJ02A1100: Biorefineries, 5 cr
  - BJ02A1200: Bioeconomy, 5 cr
  - BJ02A1500: Current Issues in Enabling Technologies for Circular Economy, 5 cr
  - BJ02A1600: Biobased Materials and Advanced Organic Chemistry, 5 cr
  - BJ02A4070: Principles of Thermal Gas-Liquid Processes, 5 cr

MaDSaCompu: Computer Vision and Pattern Recognition, 20 - 30 cr
- *Obligatory Studies 12 ECTS cr*
  - BM40A0701: Pattern Recognition, 6 cr
  - BM40A1201: Digital Imaging and Image Preprocessing, 6 cr
- *Choose enough courses to attain at least 20 ECTS cr together with obligatory courses*
  - BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 cr
  - BM20A3001: Statistical Analysis in Modelling, 5 cr
  - BM20A3401: Design of Experiments, 4 cr
  - BM20A5001: Principles of Technical Computing, 4 cr
  - BM20A6200: Inverse Problems and Normed Spaces, 6 cr
  - BM40A0801: Machine Vision and Digital Image Analysis, 6 cr
  - BM40A0901: Computer Vision, 6 cr
  - BM40A1400: GPGPU Computing, 6 cr
  - CS38A0060: Fuzzy sets and fuzzy logic, 6 cr
  - CS38A0070: Fuzzy data analysis, 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

YmDSaResp: Environmental Responsibility, 20 - 30 cr
Obligatory Studies 23 ECTS cr
BH60A0252: Solid Waste Management Technology, 7 cr
BH60A2401: Energy Recovery from Solid Waste, 4 cr
BH60A2701: Energy Efficient Environment, 6 cr
BH60A5700: Business and Sustainability, 6 cr

KaSOIbm: International Business and Management, 21 - 35 cr
Elective courses 21-24 cr
A370A0401: Case-Course of Business, 6 cr
A380A0000: Cross-Cultural Issues in International Business, 6 cr
A380A0131: Business Relationships in International Value Networks, 6 cr
A380A0201: Sales and Marketing Communication, 6 cr
A380A6050: Introduction to International Business and Planning, 3 cr
CS10A0262: International Business Essentials, 6 cr

EnDMES: Modelling of Energy Systems, 21 cr
Selectable courses, choose a min. of 20 ECTS
BH70A0101: Advanced Modelling Tools for Transport Phenomena, 5 cr
BH70A0200: Advanced Topics in Modelling of Energy Systems, 6 cr
BH40A1501: Turbulence Models, 4 cr
BH30A2001: Computational Nuclear Thermal Hydraulics, 3 cr
BH30A2200: Experimental Nuclear Thermal Hydraulics, 3 cr
BH40A1560: Fundamentals of Computational Fluid Dynamics, 6 cr
BH40A1570: Advanced Computational Fluid Dynamics, 5 cr

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

SaDREE: Renewable Energy and Energy Efficiency, 20 cr
Choose a min. of 20 ECTS cr. BL10A8400SS is a LUT Summer School course.
BL10A8400SS: Solar Economy and Smart Grids, 3 cr
BL20A1300: Energy Resources, 6 cr
BL20A1400: Renewable Energy Technology, 6 cr
BL20A1500: Energy Scenarios, 6 cr
BL40A2301: Energy Efficiency, 6 cr
BH61A0600: Bioenergy, 3 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
FyDInt300: Technical Physics, 20 - 26 cr
A minimum of 20 ECTS cr should be selected from the courses below.
BM30A0500: Applied Optics, 6 cr
BM30A1500: Advanced Topics in Material Science, 6 cr
BM30A1600: Microelectronics, 6 cr
BM30A1701: Physics of Semiconductor Devices, 6 cr
BM30A2100: Microelectronics Processing Technology, 2 cr
BM30A2200: Semiconductor and Superconductor Physics, 6 cr
BM30A2500: Nanophysics, 6 cr
MaDIntM300: Technomathematics, 20 cr
Choose a minimum of 20 ECTS cr
BM10A1100: Advanced Methods in Mathematics, Computing and Physics, 3 - 6 cr
BM20A3401: Design of Experiments, 4 cr
BM20A5001: Principles of Technical Computing, 4 cr
BM20A5100: Scientific Computing and Numerics for PDEs, 6 cr
BM20A6200: Inverse Problems and Normed Spaces, 6 cr
BM20A6500: Simulation and System Dynamics, 6 cr
CS38A0060: Fuzzy sets and fuzzy logic, 6 cr
CS38A0070: Fuzzy data analysis, 6 cr

Course descriptions

Descriptions of courses and study modules included in the degree structures

EnDDBES: Specialisation in Bio-Energy Systems for double degree students, 70 cr

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

No course descriptions.

Obligatory specialisation studies of 56 ECTS.

BH10A2000: Master's Thesis, 30 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Master's Thesis
Unit: LUT School of Energy Systems
Teachers: Ahti Jaatinen-Värri

Note:
In Master’s programmes taught in English, the Master’s thesis is always prepared in English.

Year:

M.Sc. (Tech.) 2

Period:

1-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri
Professors of the degree programme

Aims:

Upon completion of the course the students will be able to 1. formulate the research problem, 2. select the methods appropriate for the research problem, 3. find sources of information suitable for the research problem, and evaluate their validity and the quality and reliability of the data, 4. utilise and interpret the sources of information correctly, and 5. report the research in writing according to the scientific principles, considering the conventions used within the field of energy technology.

Contents:

The fundamentals of scientific research. Good scientific working methods when setting the research problem, selecting the research methods, and reporting the research, considering the conventions used within the field of energy technology. The utilisation of scientific information
in problem solving. Information literacy. Scientific reports. Information retrieval. Correctness of the language. Master's thesis.

Teaching Methods:

The work willbe arranged with the supervising professor.
Total workload 780 hrs.

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:

no

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

No

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

No

BH40A1600: Turbomachinery in Renewable Energy, 5 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Antti Uusitalo, Aki-Pekka Grönman, Ahti Jaatinen-Värri, Jari Backman

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Dc. (Tech.) Jari Backman, Associate professor, D.Sc. (Tech.) Aki Grönman, Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri, Researcher, D.Sc. (Tech.) Antti Uusitalo

Aims:

Upon completion of the course the students are able to 1. To choose a right type of turbomachinery for each application 2. To design the main parameters of radial and axial flow turbines and radial compressors 3. To define the performance and efficiency of a turbomachine
4. To understand principles of flow theories behind design methodologies.

Contents:

Internal flows in turbomachinery, the design of an axial flow and radial flow turbines, the design of radial compressors, gas turbines, engine power plants, ORC-process and turbomachinery in it, operation of turbomachinery. The course is affiliated on the sustainability of energy systems and based on international scientific research.

Teaching Methods:

1st period, lectures + exercises 6 h, quizzes 4 h, case study 2 h, PBL tutorial 2 h, independent studies 26 h, 2nd period lectures + exercises 12 h, quizzes 6 h, case study 2 h, PBL tutorial 2 h, independent studies 68 h.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, PBL 40%, case 40% and quizzes 20%.

Course Materials:

Material Notebook, Moodle course material: summary, exercises, quizzes.

Prerequisites:

BH40A0801 Turbomachinery attended or ongoing.

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

15-

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

Max 5

BH50A1200: Energy Systems Engineering, 6 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: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Juha Kaikko, D.Sc. (Tech.) Ekaterina Sermyagina

Aims:

Upon completion of thecourse the student will be able to 1. describe different types of energy production processes, 2. utilize thermodynamics and heat and mass balances inthe design of small scale energy systems, 3. use a “Systems Engineering” type approach to define the design values for energy production processes, 4. define small scale bioenergy production projects, 5. understand how plant requirements affect the planning and implementation phases of small energy systems, and 6. define economic constraints to small scale energy processes.

Contents:

History and fundamentals of thermodynamics and energy engineering. Modern problems of power plan tengineering. Combined heat and power production, especially from biomass. Fundamentals of steam and gas turbines in energy production. Engineering design: heat and mass balances in the design of small scale energy systems. Systems engineering. Planning and implementation of energy systems. Economic optimization of energy system projects.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises.Written assignment, written examination. Independent study approximately:Written assignment 80 h. Preparation for the examination 16 h and the examination3 h. Studying given material 33 h.
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 50 %,written assignment 50 %.

Course Materials:

Lecture notes.

Prerequisites:

Understanding of basic thermodynamics.

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

max 5

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

max 5

BH50A1400: Steam Boilers, 6 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: Esa Vakkilainen

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student will be able to 1. list typical biomass fuels and their properties, 2. understand the terminology used in maintenance management, 3. understand steam generation processes, especially from biomass, 4. describe the construction of steam boilers, 5. apply different types of steam boilers using different types of fuels, and 6. realize restrictions caused by corrosion, erosion and fouling.

Contents:

Characteristics of fuels, especially of biofuels. Combustion and gasification. Design of a steam boiler and its components. CCS. Energy balances. Solving steam boiler problems by mathematical modelling and algorithmization. Operation and maintenance of boilers: corrosion, fouling, emissions.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises. Written assignment. Independent study approximately: Written assignment 48 h. Preparation for the examination 18 h and the examination 3 h. Studying given materials 63 h.
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 70 %, written assignment 30 %.

Course Materials:

Lecture notes.
Teir, Sebastian: Steam Boiler Technology, 2nd ed. 2006.
Vakkilainen, Esa, Steam generation from Biomass, 2016.

Prerequisites:

Recommended: BH50A1200 Energy Systems Engineering.

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

max 5

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

max 5

BH50A1500: Bioenergy Technology Solutions, 6 cr

Validity: 01.08.2010 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Esa Vakkilainen

Year:

M.Sc. (Tech.) 2

Period:

2-3

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student will be able to 1. discuss the EU bioenergy policies including the effects of carbontrading, RES and energy efficiency, 2. understand the role and limitations of bioenergy use in Europe, 3. create a strategic vision for any country to usebioenergy, 4. understand different bioenergy generation technologies, and 5. list the biofuel production technologies, and 6. Independently follow discussions around future directions of Bioenergy technology. Independent creation of large report.

Contents:

Comparison of various bioenergy visions. Technological solutions and case studies from biomass supply and biofuelrefining, end-use technologies of biofuels in different sectors. Bioenergy challenges. Bioenergy politics.

Teaching Methods:

12 h of lectures. Group assignment. Written examination. Independent study approximately: Written assignment 48 h. Preparation for the examination 16 h + the examination 3 h. Studying given materials 77 h.
Total workload 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 60 %, assignment 40 %.

Course Materials:

Lecture notes.

Prerequisites:

BH61A0600 Bioenergy.

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

No

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

max 5

BH61A0600: Bioenergy, 3 cr

Validity: 01.08.2011 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Tapio Ranta

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Tapio Ranta, D.Sc. (Tech.), Professor

Aims:

Upon completion of the course the student will be able to understand the meaning of bioenergy, alternative biomass resources,supply methods, refining and end-user applications; describe the quality properties of solid biofuels and how they are measured and evaluated by using standards; and explain the meaning of sustainability in bioenergy systems.

Contents:

The role of bioenergy in the EU energy policy,incentive programmes and future plans. Raw-material sources of bioenergy, potential resources and current use. Biomass supply systems and logistics. Refined biofuel commodities, biogas and liquid biofuels. Biomass international trade. Quality properties of solid biofuels, quality measurement and standards. Sustainable bioenergy.

Teaching Methods:

1st period: 12 h of lectures. Written examination 3 h. 63 h of self-study.
Total workload 78 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:

Energy Visions 2050, VTT. 2009. Chapters 2, 4.4, 5.2- 5.4.
Additional material will be announced later during lectures.

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

15–

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

max 5

Selectable specialisation studies, choose enough to attain a total of 70 ECTS.

BH30A0302: Nuclear Power Plant Engineering, 6 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Anne Jordan, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to explain the functional principles of nuclear power plants and perform engineering design of main heat transfer and power conversion processes. The student will learn elements of engineering design of light water reactor plants process components (excluding the reactor core) and radiation shielding. The student understands nuclear fuel cycle and related technologies, can manage nuclear waste and apply nuclear safety principles.

Contents:

Nuclear reactor as heat source. Power conversion in light water reactor power plants. Main process systems and safety systems of light water reactors. Health effects of ionising radiation, radiation protection. Nuclear fuel cycle, nuclear waste management. Nuclear safety in design, major nuclear accidents.

Teaching Methods:

Lectures 14 h, tutorials 14 h, presentation 25 h, independent study 22 h, interim exam 3 h, 3rd period. Lectures 14 h, tutorials 14 h, assignment 25 h, independent study 22 h, interim exam 3 h, 4th period. Assignment and presentation. Two written interim exams or one written final examination. Total workload 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:

2

Assessment:

0-5. Written examination 70 %, assignment and presentation 30 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy or equivalent skills. BH30A0201 Nuclear Reactor Design recommended.

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

max 10

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

max 5

BH40A1800: Steam Turbines, 3 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: Aki-Pekka Grönman, Juhani Hyvärinen, Teemu Turunen-Saaresti

Year:

M.Sc. (Tech.) 2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Aki Grönman, D.Sc., Associate professor

Aims:

Upon completion of the course the students are able to: 1. Understand how the size of the turbine affects the design 2. Understand what requirements different power plants have for steam turbines and how turbines are connected to other parts of the plant 3. Understand the fundamentals of condensation in steam turbines 4. Understand the aerodynamic design principles of steam turbines.

Contents:

Influence of turbine size on the design and construction, turbines in different power plants, condensation in turbines, steam turbine aerodynamics, hood, and condenser.

Teaching Methods:

Lectures 14 h, exercises 14 h, Quizzes 8 h, Home assignments 14 h, Group assignment 28 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Quizzes 20%, Assignments 80%.

Course Materials:

Lecture material in Moodle.

Prerequisites:

Recommended course BH40A0801 Turbomachinery or similar knowledge.

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

15–

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

max 5

BH50A1701: District Heating, 4 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Esa Vakkilainen, D.Sc. (Tech.) Jussi Saari

Aims:

Upon completion of the course the student will be able to 1. describe the basics of district heating in the world and in Finland, 2. explain the technical solutions of generating and delivering district heating at a detailed level, do engineering design to 3. dimension heat output and annual thermal energy necessary for various heating applications, 4. dimension the district heating system and its components, 5. understand and calculate various losses, 6. evaluate the basic design and use of district heating networks and heat production.

Contents:

The formation of energy demand in buildings and the consumption variation. Consumer devices, connections and energy measurement. Abitility to design piping as well as network planning and control. Production of district heating, district heating plants and heating power plants. Cost and tariffs for district heating.

Teaching Methods:

3rd period: 10 h of lectures. Independent study 14 h. Independent calculations and online tasks 20 h. 4th period: Written assignment 48 h. Evaluating assignments 12 h.
Total workload 104 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Written assignment 60 %, independent calculations and online tasks 40 %.

Course Materials:

Frederiksen, Svend and Werner, Sven: District Heating and Cooling, Studentlitteratur, 2014.
Koskelainen, Lasse et al.: Kaukolämmön käsikirja, Energiateollisuus, 2006.
Lecture notes.

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

Yes, 5

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

Yes, 5

BH61A0201: Energy Economics, 5 cr

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

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Tapio Ranta

Aims:

Upon completion of the course the students will be able to utilise energy economic calculation methods and to calculate the additional cost in the energy production costs caused by emission trading. Students will be able to describe the basic concepts of Finnish energy economics and explain the structure of energy taxation in Finland, and calculate the energy taxes of fuels. Students will understand the structure of energy tariffs, and will be able to compile a duration curve of the consumption curve of energy.

Contents:

Use of energy statistics. The variation in energy demand and duration curves. Calculation methods for energy production costs. Profitability calculations of energy projects. Environmental impacts in energy production, especially carbon dioxide emissions. Energy and fuel markets. The effect of emission trading on the price of electricity, and energy tariffs. Energy taxation and the pricing system of natural gas. Energy economics in Finland and EU. The need for investments in electricity production. National energy and climate strategy. Fuel economics. Energy scenarios.

Teaching Methods:

3rd period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. 4th period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. Written examination. 98 h of self-study.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Examination 80%, homework 20 %.

Course Materials:

Material on Moodle.

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

15–

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

max 5

BH70A0101: Advanced Modelling Tools for Transport Phenomena, 5 cr

Validity: 01.08.2009 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Timo Hyppänen, Payman Jalali

Year:

M.Sc. (Tech.) 1-2

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Timo Hyppänen, Docent, D.Sc. (Tech.) Payman Jalali

Aims:

Transport phenomena are dealing with the heat, mass and momentum transfer in engineering and science. In this course, advanced modeling tools and methods are introduced for students of energy technology and other departments with related background in heat transfer and fluid dynamics. Students will learn how the related computer packages such as FLUENT, COMSOL Multiphysics and MATLAB can be used to solve and analyze heat transfer and fluid flow problems using computational fluid dynamics (CFD). This course provides a mathematical basis for problem formulation, and coding /solving using the above-mentioned computational packages. Students will learn how to solve simple transport problems using their own codes in MATLAB. Then more complex problems will be taught to solve using COMSOL and FLUENT packages. Upon completion of this course, they will be able to start working on various topics in heat and fluid flow engineering for advanced designs or analysis.

Contents:

Introduction to ‘transport phenomena’ and related problems, feeding problems into CFD algorithms and methods (discretization of equations and domains, transforming differential equations into algebraic equations etc.), diffusion and convection equations solved by finite
difference and finite volume methods, complexities due to property variation, geometry and boundary conditions, application of computational packages (such as MATLAB, FLUENT, COMSOL Multiphysics etc.) in solving transport phenomena problems.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of exercises. 4th period: 12 h of lectures, 12 h of exercises. 3 - 6 homeworks and 2 projects.
Total workload 130 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):

Yes

Assessment:

0 - 5. Examination 40 %, homeworks and projects 60 %.

Course Materials:

J.D. Anderson: Computational Fluid Dynamics, McGraw-Hill, Inc. 1995.
D.A. Anderson, J.C. Tannehill, R.H. Pletcher: Computational Fluid Mechanics and HeatTransfer, McGraw-Hill, Inc. 1984.
J.H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics, Springer-Verlag 1996.
C. Hirsch: Numerical Computation of Internal and External Flows, Volume 1: Fundamentals of Numerical Discretization, John Wiley & Sons, 1988.
MATLAB user manual. FLUENT user manual. COMSOL Multiphysics manual. Moodle.

Prerequisites:

Basic knowledge on programming using MATLAB or any other language. Basic Fluid Mechanics and Heat Transfer courses passed.

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

max 10

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

max 5

BH70A0200: Advanced Topics in Modelling of Energy Systems, 6 cr

Validity: 01.08.2010 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Juha Kaikko, Tero Tynjälä, Juhani Vihavainen, Teemu Turunen-Saaresti, Timo Hyppänen, Jouni Ritvanen, Esa Vakkilainen

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Jouni Ritvanen

Aims:

Upon completion of the course the student will be able to: 1. create stationary and time dependent mass, momentum and energy balances for various kinds of energy systems, 2. perform design tasks, utilize mathematical software in calculation, and analyze the characteristics of
energy systems, 3. include material property definitions into mathematical software or into own code when simulating energy systems, 4. create, solve and analyze the set of stationary and time dependent balance equations using Excel and MATLAB, 5. create, solve and analyze stationary energy systems with IPSEpro software package, and 6. create, solve and analyze time dependent energy systems with APROS software package.

Contents:

Advanced problems in the modelling of energy systems needed by engineers and researchers. The course lectures provide mathematical basis for problem formulation, and exercises providing a chance to work with various computational packages.

Teaching Methods:

1st period: 14 h of lectures and 14 h of case exercises. 2nd period: 12 h of lectures, 12 h of case exercises and 4 h of seminars. Individual work: Written assignments 52 h. Seminar work 48 h. Total individual work 100 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. Written assignments 60 %, seminar work 40 %.

Course Materials:

Moodle.

Prerequisites:

BH20A0450 Heat Transfer, BH20A0800 Engineering Thermodynamics, BH40A1451 Fluid Dynamics II, or similar skills.

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

max 10

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

max 5

BL20A1500: Energy Scenarios, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Describe the sustainability requirements of future energy systems as the major guard rail for the energy transformation. 2. Analyse energy transformation scenarios and identify the key technologies and setups for sustainable energy progress. 3. Describe the energy transformation in all sectors, the major technologies, the required transformation period and entire system cost optimization. 4. Describe the special role of power technologies for the energy transformation. 5. Recognize the difference between standard levelized cost ofenergy and total societal cost of energy.

Contents:

The course comprises the key elements of energy scenarios: demand, supply, cost, constraints. Energy demand is an aggregate of power, heat, cooling, mobility, agriculture and industrial energy needs. The demand has tobe matched with supply of energy fulfilling sustainability criteria, safety requirements and societal acceptance for the least cost. A complete set of demand curves, technical characteristics of all major technologies, current and projected technology costs and emission factors are taken into account for sustainable energy transformation pathway formulation. The special relevance ofwind energy and solar photovoltaics, the increasing relevance of power technologies,the role of storage technologies and the necessity of societal cost of energy are discussed in detail. Real scenarios for Finland, Europe and the World used as references.

Teaching Methods:

1st period lectures 14 h, exercises 14 h. 2ndperiod lectures 14 h, exercises 14 h, presentation/oral examination 1 h. Independent study 99 h. Total workload 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, presentation/oral examination 100 %

Course Materials:

Material handed out in class and made available on Moodle.

Prerequisites:

BL20A1300 Energy Resources and BL20A1400 Renewable Energy Technology (at least one of the two courses)

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

max 15

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

max 5

BL20A1400: Renewable Energy Technology, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Identify the major renewable energy (RE) conversion technologies, mainly converting resources to electricity. 2. Describe the major characteristics of the technologies, in particular applications, efficiency, economics, industrial scale and future prospects. 3. Analyse the need for storage technologies and their different fields of application based on their key technical and economic features.

Contents:

The course is focused on the conversion of the resources to electricity. The RE technologies discussed in the course are: wind turbines, solar photovoltaics, solar thermal electricity generation and hydro powerplants. The storage technologies covered comprise a general overview and in particular include battery storage, pumped hydro storage and power-to-gas technologies. All technologies are classified with respect to their applications, efficiency, maturity, economics, industrial scaling and expected relevance for the ongoing energy transformation.

Teaching Methods:

3rd period lectures 14 h, exercises 14 h. 4thperiod lectures 14 h, exercises 14 h, examination 3 h.
Independent study 97 h.
Total workload 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:

Material handed out in class and made available on Moodle.

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

15–

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

max 5

BL20A0401: Electricity Market, 5 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: Samuli Honkapuro

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Associate Professor, D.Sc. (Tech.) Samuli Honkapuro

Aims:

Upon completion of the course the student will be able to: 1. describe the characteristics of the different business sectors in the Nordic electricity market, 2. explain electricity price formation, 3. explain the operation principle of the power exchange, 4. identify and describe
the products of the power exchange, 5. select the right risk management method for electricity trade, 6. describe the tasks of the different parties in an electric power system in maintaining technical and commercial power balance, including demand side management.

Contents:

The restructuring of the electricity markets, power exchange, electricity trade, balance management.

Teaching Methods:

28 h of lectures 10 h optional Moodle quizzes 1st period. 89 h independent studies. Written examination 3 h.
Total workload 130 h

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, examination 100%. Non-mandatory Moodle quizzes provide extra points to exam.

Course Materials:

Material distributed in Moodle.

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

15–

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

max 15

ENDDNE: Specialisation in Nuclear Engineering for double degree students, 70 cr

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

No course descriptions.

Obligatory specialisation studies of 62 ECTS.

BH10A2000: Master's Thesis, 30 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Master's Thesis
Unit: LUT School of Energy Systems
Teachers: Ahti Jaatinen-Värri

Note:

In Master’s programmes taught in English, the Master’s thesis is always prepared in English.

Year:

M.Sc. (Tech.) 2

Period:

1-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri
Professors of the degree programme

Aims:

Upon completion of the course the students will be able to 1. formulate the research problem, 2. select the methods appropriate for the research problem, 3. find sources of information suitable for the research problem, and evaluate their validity and the quality and reliability of the data, 4. utilise and interpret the sources of information correctly, and 5. report the research in writing according to the scientific principles, considering the conventions used within the field of energy technology.

Contents:

The fundamentals of scientific research. Good scientific working methods when setting the research problem, selecting the research methods, and reporting the research, considering the conventions used within the field of energy technology. The utilisation of scientific information
in problem solving. Information literacy. Scientific reports. Information retrieval. Correctness of the language. Master’s thesis.

Teaching Methods:

The work willbe arranged with the supervising professor.
Total workload 780 hrs.

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:

no

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

No

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

No

BH30A0201: Nuclear Reactor Design, 6 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Anne Jordan, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to explain physical phenome underlying nuclear reactors, and perform engineering design of a critical nuclear reactor using diffusion theory, and perform thermal engineering design of the reactor core. Students will learn the main characteristics of commercially important nuclear reactor types.

Contents:

Interaction of radiation with matter. Nuclear reactions and their cross sections. Reactor physics, diffusion theory, a simplified criticality calculation. The design principles for the reactor core, thermal dimensioning. An overview at the nuclear power programmes of different countries. Major reactor commercial nuclear types: PWR, BWR, Small Modular Reactors, CANDU and RBMK, gas-cooled reactors, and fast reactors.

Teaching Methods:

Lectures 28 h, tutorials 14 h, country presentation 20 h, preparation for the interim exam 13 h and interim exam 3 h, 1st period. Lectures 14 h, tutorials 14 h, assignment 39 h, preparation for the interim exam 8 h and interim exam 3 h, 2nd period. Assignment and country presentation. Two written interim exams or one written final examination.
Total workload 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:

2

Assessment:

0-5. Written examination 70 %, assignment and country presentation 30 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes.
Lamarsh & Baratta: Introduction to Nuclear Engineering, 3rd edition (2014), where applicable.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy or equivalent skills.

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

max 10

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

max 5

BH30A0302: Nuclear Power Plant Engineering, 6 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Anne Jordan, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to explain the functional principles of nuclear power plants and perform engineering design of main heat transfer and power conversion processes. The student will learn elements of engineering design of light water reactor plants process components (excluding the reactor core) and radiation shielding. The student understands nuclear fuel cycle and related technologies, can manage nuclear waste and apply nuclear safety principles.

Contents:

Nuclear reactor as heat source. Power conversion in light water reactor power plants. Main process systems and safety systems of light water reactors. Health effects of ionising radiation, radiation protection. Nuclear fuel cycle, nuclear waste management. Nuclear safety in design, major nuclear accidents.

Teaching Methods:

Lectures 14 h, tutorials 14 h, presentation 25 h, independent study 22 h, interim exam 3 h, 3rd period. Lectures 14 h, tutorials 14 h, assignment 25 h, independent study 22 h, interim exam 3 h, 4th period. Assignment and presentation. Two written interim exams or one written final examination. Total workload 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:

2

Assessment:

0-5. Written examination 70 %, assignment and presentation 30 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy or equivalent skills. BH30A0201 Nuclear Reactor Design recommended.

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

max 10

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

max 5

BH30A2001: Computational Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Otso-Pekka Kauppinen, Juhani Vihavainen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Tech.) Juhani Vihavainen

Aims:

Upon completion of the course students will understand basic equations and special features in thermal hydraulic system code modelling. The students are able to use system codes introduced in this course, APROS and TRACE, and understand engineering design and modelling basis.

Contents:

Thermal hydraulic phenomena of nuclear power plant during normal operation and incident and accident situations. Calculation and modelling of a two phase flow in computer codes. Modelling of essential processes in nuclear power plants with APROS and TRACE software and CFD codes.

Teaching Methods:

Lectures 14 h, tutorials 14 h, assignment 40 h, preparation for the examination 7 h, written examination 3 h.
Total workload 78 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 50 %, assignment 50 %.

Course Materials:

Lecture materials. APROS and TRACE code manuals, as applicable.
Todreas, Kazimi: Nuclear Systems I & II, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design and BH30A1901 Theoretical Nuclear Thermal Hydraulics.

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

No

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

max 5

BH30A1701: Nuclear Reactor Physics Methods, 3 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Ville Rintala, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 2

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Assistant professor, D. Sc. (Tech.) Heikki Suikkanen, M.Sc. (Tech.) Ville Rintala

Aims:

Upon completion of the course the students will be able to derive the neutron transport equation from the basic physical phenomena, understand the concepts of neutron flux and current, and use simple numerical calculation methods for the neutron flux solution with diffusion approximation.

Contents:

The transport equation for neutrons. The diffusion of neutrons. Two-group diffusion theory. Solution process of reactor core simulator. Simple numerical methods of reactor physics.

Teaching Methods:

Lectures 14 h, tutorials 14 h, computer exercises 4 h, assignment 46 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, assignment 100 %.

Course Materials:

Lecture notes: Leikkonen, Reaktorifysiikka (in Finnish).
Reuss: Neutron Physics. Duderstadt & Hamilton: Nuclear Reactor Analysis, as applicable.
Stacey: Nuclear Reactor Physics, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design and BH30A2104 Nuclear Reactor Dynamics.

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

No

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

max 5

BH30A1801: Nuclear Reactor Physics Analyses, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Ville Rintala

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Assistant professor, D. Sc. (Tech.) Heikki Suikkanen, M.Sc. (Tech.) Ville Rintala

Aims:

Upon completion of the course the students will be able to understand the deterministic reactor physics calculation system: transport codes for fuel bundle calculations and nodal methods for the whole core calculations, design the reactor loading compliant with applicable limitations (In-Core Fuel Management), and carry out simple Monte-Carlo calculations of reactor physics.

Contents:

Preparation of nuclear data. Fuel homogenization. Core simulators. Fuel performance codes. Nuclear criticality safety. Core design.

Teaching Methods:

Lectures 18 h, tutorials 14 h, computer calculations 4 h, preparation for the examination 39 h, written examination 3 h.
Total workload 78 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 %. Possible to raise the grade by tutorials.

Course Materials:

Reuss: Neutron Physics,
Duderstadt & Hamilton: Nuclear Reactor Analysis,
Stacey: Nuclear Reactor Physics, where applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design, BH30A1701 Nuclear Reactor Physics Methods, BH30A2104 Nuclear Reactor Dynamics.

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

No

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

max 5

BH30A1901: Theoretical Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Otso-Pekka Kauppinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA)

Year:

M.Sc. (Tech.) 1

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to understand one-dimensional two-phase flow, heat transfer, boiling and condensation in pipelike geometry, master the basic continuity and constitutive equations for two-phase flow, utilise the basic equations in manual calculations, understand the continuity and constitutive equations used in computer models used in the thermal-hydraulic system codes (APROS/TRACE), and will be aware of elementary multidimensional two-phase flow modelling.

Contents:

The normal use, as well as the thermal hydraulic phenomena in disturbance and accident situations, of the reactor circuit and containment of a nuclear power plant. Continuity equations, closure laws, phenomenological models for phase interactions. Two-phase flow calculations using system codes. Two-phase flow modelling in computational fluid dynamics (CFD).

Teaching Methods:

Lectures 14 h, tutorials 14 h, computer calculations 4 h, preparation for the examination 43 h, written examination 3 h.
Total workload 78 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 %. Possible to raise the grade by tutorials.

Course Materials:

Ghiaasian: Two-Phase Flow, Boiling and Condensation, where applicable.
Todreas, Kazimi: Nuclear Systems I & II, where applicable.

Winterton: Thermal Design of Nuclear Reactors, where applicable.
Wallis: One-dimensional Two-phase flow.

Prerequisites:

BH30A0201 Nuclear Reactor Design

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

max 10

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

max 5

BH30A2104: Nuclear Reactor Dynamics, 2 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Heikki Suikkanen, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Assistant professor, D.Sc. (Tech.) Heikki Suikkanen

Aims:

Upon completion of the course the student will be able to explain nuclear reactor kinetics and related feedback mechanisms, principles of nuclear reactor control, and principles of efficient nuclear fuel utilisation.

Contents:

Nuclear reactor dynamic response and control. Neutron sources, approach to criticality, reactivity feedbacks in critical reactors, reactivity excursions, reactor power management, reactor poisons, fuel burnup management.

Teaching Methods:

Lectures 14 h, tutorials and homeworks 22 h, preparation for the examination 13 h, written examination 3 h.
Total workload 52 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 %. Possible to raise the grade by homeworks.

Course Materials:

Lecture notes.
Reuss: Neutron Physics, Part I, as applicable.
Lamarsh & Baratta: Introduction to Nuclear Engineering, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design

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

max 5

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

max 5

BH30A2200: Experimental Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2014 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Juhani Vihavainen, Otso-Pekka Kauppinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to describe basic measurement techniques for one- and two-phase flows, understand similitude and scaling, perform engineering design of downscaled models, understand the interaction between experiments and computer code calculations, describe advanced flow structure mapping techniques (e.g. wire mesh sensing, particle image velocimetry).

Contents:

Temperature, pressure, pressure drop, liquid level and flow measurement techniques. Void fraction measurement. Similitude, scaling principles. Model design. Designing experiments for computer code validation. Advanced flow structure measurement techniques.

Teaching Methods:

Lectures 14 h, tutorials 14 h, laboratory demonstrations 16 h, computer calculations 4 h, quiz 8 h, writing reports 22 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5. Quiz 25%, reports of laboratory works 75%.

Course Materials:

Ghiaasian: Two-Phase Flow, Boiling and Condensation, as applicable.

Prerequisites:

BH40A0701 Measurements in Energy Technology or equivalent course experience.

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

max 5

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

max 5

BH40A1800: Steam Turbines, 3 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: Aki-Pekka Grönman, Juhani Hyvärinen, Teemu Turunen-Saaresti

Year:

M.Sc. (Tech.) 2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Aki Grönman, D.Sc., Associate professor

Aims:

Upon completion of the course the students are able to: 1. Understand how the size of the turbine affects the design 2. Understand what requirements different power plants have for steam turbines and how turbines are connected to other parts of the plant 3. Understand the fundamentals of condensation in steam turbines 4. Understand the aerodynamic design principles of steam turbines.

Contents:

Influence of turbine size on the design and construction, turbines in different power plants, condensation in turbines, steam turbine aerodynamics, hood, and condenser.

Teaching Methods:

Lectures 14 h, exercises 14 h, Quizzes 8 h, Home assignments 14 h, Group assignment 28 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Quizzes 20%, Assignments 80%.

Course Materials:

Lecture material in Moodle.

Prerequisites:

Recommended course BH40A0801 Turbomachinery or similar knowledge.

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

15–

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

max 5

Selectable specialisation studies, choose enough to attain a total of 70 ECTS.

BH30A0701: Reliability Engineering, 4 cr

Validity: 01.08.2014 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Juhani Hyvärinen, Elina Hujala

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:

1-2

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Tech.) Juhani Vihavainen, M.Sc. (Tech.), M.Sc. Elina Hujala.

Aims:

Upon completion of the course students will be able to calculate the reliability parameters for separate components and simple systems, formulate and solve fault and event trees for systems, and estimate the effect of human factors.

Contents:

Introduction to reliability engineering. Boolean algebra. The reliability parameters of components. The reliability engineering structure of systems, examples from different fields. Structural functions, reliability flow charts, fault trees, event trees, minimal cut sets. The reliability parameters of systems and their determination using different methods. Damage and effect analysis. The determination of parameters and trends from flaw observations. The improvement of the usage reliability of a system. Humans as a part of systems. Common mode failures and uncertainty analyses. The reliability of structures.

Teaching Methods:

Lectures 21 h, tutorials 14 h, 1st period. Lectures 21 h, tutorials 14 h, 2nd period. Preparation for the examination 31 h and written examination 3 h.
Total workload 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 100 %. Possible to raise the grade by tutorials.

Course Materials:

Rausand M. & Hoyland A: System Reliability Theory, Models, Statisticals Methods and Applications.

Prerequisites:

Recommended BM20A1401 Tilastomatematiikka I or equivalent knowledge.

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

max 10

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

max 5

BH40A1500: Turbulence Models, 4 cr

Validity: 01.08.2010 - 31.12.2016
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Teemu Turunen-Saaresti

Aims:

Upon completion of the course the student will be able to recognize the characteristics of turbulence models and to estimate the suitability of different turbulence models for various fluid mechanical problems. In addition, the student will be able to interpret the physical basis and the theory of turbulence models.

Contents:

Navier-Stokes equations, RANS equations, eddy viscosity, algebraic, one equation and two equation models, Reynolds stress model and Large Eddy Simulation. This course is also suitable for postgraduate students.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of tutorials. 4th period: 12 h of lectures, 12 h of tutorials. Homework 36 h, preparation for the exam 16 h, written examination 3 h. Total workload 103 h.

Assessment:

0 - 5. Examination 50 %, homework 50 %.

Course Materials:

David C. Wilcox: Turbulence models for CFD. Noppa portal (noppa.lut.fi).

Prerequisites:

BH70A0001 Numerical Methods in Heat Transfer

BH50A1200: Energy Systems Engineering, 6 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: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Juha Kaikko, D.Sc. (Tech.) Ekaterina Sermyagina

Aims:

Upon completion of thecourse the student will be able to 1. describe different types of energy production processes, 2. utilize thermodynamics and heat and mass balances inthe design of small scale energy systems, 3. use a “Systems Engineering” type approach to define the design values for energy production processes, 4. define small scale bioenergy production projects, 5. understand how plant requirements affect the planning and implementation phases of small energy systems, and 6. define economic constraints to small scale energy processes.

Contents:

History and fundamentals of thermodynamics and energy engineering. Modern problems of power plan tengineering. Combined heat and power production, especially from biomass. Fundamentals of steam and gas turbines in energy production. Engineering design: heat and mass balances in the design of small scale energy systems. Systems engineering. Planning and implementation of energy systems. Economic optimization of energy system projects.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises.Written assignment, written examination. Independent study approximately:Written assignment 80 h. Preparation for the examination 16 h and the examination3 h. Studying given material 33 h. 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 50 %,written assignment 50 %.

Course Materials:

Lecture notes.

Prerequisites:

Understanding of basic thermodynamics.

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

max 5

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

max 5

BH50A1400: Steam Boilers, 6 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: Esa Vakkilainen

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student will be able to 1. list typical biomass fuels and their properties, 2. understand the terminology used in maintenance management, 3. understand steam generation processes, especially from biomass, 4. describe the construction of steam boilers, 5. apply different types of steam boilers using different types of fuels, and 6. realize restrictions caused by corrosion, erosion and fouling.

Contents:

Characteristics of fuels, especially of biofuels. Combustion and gasification. Design of a steam boiler and its components. CCS. Energy balances. Solving steam boiler problems by mathematical modelling and algorithmization. Operation and maintenance of boilers: corrosion, fouling, emissions.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises. Written assignment. Independent study approximately: Written assignment 48 h. Preparation for the examination 18 h and the examination 3 h. Studying given materials 63 h.
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 70 %, written assignment 30 %.

Course Materials:

Lecture notes.
Teir, Sebastian: Steam Boiler Technology, 2nd ed. 2006.
Vakkilainen, Esa, Steam generation from Biomass, 2016.

Prerequisites:

Recommended: BH50A1200 Energy Systems Engineering.

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

max 5

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

max 5

BH61A0201: Energy Economics, 5 cr

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

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Tapio Ranta

Aims:

Upon completion of the course the students will be able to utilise energy economic calculation methods and to calculate the additional cost in the energy production costs caused by emission trading. Students will be able to describe the basic concepts of Finnish energy economics and explain the structure of energy taxation in Finland, and calculate the energy taxes of fuels. Students will understand the structure of energy tariffs, and will be able to compile a duration curve of the consumption curve of energy.

Contents:

Use of energy statistics. The variation in energy demand and duration curves. Calculation methods for energy production costs. Profitability calculations of energy projects. Environmental impacts in energy production, especially carbon dioxide emissions. Energy and fuel markets. The effect of emission trading on the price of electricity, and energy tariffs. Energy taxation and the pricing system of natural gas. Energy economics in Finland and EU. The need for investments in electricity production. National energy and climate strategy. Fuel economics. Energy scenarios.

Teaching Methods:

3rd period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. 4th period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. Written examination. 98 h of self-study.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Examination 80%, homework 20 %.

Course Materials:

Material on Moodle.

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

15–

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

max 5

BL20A0401: Electricity Market, 5 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: Samuli Honkapuro

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Associate Professor, D.Sc. (Tech.) Samuli Honkapuro

Aims:

Upon completion of the course the student will be able to: 1. describe the characteristics of the different business sectors in the Nordic electricity market, 2. explain electricity price formation, 3. explain the operation principle of the power exchange, 4. identify and describe
the products of the power exchange, 5. select the right risk management method for electricity trade, 6. describe the tasks of the different parties in an electric power system in maintaining technical and commercial power balance, including demand side management.

Contents:

The restructuring of the electricity markets, power exchange, electricity trade, balance management.

Teaching Methods:

28 h of lectures 10 h optional Moodle quizzes 1st period. 89 h independent studies. Written examination 3 h.
Total workload 130 h

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, examination 100%. Non-mandatory Moodle quizzes provide extra points to exam.

Course Materials:

Material distributed in Moodle.

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

15–

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

max 15

BL20A1400: Renewable Energy Technology, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Identify the major renewable energy (RE) conversion technologies, mainly converting resources to electricity. 2. Describe the major characteristics of the technologies, in particular applications, efficiency, economics, industrial scale and future prospects. 3. Analyse the need for storage technologies and their different fields of application based on their key technical and economic features.

Contents:

The course is focused on the conversion of the resources to electricity. The RE technologies discussed in the course are: wind turbines, solar photovoltaics, solar thermal electricity generation and hydro powerplants. The storage technologies covered comprise a general overview and in particular include battery storage, pumped hydro storage and power-to-gas technologies. All technologies are classified with respect to their applications, efficiency, maturity, economics, industrial scaling and expected relevance for the ongoing energy transformation.

Teaching Methods:

3rd period lectures 14 h, exercises 14 h. 4thperiod lectures 14 h, exercises 14 h, examination 3 h.
Independent study 97 h.
Total workload 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:

Material handed out in class and made available on Moodle.

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

15–

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

max 5

BL20A1500: Energy Scenarios, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Describe the sustainability requirements of future energy systems as the major guard rail for the energy transformation. 2. Analyse energy transformation scenarios and identify the key technologies and setups for sustainable energy progress. 3. Describe the energy transformation in all sectors, the major technologies, the required transformation period and entire system cost optimization. 4. Describe the special role of power technologies for the energy transformation. 5. Recognize the difference between standard levelized cost ofenergy and total societal cost of energy.

Contents:

The course comprises the key elements of energy scenarios: demand, supply, cost, constraints. Energy demand is an aggregate of power, heat, cooling, mobility, agriculture and industrial energy needs. The demand has tobe matched with supply of energy fulfilling sustainability criteria, safety requirements and societal acceptance for the least cost. A complete set of demand curves, technical characteristics of all major technologies, current and projected technology costs and emission factors are taken into account for sustainable energy transformation pathway formulation. The special relevance ofwind energy and solar photovoltaics, the increasing relevance of power technologies,the role of storage technologies and

the necessity of societal cost of energy are discussed in detail. Real scenarios for Finland, Europe and the World used as references.

Teaching Methods:

1st period lectures 14 h, exercises 14 h. 2ndperiod lectures 14 h, exercises 14 h, presentation/oral examination 1 h. Independent study 99 h. Total workload 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, presentation/oral examination 100 %

Course Materials:

Material handed out in class and made available on Moodle.

Prerequisites:

BL20A1300 Energy Resources and BL20A1400 Renewable Energy Technology (at least one of the two courses)

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

max 15

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

max 5

EnCoreES: Core Studies, Energy Systems, 18 cr

Validity: 01.08.2018 -
Form of study: Basic studies
Type: Study module
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F

No course descriptions.

Obligatory core studies, 18 ECTS.

BH40A1560: Fundamentals of Computational Fluid Dynamics, 6 cr

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

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Assoc. Prof. (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti
M.Sc. (Tech.) Alireza Ameli

Aims:

This course acquaints students with the basic procedures of conducting computational fluid dynamics (CFD) simulations and the key numerical methods in heat and mass transfer. Students will be able to mesh problems efficiently and detect problems related to meshing and computational grids/meshes. Students are also be able to use numerical software(s) for the computation of simple cases, interpret and analyze gained results and explaintheory and limitations of studied numerical methods. In addition, students areable to form equations using the finite volume method. A CFD software is used to design simple engineering flow problems.

Contents:

Numerical solution methods for the conservation of mass, momentumand energy. Solutions for heat transfer problems including conduction,radiation and convection. The finite volume method. Formulation of discretized conservation equations. Differentiation methods. The solution of equation sets. Setting boundary conditions. Physics of flow problem. Different types of grids. Setting up steady and transient CFD simulations. Meshing. Solution procedures and techniques.Visualization techniques and post-processing the results.

Teaching Methods:

1st period: 12 h of lectures, 12 h of exercises. 2nd period: 12 h of lectures, 12 h of exercises. Homeworks 24 h. Project work 73 h. Preparing for the examination 8 h. Written examination 3 h.
Total workload 156 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

0-5. Homework 30%, Project work 40%, Exam 30%.

Course Materials:

Versteeg, H.K.: An introduction to Computation al Fluid Dynamics, The Finite Volume Method.

Prerequisites:

BM20A5001 Principles of Technical Computing or equivalent knowledge.

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

Max. 10

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

Max 10

BH50A1300: Maintenance Management, 4 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: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Juha Kaikko, Professor, D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student willbe able to 1. identify the terminology used in maintenance management, 2. explain failure models, 3. utilize the concepts of reliability and availability, 4. explain maintenance strategies, 5. use methods to assess and control maintenance, and 6. describe how maintenance management is organized in power industry.

Contents:

Terminology. Engineering design: failure models, reliability and availability. Maintenance strategies. Maintenance assessment and control. Maintenance in power industry.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 6 h of lectures and case exercises. Written assignment. Written examination. Independent study approximately: Written assignment 32 h. Preparation for the examination 14 h and the examination 3 h. Studying given material 37 h.
Total workload 104 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

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

Course Materials:

Crespo Márquez, A.: The Maintenance Management Framework: Models and Methods for Complex Systems Maintenance, Springer-Verlag, 2007.
Dhillon, B.S.: Engineering Maintenance: A ModernApproach, CRC Press, 2002.
Lecture notes.

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

max 5

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

max 5

BH60A4400: Introduction to Sustainability, 3 cr

Validity: 01.08.2013 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Risto Soukka, Virgilio Panapanaan, Mirja Mikkilä

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

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

Contents:

The idea is to learn and understand sustainability challenges and their interconnectedness, and find out how we could move or transit towards a more sustainable world.

Teaching Methods:

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

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Examination 60 %, assignment 40 %.

Course Materials:

Will be announced during lectures. Moodle.

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

max 5

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

max 5

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

Validity: 01.08.2013 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

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

Note:

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

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

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

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

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

Course Materials:

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

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

No

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

No

BL20A0910: Technology and Society, 4 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: Johanna Naukkarinen

Note:

Course is taught fully on-line and continuously rolling (no tie to the LUT periods)
Enrolment by e-mail to post-doctoral researcher Johanna Naukkarinen.

Year:

M.Sc. (Tech.) 1-2

Period:

1-4

Teaching Language:

English

Teacher(s) in Charge:

Johanna Naukkarinen, D.Sc. (Tech.), Post-doctoral researcher

Aims:

Upon completion of the course the student will be able to:
1. understand and explain the general interplay between technology and society
2. analyze the possible effects of different technologies on society
3. evaluate how the societal factors may affect the development and dissemination of different technologies.

Contents:

Social and economic factors affecting the development and adoption of technologies, mechanisms of interplay between society and technology, predicting the potential impact of technology.

Teaching Methods:

The completion of the course consist of completing the learning tasks in a topic related massive open online -course (MOOC) of teacher's choice and keeping a learning diary. The MOOC will be announced at the beginning of the academic year. Formal passing or a certificate on completion of the MOOC is not required, but student has to proof that all the required assignments have been sufficiently done.
Total workload 104 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

Grading on a scale 0-5
50 % of the assessment is based on the quality of MOOC learning assignment and 50 % on the quality of the learning diary. More exact assessment matrix can be found on course Moodle-area.

Course Materials:

The content of the chosen MOOC, article(s) provided in the Moodle-area

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

Primarily for M.Sc students in electrical engineering, energy technology and circular economy.

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

No

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

No

EnDSBio: Specialisation in Bio-Energy Systems, 60 cr

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

No course descriptions.

Obligatory specialisation studies of 56 ECTS.

BH10A2000: Master's Thesis, 30 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Master's Thesis
Unit: LUT School of Energy Systems
Teachers: Ahti Jaatinen-Värri

Note:

In Master’s programmes taught in English, the Master’s thesis is always prepared in English.

Year:

M.Sc. (Tech.) 2

Period:

1-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri
Professors of the degree programme

Aims:

Upon completion of the course the students will be able to 1. formulate the research problem, 2. select the methods appropriate for the research problem, 3. find sources of information suitable for the research problem, and evaluate their validity and the quality and reliability of the data, 4. utilise and interpret the sources of information correctly, and 5. report the research in writing according to the scientific principles, considering the conventions used within the field of energy technology.

Contents:

The fundamentals of scientific research. Good scientific working methods when setting the research problem, selecting the research methods, and reporting the research, considering the conventions used within the field of energy technology. The utilisation of scientific information
in problem solving. Information literacy. Scientific reports. Information retrieval. Correctness of the language. Master's thesis.

Teaching Methods:

The work willbe arranged with the supervising professor.
Total workload 780 hrs.

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:

no

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

No

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

No

BH40A1600: Turbomachinery in Renewable Energy, 5 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Antti Uusitalo, Aki-Pekka Grönman, Ahti Jaatinen-Värri, Jari Backman

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Dc. (Tech.) Jari Backman, Associate professor, D.Sc. (Tech.) Aki Grönman, Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri, Researcher, D.Sc. (Tech.) Antti Uusitalo

Aims:

Upon completion of the course the students are able to 1. To choose a right type of turbomachinery for each application 2. To design the main parameters of radial and axial flow turbines and radial compressors 3. To define the performance and efficiency of a turbomachine
4. To understand principles of flow theories behind design methodologies.

Contents:

Internal flows in turbomachinery, the design of an axial flow and radial flow turbines, the design of radial compressors, gas turbines, engine power plants, ORC-process and turbomachinery in it, operation of turbomachinery. The course is affiliated on the sustainability of energy systems and based on international scientific research.

Teaching Methods:

1st period, lectures + exercises 6 h, quizzes 4 h, case study 2 h, PBL tutorial 2 h, independent studies 26 h, 2nd period lectures + exercises 12 h, quizzes 6 h, case study 2 h, PBL tutorial 2 h, independent studies 68 h.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, PBL 40%, case 40% and quizzes 20%.

Course Materials:

Material Notebook, Moodle course material: summary, exercises, quizzes.

Prerequisites:

BH40A0801 Turbomachinery attended or ongoing.

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

15-

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

Max 5

BH50A1200: Energy Systems Engineering, 6 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: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Juha Kaikko, D.Sc. (Tech.) Ekaterina Sermyagina

Aims:

Upon completion of thecourse the student will be able to 1. describe different types of energy production processes, 2. utilize thermodynamics and heat and mass balances inthe design of small scale energy systems, 3. use a “Systems Engineering” type approach to define the design values for energy production processes, 4. define small scale bioenergy production projects, 5. understand how plant requirements affect the planning and implementation phases of small energy systems, and 6. define economic constraints to small scale energy processes.

Contents:

History and fundamentals of thermodynamics and energy engineering. Modern problems of power plan tengineering. Combined heat and power production, especially from biomass. Fundamentals of steam and gas turbines in energy production. Engineering design: heat and mass balances in the design of small scale energy systems. Systems engineering. Planning and implementation of energy systems. Economic optimization of energy system projects.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises.Written assignment, written examination. Independent study approximately:Written assignment 80 h. Preparation for the examination 16 h and the examination3 h. Studying given material 33 h.
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 50 %,written assignment 50 %.

Course Materials:

Lecture notes.

Prerequisites:

Understanding of basic thermodynamics.

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

max 5

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

max 5

BH50A1400: Steam Boilers, 6 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: Esa Vakkilainen

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student will be able to 1. list typical biomass fuels and their properties, 2. understand the terminology used in maintenance management, 3. understand steam generation processes, especially from biomass, 4. describe the construction of steam boilers, 5. apply different types of steam boilers using different types of fuels, and 6. realize restrictions caused by corrosion, erosion and fouling.

Contents:

Characteristics of fuels, especially of biofuels. Combustion and gasification. Design of a steam boiler and its components. CCS. Energy balances. Solving steam boiler problems by mathematical modelling and algorithmization. Operation and maintenance of boilers: corrosion, fouling, emissions.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises. Written assignment. Independent study approximately: Written assignment 48 h. Preparation for the examination 18 h and the examination 3 h. Studying given materials 63 h.
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 70 %, written assignment 30 %.

Course Materials:

Lecture notes.
Teir, Sebastian: Steam Boiler Technology, 2nd ed. 2006.
Vakkilainen, Esa, Steam generation from Biomass, 2016.

Prerequisites:

Recommended: BH50A1200 Energy Systems Engineering.

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

max 5

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

max 5

BH50A1500: Bioenergy Technology Solutions, 6 cr

Validity: 01.08.2010 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Esa Vakkilainen

Year:

M.Sc. (Tech.) 2

Period:

2-3

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student will be able to 1. discuss the EU bioenergy policies including the effects of carbontrading, RES and energy efficiency, 2. understand the role and limitations of bioenergy use in Europe, 3. create a strategic vision for any country to usebioenergy, 4. understand different bioenergy generation technologies, and 5. list the biofuel production technologies, and 6. Independently follow discussions around future directions of Bioenergy technology. Independent creation of large report.

Contents:

Comparison of various bioenergy visions. Technological solutions and case studies from biomass supply and biofuelrefining, end-use technologies of biofuels in different sectors. Bioenergy challenges. Bioenergy politics.

Teaching Methods:

12 h of lectures. Group assignment. Written examination. Independent study approximately: Written assignment 48 h. Preparation for the examination 16 h + the examination 3 h. Studying given materials 77 h.
Total workload 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 60 %, assignment 40 %.

Course Materials:

Lecture notes.

Prerequisites:

BH61A0600 Bioenergy.

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

No

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

max 5

BH61A0600: Bioenergy, 3 cr

Validity: 01.08.2011 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Tapio Ranta

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Tapio Ranta, D.Sc. (Tech.), Professor

Aims:

Upon completion of the course the student will be able to understand the meaning of bioenergy, alternative biomass resources,supply methods, refining and end-user applications; describe the quality properties of solid biofuels and how they are measured and evaluated by using standards; and explain the meaning of sustainability in bioenergy systems.

Contents:

The role of bioenergy in the EU energy policy,incentive programmes and future plans. Raw-material sources of bioenergy, potential resources and current use. Biomass supply systems and logistics. Refined biofuel commodities, biogas and liquid biofuels. Biomass international trade. Quality properties of solid biofuels, quality measurement and standards. Sustainable bioenergy.

Teaching Methods:

1st period: 12 h of lectures. Written examination 3 h. 63 h of self-study.
Total workload 78 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:

Energy Visions 2050, VTT. 2009. Chapters 2, 4.4, 5.2- 5.4.
Additional material will be announced later during lectures.

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

15–

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

max 5

Choose enough selectable courses to attain a min. of 72 ECTS in specialisation studies.

BH30A0302: Nuclear Power Plant Engineering, 6 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Anne Jordan, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to explain the functional principles of nuclear power plants and perform engineering design of main heat transfer and power conversion processes. The student will learn elements of engineering design of light water reactor plants process components (excluding the reactor core) and radiation shielding. The student understands nuclear fuel cycle and related technologies, can manage nuclear waste and apply nuclear safety principles.

Contents:

Nuclear reactor as heat source. Power conversion in light water reactor power plants. Main process systems and safety systems of light water reactors. Health effects of ionising radiation, radiation protection. Nuclear fuel cycle, nuclear waste management. Nuclear safety in design, major nuclear accidents.

Teaching Methods:

Lectures 14 h, tutorials 14 h, presentation 25 h, independent study 22 h, interim exam 3 h, 3rd period. Lectures 14 h, tutorials 14 h, assignment 25 h, independent study 22 h, interim exam 3 h, 4th period. Assignment and presentation. Two written interim exams or one written final examination. Total workload 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:

2

Assessment:

0-5. Written examination 70 %, assignment and presentation 30 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy or equivalent skills. BH30A0201 Nuclear Reactor Design recommended.

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

max 10

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

max 5

BH40A1570: Advanced Computational Fluid Dynamics, 5 cr

Validity: 01.01.2018 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Assoc. Prof. (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti
M.Sc. (Tech.) Alireza Ameli

Aims:

The aim of the course is to acquaint students with the numerical simulations of multiphase and real gas flows, condensation, advance heat transfer (multi-fluid) and turbomachinery. After completing the course, students are able to simulate above-mentioned flow using a CFD software and write own functions to a CFD software. In addition, students are able to identify the limitations and simplifications of numerical simulations related to problems.

Contents:

Advanced topics of computational fluid dynamics. Multiphase flows. Real gasmodels. Condensation. Multi-fluid heat transfer. Turbomachinery. Meshing. Implementation of functions to a CFD software. Transient multi-domain simulation.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of exercises. 4th period: 12 h of lectures, 12 h of exercises. Homeworks 24 h. Project works 58 h.
Total workload 130 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5. Homeworks 50% and project works 50%.

Course Materials:

Material in course's Moodle page. Notes done by the lecturers.

Prerequisites:

BH40A1560 Fundamentals of Computational Fluid Dynamics or equivalent knowledge.

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

Max. 10

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

Max. 10

BH40A1800: Steam Turbines, 3 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: Aki-Pekka Grönman, Juhani Hyvärinen, Teemu Turunen-Saaresti

Year:

M.Sc. (Tech.) 2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Aki Grönman, D.Sc., Associate professor

Aims:

Upon completion of the course the students are able to: 1. Understand how the size of the turbine affects the design 2. Understand what requirements different power plants have for steam turbines and how turbines are connected to other parts of the plant 3. Understand the fundamentals of condensation in steam turbines 4. Understand the aerodynamic design principles of steam turbines.

Contents:

Influence of turbine size on the design and construction, turbines in different power plants, condensation in turbines, steam turbine aerodynamics, hood, and condenser.

Teaching Methods:

Lectures 14 h, exercises 14 h, Quizzes 8 h, Home assignments 14 h, Group assignment 28 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Quizzes 20%, Assignments 80%.

Course Materials:

Lecture material in Moodle.

Prerequisites:

Recommended course BH40A0801 Turbomachinery or similar knowledge.

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

15–

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

max 5

BH50A1701: District Heating, 4 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Esa Vakkilainen, D.Sc. (Tech.) Jussi Saari

Aims:

Upon completion of the course the student will be able to 1. describe the basics of district heating in the world and in Finland, 2. explain the technical solutions of generating and delivering district heating at a detailed level, do engineering design to 3. dimension heat output and annual thermal energy necessary for various heating applications, 4. dimension the district heating system and its components, 5. understand and calculate various losses, 6. evaluate the basic design and use of district heating networks and heat production.

Contents:

The formation of energy demand in buildings and the consumption variation. Consumer devices, connections and energy measurement. Abitility to design piping as well as network planning and control. Production of district heating, district heating plants and heating power plants. Cost and tariffs for district heating.

Teaching Methods:

3rd period: 10 h of lectures. Independent study 14 h. Independent calculations and online tasks 20 h. 4th period: Written assignment 48 h. Evaluating assignments 12 h.
Total workload 104 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Written assignment 60 %, independent calculations and online tasks 40 %.

Course Materials:

Frederiksen, Svend and Werner, Sven: District Heating and Cooling, Studentlitteratur, 2014.
Koskelainen, Lasse et al.: Kaukolämmön käsikirja, Energiateollisuus, 2006.
Lecture notes.

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

Yes, 5

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

Yes, 5

BH61A0201: Energy Economics, 5 cr

Validity: 01.01.2018 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Tapio Ranta

Aims:

Upon completion of the course the students will be able to utilise energy economic calculation methods and to calculate the additional cost in the energy production costs caused by emission trading. Students will be able to describe the basic concepts of Finnish energy economics and explain the structure of energy taxation in Finland, and calculate the energy taxes of fuels. Students will understand the structure of energy tariffs, and will be able to compile a duration curve of the consumption curve of energy.

Contents:

Use of energy statistics. The variation in energy demand and duration curves. Calculation methods for energy production costs. Profitability calculations of energy projects. Environmental impacts in energy production, especially carbon dioxide emissions. Energy and fuel markets. The effect of emission trading on the price of electricity, and energy tariffs. Energy taxation and the pricing system of natural gas. Energy economics in Finland and EU. The need for investments in electricity production. National energy and climate strategy. Fuel economics. Energy scenarios.

Teaching Methods:

3rd period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. 4th period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. Written examination. 98 h of self-study.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Examination 80%, homework 20 %.

Course Materials:

Material on Moodle.

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

15–

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

max 5

BH70A0101: Advanced Modelling Tools for Transport Phenomena, 5 cr

Validity: 01.08.2009 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Timo Hyppänen, Payman Jalali

Year:

M.Sc. (Tech.) 1-2

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Timo Hyppänen, Docent, D.Sc. (Tech.) Payman Jalali

Aims:

Transport phenomena are dealing with the heat, mass and momentum transfer in engineering and science. In this course, advanced modeling tools and methods are introduced for students of energy technology and other departments with related background in heat transfer and fluid dynamics. Students will learn how the related computer packages such as FLUENT, COMSOL Multiphysics and MATLAB can be used to solve and analyze heat transfer and fluid flow problems using computational fluid dynamics (CFD). This course provides a mathematical basis for problem formulation, and coding /solving using the above-mentioned computational packages. Students will learn how to solve simple transport problems using their own codes in MATLAB. Then more complex problems will be taught to solve using COMSOL and FLUENT packages. Upon completion of this course, they will be able to start working on various topics in heat and fluid flow engineering for advanced designs or analysis.

Contents:

Introduction to ‘transport phenomena’ and related problems, feeding problems into CFD algorithms and methods (discretization of equations and domains, transforming differential equations into algebraic equations etc.), diffusion and convection equations solved by finite
difference and finite volume methods, complexities due to property variation, geometry and boundary conditions, application of computational packages (such as MATLAB, FLUENT, COMSOL Multiphysics etc.) in solving transport phenomena problems.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of exercises. 4th period: 12 h of lectures, 12 h of exercises. 3 - 6 homeworks and 2 projects.
Total workload 130 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):

Yes

Assessment:

0 - 5. Examination 40 %, homeworks and projects 60 %.

Course Materials:

J.D. Anderson: Computational Fluid Dynamics, McGraw-Hill, Inc. 1995.
D.A. Anderson, J.C. Tannehill, R.H. Pletcher: Computational Fluid Mechanics and HeatTransfer, McGraw-Hill, Inc. 1984.
J.H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics, Springer-Verlag 1996.
C. Hirsch: Numerical Computation of Internal and External Flows, Volume 1: Fundamentals of Numerical Discretization, John Wiley & Sons, 1988.
MATLAB user manual. FLUENT user manual. COMSOL Multiphysics manual. Moodle.

Prerequisites:

Basic knowledge on programming using MATLAB or any other language. Basic Fluid Mechanics and Heat Transfer courses passed.

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

max 10

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

max 5

BH70A0200: Advanced Topics in Modelling of Energy Systems, 6 cr

Validity: 01.08.2010 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Juha Kaikko, Tero Tynjälä, Juhani Vihavainen, Teemu Turunen-Saaresti, Timo Hyppänen, Jouni Ritvanen, Esa Vakkilainen

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Jouni Ritvanen

Aims:

Upon completion of the course the student will be able to: 1. create stationary and time dependent mass, momentum and energy balances for various kinds of energy systems, 2. perform design tasks, utilize mathematical software in calculation, and analyze the characteristics of
energy systems, 3. include material property definitions into mathematical software or into own code when simulating energy systems, 4. create, solve and analyze the set of stationary and time dependent balance equations using Excel and MATLAB, 5. create, solve and analyze stationary energy systems with IPSEpro software package, and 6. create, solve and analyze time dependent energy systems with APROS software package.

Contents:

Advanced problems in the modelling of energy systems needed by engineers and researchers. The course lectures provide mathematical basis for problem formulation, and exercises providing a chance to work with various computational packages.

Teaching Methods:

1st period: 14 h of lectures and 14 h of case exercises. 2nd period: 12 h of lectures, 12 h of case exercises and 4 h of seminars. Individual work: Written assignments 52 h. Seminar work 48 h. Total individual work 100 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. Written assignments 60 %, seminar work 40 %.

Course Materials:

Moodle.

Prerequisites:

BH20A0450 Heat Transfer, BH20A0800 Engineering Thermodynamics, BH40A1451 Fluid Dynamics II, or similar skills.

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

max 10

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

max 5

BL20A0401: Electricity Market, 5 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: Samuli Honkapuro

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Associate Professor, D.Sc. (Tech.) Samuli Honkapuro

Aims:

Upon completion of the course the student will be able to: 1. describe the characteristics of the different business sectors in the Nordic electricity market, 2. explain electricity price formation, 3. explain the operation principle of the power exchange, 4. identify and describe
the products of the power exchange, 5. select the right risk management method for electricity trade, 6. describe the tasks of the different parties in an electric power system in maintaining technical and commercial power balance, including demand side management.

Contents:

The restructuring of the electricity markets, power exchange, electricity trade, balance management.

Teaching Methods:

28 h of lectures 10 h optional Moodle quizzes 1st period. 89 h independent studies. Written examination 3 h.
Total workload 130 h

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, examination 100%. Non-mandatory Moodle quizzes provide extra points to exam.

Course Materials:

Material distributed in Moodle.

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

15–

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

max 15

BL20A1400: Renewable Energy Technology, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Identify the major renewable energy (RE) conversion technologies, mainly converting resources to electricity. 2. Describe the major characteristics of the technologies, in particular applications, efficiency, economics, industrial scale and future prospects. 3. Analyse the need for storage technologies and their different fields of application based on their key technical and economic features.

Contents:

The course is focused on the conversion of the resources to electricity. The RE technologies discussed in the course are: wind turbines, solar photovoltaics, solar thermal electricity generation and hydro powerplants. The storage technologies covered comprise a general overview and in particular include battery storage, pumped hydro storage and power-to-gas technologies. All technologies are classified with respect to their applications, efficiency, maturity, economics, industrial scaling and expected relevance for the ongoing energy transformation.

Teaching Methods:

3rd period lectures 14 h, exercises 14 h. 4thperiod lectures 14 h, exercises 14 h, examination 3 h.
Independent study 97 h.
Total workload 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:

Material handed out in class and made available on Moodle.

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

15–

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

max 5

BL20A1500: Energy Scenarios, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Describe the sustainability requirements of future energy systems as the major guard rail for the energy transformation. 2. Analyse energy transformation scenarios and identify the key technologies and setups for sustainable energy progress. 3. Describe the energy transformation in all sectors, the major technologies, the required transformation period and entire system cost optimization. 4. Describe the special role of power technologies for the energy transformation. 5. Recognize the difference between standard levelized cost ofenergy and total societal cost of energy.

Contents:

The course comprises the key elements of energy scenarios: demand, supply, cost, constraints. Energy demand is an aggregate of power, heat, cooling, mobility, agriculture and industrial energy needs. The demand has tobe matched with supply of energy fulfilling sustainability criteria, safety requirements and societal acceptance for the least cost. A complete set of demand curves, technical characteristics of all major technologies, current and projected technology costs and emission factors are taken into account for sustainable energy transformation pathway formulation. The special relevance ofwind energy and solar photovoltaics, the increasing relevance of power technologies,the role of storage technologies and the necessity of societal cost of energy are discussed in detail. Real scenarios for Finland, Europe and the World used as references.

Teaching Methods:

1st period lectures 14 h, exercises 14 h. 2ndperiod lectures 14 h, exercises 14 h, presentation/oral examination 1 h. Independent study 99 h. Total workload 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, presentation/oral examination 100 %

Course Materials:

Material handed out in class and made available on Moodle.

Prerequisites:

BL20A1300 Energy Resources and BL20A1400 Renewable Energy Technology (at least one of the two courses)

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

max 15

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

max 5

EnDSNuclear: Specialisation in Nuclear Engineering, 60 cr

Validity: 01.08.2016 -

Form of study:

Type: Study module
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F

No course descriptions.

Master's Thesis and Diplomityö are alternative to each other.Students who have completed BSc at LUT, may do the thesis in Finnish. Students admitted directly to this MSc programme, write the thesis in English.

BH10A1101: Master's Thesis, 30 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Master's Thesis
Unit: LUT School of Energy Systems
Teachers: Ahti Jaatinen-Värri

Year:

M.Sc. (Tech.) 2

Period:

1-4

Teaching Language:

Finnish

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri

Aims:

Upon completion of the course the students will be able to 1. formulate the research problem, 2. select the methods appropriate for the research problem, 3. find sources of information suitable for the research problem, and evaluate their validity and the quality and reliability of the data, 4. utilise and interpret the sources of information correctly, and 5. report the research in writing according to the scientific principles, considering the conventions used within the field of energy technology.

Contents:

The fundamentals of scientific research. Good scientific working methods when setting the research problem, selecting the research methods, and reporting the research, considering the conventions used within the field of energy technology. The utilisation of scientific information
in problem solving. Information literacy. Scientific reports. Information retrieval. Correctness of the language. Master’s thesis.

Teaching Methods:

The work will be arranged with the supervising professor.
Total workload 780 hrs.

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:

No

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

No

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

No

BH10A2000: Master's Thesis, 30 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Master's Thesis
Unit: LUT School of Energy Systems
Teachers: Ahti Jaatinen-Värri

Note:

In Master’s programmes taught in English, the Master’s thesis is always prepared in English.

Year:

M.Sc. (Tech.) 2

Period:

1-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.) Ahti Jaatinen-Värri
Professors of the degree programme

Aims:

Upon completion of the course the students will be able to 1. formulate the research problem, 2. select the methods appropriate for the research problem, 3. find sources of information suitable for the research problem, and evaluate their validity and the quality and reliability of the data, 4. utilise and interpret the sources of information correctly, and 5. report the research in writing according to the scientific principles, considering the conventions used within the field of energy technology.

Contents:

The fundamentals of scientific research. Good scientific working methods when setting the research problem, selecting the research methods, and reporting the research, considering the conventions used within the field of energy technology. The utilisation of scientific information
in problem solving. Information literacy. Scientific reports. Information retrieval. Correctness of the language. Master’s thesis.

Teaching Methods:

The work willbe arranged with the supervising professor.
Total workload 780 hrs.

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:

no

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

No

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

No

Obligatory specialisation studies, including the thesis, of 62 ECTS.

BH30A0201: Nuclear Reactor Design, 6 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Anne Jordan, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to explain physical phenome underlying nuclear reactors, and perform engineering design of a critical nuclear reactor using diffusion theory, and perform thermal engineering design of the reactor core. Students will learn the main characteristics of commercially important nuclear reactor types.

Contents:

Interaction of radiation with matter. Nuclear reactions and their cross sections. Reactor physics, diffusion theory, a simplified criticality calculation. The design principles for the reactor core, thermal dimensioning. An overview at the nuclear power programmes of different countries. Major reactor commercial nuclear types: PWR, BWR, Small Modular Reactors, CANDU and RBMK, gas-cooled reactors, and fast reactors.

Teaching Methods:

Lectures 28 h, tutorials 14 h, country presentation 20 h, preparation for the interim exam 13 h and interim exam 3 h, 1st period. Lectures 14 h, tutorials 14 h, assignment 39 h, preparation for the interim exam 8 h and interim exam 3 h, 2nd period. Assignment and country presentation. Two written interim exams or one written final examination.
Total workload 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:

2

Assessment:

0-5. Written examination 70 %, assignment and country presentation 30 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes.
Lamarsh & Baratta: Introduction to Nuclear Engineering, 3rd edition (2014), where applicable.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy or equivalent skills.

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

max 10

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

max 5

BH30A0302: Nuclear Power Plant Engineering, 6 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Anne Jordan, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to explain the functional principles of nuclear power plants and perform engineering design of main heat transfer and power conversion processes. The student will learn elements of engineering design of light water reactor plants process components (excluding the reactor core) and radiation shielding. The student understands nuclear fuel cycle and related technologies, can manage nuclear waste and apply nuclear safety principles.

Contents:

Nuclear reactor as heat source. Power conversion in light water reactor power plants. Main process systems and safety systems of light water reactors. Health effects of ionising radiation, radiation protection. Nuclear fuel cycle, nuclear waste management. Nuclear safety in design, major nuclear accidents.

Teaching Methods:

Lectures 14 h, tutorials 14 h, presentation 25 h, independent study 22 h, interim exam 3 h, 3rd period. Lectures 14 h, tutorials 14 h, assignment 25 h, independent study 22 h, interim exam 3 h, 4th period. Assignment and presentation. Two written interim exams or one written final examination. Total workload 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:

2

Assessment:

0-5. Written examination 70 %, assignment and presentation 30 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy or equivalent skills. BH30A0201 Nuclear Reactor Design recommended.

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

max 10

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

max 5

BH30A1701: Nuclear Reactor Physics Methods, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Ville Rintala, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 2

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Assistant professor, D. Sc. (Tech.) Heikki Suikkanen, M.Sc. (Tech.) Ville Rintala

Aims:

Upon completion of the course the students will be able to derive the neutron transport equation from the basic physical phenomena, understand the concepts of neutron flux and current, and use simple numerical calculation methods for the neutron flux solution with diffusion approximation.

Contents:

The transport equation for neutrons. The diffusion of neutrons. Two-group diffusion theory. Solution process of reactor core simulator. Simple numerical methods of reactor physics.

Teaching Methods:

Lectures 14 h, tutorials 14 h, computer exercises 4 h, assignment 46 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, assignment 100 %.

Course Materials:

Lecture notes: Leikkonen, Reaktorifysiikka (in Finnish).
Reuss: Neutron Physics. Duderstadt & Hamilton: Nuclear Reactor Analysis, as applicable.
Stacey: Nuclear Reactor Physics, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design and BH30A2104 Nuclear Reactor Dynamics.

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

No

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

max 5

BH30A1801: Nuclear Reactor Physics Analyses, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Ville Rintala

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Assistant professor, D. Sc. (Tech.) Heikki Suikkanen, M.Sc. (Tech.) Ville Rintala

Aims:

Upon completion of the course the students will be able to understand the deterministic reactor physics calculation system: transport codes for fuel bundle calculations and nodal methods for the whole core calculations, design the reactor loading compliant with applicable limitations (In-Core Fuel Management), and carry out simple Monte-Carlo calculations of reactor physics.

Contents:

Preparation of nuclear data. Fuel homogenization. Core simulators. Fuel performance codes. Nuclear criticality safety. Core design.

Teaching Methods:

Lectures 18 h, tutorials 14 h, computer calculations 4 h, preparation for the examination 39 h, written examination 3 h.
Total workload 78 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 %. Possible to raise the grade by tutorials.

Course Materials:

Reuss: Neutron Physics,
Duderstadt & Hamilton: Nuclear Reactor Analysis,
Stacey: Nuclear Reactor Physics, where applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design, BH30A1701 Nuclear Reactor Physics Methods, BH30A2104 Nuclear Reactor Dynamics.

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

No

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

max 5

BH30A1901: Theoretical Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Otso-Pekka Kauppinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA)

Year:

M.Sc. (Tech.) 1

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to understand one-dimensional two-phase flow, heat transfer, boiling and condensation in pipelike geometry, master the basic continuity and constitutive equations for two-phase flow, utilise the basic equations in manual calculations, understand the continuity and constitutive equations used in computer models used in the thermal-hydraulic system codes (APROS/TRACE), and will be aware of elementary multidimensional two-phase flow modelling.

Contents:

The normal use, as well as the thermal hydraulic phenomena in disturbance and accident situations, of the reactor circuit and containment of a nuclear power plant. Continuity equations, closure laws, phenomenological models for phase interactions. Two-phase flow calculations using system codes. Two-phase flow modelling in computational fluid dynamics (CFD).

Teaching Methods:

Lectures 14 h, tutorials 14 h, computer calculations 4 h, preparation for the examination 43 h, written examination 3 h.
Total workload 78 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 %. Possible to raise the grade by tutorials.

Course Materials:

Ghiaasian: Two-Phase Flow, Boiling and Condensation, where applicable.
Todreas, Kazimi: Nuclear Systems I & II, where applicable.
Winterton: Thermal Design of Nuclear Reactors, where applicable.
Wallis: One-dimensional Two-phase flow.

Prerequisites:

BH30A0201 Nuclear Reactor Design

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

max 10

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

max 5

BH30A2001: Computational Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Otso-Pekka Kauppinen, Juhani Vihavainen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Tech.) Juhani Vihavainen

Aims:

Upon completion of the course students will understand basic equations and special features in thermal hydraulic system code modelling. The students are able to use system codes introduced in this course, APROS and TRACE, and understand engineering design and modelling basis.

Contents:

Thermal hydraulic phenomena of nuclear power plant during normal operation and incident and accident situations. Calculation and modelling of a two phase flow in computer codes. Modelling of essential processes in nuclear power plants with APROS and TRACE software and CFD codes.

Teaching Methods:

Lectures 14 h, tutorials 14 h, assignment 40 h, preparation for the examination 7 h, written examination 3 h.
Total workload 78 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 50 %, assignment 50 %.

Course Materials:

Lecture materials. APROS and TRACE code manuals, as applicable.
Todreas, Kazimi: Nuclear Systems I & II, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design and BH30A1901 Theoretical Nuclear Thermal Hydraulics.

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

No

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

max 5

BH30A2104: Nuclear Reactor Dynamics, 2 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Heikki Suikkanen, Juhani Hyvärinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Assistant professor, D.Sc. (Tech.) Heikki Suikkanen

Aims:

Upon completion of the course the student will be able to explain nuclear reactor kinetics and related feedback mechanisms, principles of nuclear reactor control, and principles of efficient nuclear fuel utilisation.

Contents:

Nuclear reactor dynamic response and control. Neutron sources, approach to criticality, reactivity feedbacks in critical reactors, reactivity excursions, reactor power management, reactor poisons, fuel burnup management.

Teaching Methods:

Lectures 14 h, tutorials and homeworks 22 h, preparation for the examination 13 h, written examination 3 h.
Total workload 52 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 %. Possible to raise the grade by homeworks.

Course Materials:

Lecture notes.
Reuss: Neutron Physics, Part I, as applicable.
Lamarsh & Baratta: Introduction to Nuclear Engineering, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design

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

max 5

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

max 5

BH30A2200: Experimental Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2014 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Juhani Vihavainen, Otso-Pekka Kauppinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to describe basic measurement techniques for one- and two-phase flows, understand similitude and scaling, perform engineering design of downscaled models, understand the interaction between experiments and computer code calculations, describe advanced flow structure mapping techniques (e.g. wire mesh sensing, particle image velocimetry).

Contents:

Temperature, pressure, pressure drop, liquid level and flow measurement techniques. Void fraction measurement. Similitude, scaling principles. Model design. Designing experiments for computer code validation. Advanced flow structure measurement techniques.

Teaching Methods:

Lectures 14 h, tutorials 14 h, laboratory demonstrations 16 h, computer calculations 4 h, quiz 8 h, writing reports 22 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5. Quiz 25%, reports of laboratory works 75%.

Course Materials:

Ghiaasian: Two-Phase Flow, Boiling and Condensation, as applicable.

Prerequisites:

BH40A0701 Measurements in Energy Technology or equivalent course experience.

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

max 5

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

max 5

BH40A1800: Steam Turbines, 3 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: Aki-Pekka Grönman, Juhani Hyvärinen, Teemu Turunen-Saaresti

Year:

M.Sc. (Tech.) 2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Aki Grönman, D.Sc., Associate professor

Aims:

Upon completion of the course the students are able to: 1. Understand how the size of the turbine affects the design 2. Understand what requirements different power plants have for steam turbines and how turbines are connected to other parts of the plant 3. Understand the fundamentals of condensation in steam turbines 4. Understand the aerodynamic design principles of steam turbines.

Contents:

Influence of turbine size on the design and construction, turbines in different power plants, condensation in turbines, steam turbine aerodynamics, hood, and condenser.

Teaching Methods:

Lectures 14 h, exercises 14 h, Quizzes 8 h, Home assignments 14 h, Group assignment 28 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Quizzes 20%, Assignments 80%.

Course Materials:

Lecture material in Moodle.

Prerequisites:

Recommended course BH40A0801 Turbomachinery or similar knowledge.

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

15–

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

max 5

Choose enough courses to attain a min. of 72 ECTS in specialisation studies.

BH30A0600: Radiation Protection, 3 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: Juhani Hyvärinen, Elina Hujala

Note:

The course will be lectured every other year, next during the academic year 2019-2020.
In the course it is possible to take the qualification of radiation safety officer.

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

Yes, 2019-2020.

Year:

M.Sc. (Tech.) 1-2

Period:

2

Teaching Language:

Finnish

Teacher(s) in Charge:

Assistant professor, D.Sc.(Tech.) Heikki Suikkanen, M.Sc.(Tech), M.Sc. Elina Hujala

Aims:

Upon completion of the course students will be able to act as a radiation protection manager as mentioned in the radiation act for sealed sources and industrial radiography.

Contents:

Lectures on radiation protection and safety.

Teaching Methods:

Lectures 28 h, tutorials 14 h, laboratory work 4 h, assignment 21 h, preparation for the examination 8 h and written examination 3 h. Total workload 78 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 %. Possible to raise the grade by tutorials.

Course Materials:

Lecture notes. Radiation and Nuclear Safety Authority, Finland: Säteily- and ydinturvallisuus, where applicable, as well as the valid legislation and the related radiation safety regulations.

Prerequisites:

BH30A0001 Introduction to Nuclear Energy.

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

No

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

max 5

BH30A0701: Reliability Engineering, 4 cr

Validity: 01.08.2014 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Juhani Hyvärinen, Elina Hujala

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:

1-2

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Tech.) Juhani Vihavainen, M.Sc. (Tech.), M.Sc. Elina Hujala.

Aims:

Upon completion of the course students will be able to calculate the reliability parameters for separate components and simple systems, formulate and solve fault and event trees for systems, and estimate the effect of human factors.

Contents:

Introduction to reliability engineering. Boolean algebra. The reliability parameters of components. The reliability engineering structure of systems, examples from different fields. Structural functions, reliability flow charts, fault trees, event trees, minimal cut sets. The reliability parameters of systems and their determination using different methods. Damage and effect analysis. The determination of parameters and trends from flaw observations. The improvement of the usage reliability of a system. Humans as a part of systems. Common mode failures and uncertainty analyses. The reliability of structures.

Teaching Methods:

Lectures 21 h, tutorials 14 h, 1st period. Lectures 21 h, tutorials 14 h, 2nd period. Preparation for the examination 31 h and written examination 3 h.
Total workload 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 100 %. Possible to raise the grade by tutorials.

Course Materials:

Rausand M. & Hoyland A: System Reliability Theory, Models, Statisticals Methods and Applications.

Prerequisites:

Recommended BM20A1401 Tilastomatematiikka I or equivalent knowledge.

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

max 10

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

max 5

BH40A1501: Turbulence Models, 4 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Teemu Turunen-Saaresti

Year:

M.Sc. (Tech.) 2

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti

Aims:

Upon completion of the course the student will be able to recognize the characteristics of turbulence models and to estimate the suitability of different turbulence models for various fluid mechanical problems. In addition, the student will be able to interpret the physical basis and the theory of turbulence models.

Contents:

Navier-Stokes equations, RANS equations, Reynolds stress, eddy viscosity, algebraic, one equation and two equation models and advanced models.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of tutorials. 4th period: 12 h of lectures, 12 h of tutorials. Homeworks 20 h, Project work 36 h.
Total workload 104 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. Homeworks 30%, project work 70%.

Course Materials:

David C. Wilcox: Turbulence models for CFD.

Prerequisites:

BH70A0001 Numerical Methods in Heat Transfer or equivalent knowledge.

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

max 5

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

max 5

BH40A1570: Advanced Computational Fluid Dynamics, 5 cr

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

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Assoc. Prof. (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti
M.Sc. (Tech.) Alireza Ameli

Aims:

The aim of the course is to acquaint students with the numerical simulations of multiphase and real gas flows, condensation, advance heat transfer (multi-fluid) and turbomachinery. After completing the course, students are able to simulate above-mentioned flow using a CFD software and write own functions to a CFD software. In addition, students are able to identify the limitations and simplifications of numerical simulations related to problems.

Contents:

Advanced topics of computational fluid dynamics. Multiphase flows. Real gasmodels. Condensation. Multi-fluid heat transfer. Turbomachinery. Meshing. Implementation of functions to a CFD software. Transient multi-domain simulation.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of exercises. 4th period: 12 h of lectures, 12 h of exercises. Homeworks 24 h. Project works 58 h.
Total workload 130 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5. Homeworks 50% and project works 50%.

Course Materials:

Material in course's Moodle page. Notes done by the lecturers.

Prerequisites:

BH40A1560 Fundamentals of Computational Fluid Dynamics or equivalent knowledge.

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

Max. 10

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

Max. 10

BH50A1200: Energy Systems Engineering, 6 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: Esa Vakkilainen, Juha Kaikko

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Juha Kaikko, D.Sc. (Tech.) Ekaterina Sermyagina

Aims:

Upon completion of thecourse the student will be able to 1. describe different types of energy production processes, 2. utilize thermodynamics and heat and mass balances inthe design of small scale energy systems, 3. use a “Systems Engineering” type approach to define the design values for energy production processes, 4. define small scale bioenergy production projects, 5. understand how plant requirements affect the planning and implementation phases of small energy systems, and 6. define economic constraints to small scale energy processes.

Contents:

History and fundamentals of thermodynamics and energy engineering. Modern problems of power plan tengineering. Combined heat and power production, especially from biomass. Fundamentals of steam and gas turbines in energy production. Engineering design: heat and mass balances in the design of small scale energy systems. Systems engineering. Planning and implementation of energy systems. Economic optimization of energy system projects.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises.Written assignment, written examination. Independent study approximately:Written assignment 80 h. Preparation for the examination 16 h and the examination3 h. Studying given material 33 h.
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 50 %,written assignment 50 %.

Course Materials:

Lecture notes.

Prerequisites:

Understanding of basic thermodynamics.

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

max 5

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

max 5

BH50A1400: Steam Boilers, 6 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: Esa Vakkilainen

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor D.Sc. (Tech.) Esa Vakkilainen

Aims:

Upon completion of the course the student will be able to 1. list typical biomass fuels and their properties, 2. understand the terminology used in maintenance management, 3. understand steam generation processes, especially from biomass, 4. describe the construction of steam boilers, 5. apply different types of steam boilers using different types of fuels, and 6. realize restrictions caused by corrosion, erosion and fouling.

Contents:

Characteristics of fuels, especially of biofuels. Combustion and gasification. Design of a steam boiler and its components. CCS. Energy balances. Solving steam boiler problems by mathematical modelling and algorithmization. Operation and maintenance of boilers: corrosion, fouling, emissions.

Teaching Methods:

1st period: 12 h of lectures and case exercises. 2nd period: 12 h of lectures and case exercises. Written assignment. Independent study approximately: Written assignment 48 h. Preparation for the examination 18 h and the examination 3 h. Studying given materials 63 h.
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 70 %, written assignment 30 %.

Course Materials:

Lecture notes.
Teir, Sebastian: Steam Boiler Technology, 2nd ed. 2006.
Vakkilainen, Esa, Steam generation from Biomass, 2016.

Prerequisites:

Recommended: BH50A1200 Energy Systems Engineering.

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

max 5

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

max 5

BH61A0201: Energy Economics, 5 cr

Validity: 01.01.2018 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Tapio Ranta

Aims:

Upon completion of the course the students will be able to utilise energy economic calculation methods and to calculate the additional cost in the energy production costs caused by emission trading. Students will be able to describe the basic concepts of Finnish energy economics and explain the structure of energy taxation in Finland, and calculate the energy taxes of fuels. Students will understand the structure of energy tariffs, and will be able to compile a duration curve of the consumption curve of energy.

Contents:

Use of energy statistics. The variation in energy demand and duration curves. Calculation methods for energy production costs. Profitability calculations of energy projects. Environmental impacts in energy production, especially carbon dioxide emissions. Energy and fuel markets. The effect of emission trading on the price of electricity, and energy tariffs. Energy taxation and the pricing system of natural gas. Energy economics in Finland and EU. The need for investments in electricity production. National energy and climate strategy. Fuel economics. Energy scenarios.

Teaching Methods:

3rd period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. 4th period: 8 h of lectures, 6 h of exercises, homework based on lectures and exercises. Written examination. 98 h of self-study.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Examination 80%, homework 20 %.

Course Materials:

Material on Moodle.

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

15–

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

max 5

BL20A0401: Electricity Market, 5 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: Samuli Honkapuro

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Associate Professor, D.Sc. (Tech.) Samuli Honkapuro

Aims:

Upon completion of the course the student will be able to: 1. describe the characteristics of the different business sectors in the Nordic electricity market, 2. explain electricity price formation, 3. explain the operation principle of the power exchange, 4. identify and describe
the products of the power exchange, 5. select the right risk management method for electricity trade, 6. describe the tasks of the different parties in an electric power system in maintaining technical and commercial power balance, including demand side management.

Contents:

The restructuring of the electricity markets, power exchange, electricity trade, balance management.

Teaching Methods:

28 h of lectures 10 h optional Moodle quizzes 1st period. 89 h independent studies. Written examination 3 h.
Total workload 130 h

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, examination 100%. Non-mandatory Moodle quizzes provide extra points to exam.

Course Materials:

Material distributed in Moodle.

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

15–

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

max 15

BL20A1400: Renewable Energy Technology, 6 cr

Validity: 01.08.2015 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Identify the major renewable energy (RE) conversion technologies, mainly converting resources to electricity. 2. Describe the major characteristics of the technologies, in particular applications, efficiency, economics, industrial scale and future prospects. 3. Analyse the need for storage technologies and their different fields of application based on their key technical and economic features.

Contents:

The course is focused on the conversion of the resources to electricity. The RE technologies discussed in the course are: wind turbines, solar photovoltaics, solar thermal electricity generation and hydro powerplants. The storage technologies covered comprise a general overview and in particular include battery storage, pumped hydro storage and power-to-gas technologies. All technologies are classified with respect to their applications, efficiency, maturity, economics, industrial scaling and expected relevance for the ongoing energy transformation.

Teaching Methods:

3rd period lectures 14 h, exercises 14 h. 4thperiod lectures 14 h, exercises 14 h, examination 3 h.
Independent study 97 h.
Total workload 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:

Material handed out in class and made available on Moodle.

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

15–

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

max 5

BL20A1500: Energy Scenarios, 6 cr

Validity: 01.08.2015 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Describe the sustainability requirements of future energy systems as the major guard rail for the energy transformation. 2. Analyse energy transformation scenarios and identify the key technologies and setups for sustainable energy progress. 3. Describe the energy transformation in all sectors, the major technologies, the required transformation period and entire system cost optimization. 4. Describe the special role of power technologies for the energy transformation. 5. Recognize the difference between standard levelized cost ofenergy and total societal cost of energy.

Contents:

The course comprises the key elements of energy scenarios: demand, supply, cost, constraints. Energy demand is an aggregate of power, heat, cooling, mobility, agriculture and industrial energy needs. The demand has tobe matched with supply of energy fulfilling sustainability criteria, safety requirements and societal acceptance for the least cost. A complete set of demand curves, technical characteristics of all major technologies, current and projected technology costs and emission factors are taken into account for sustainable energy transformation pathway formulation. The special relevance ofwind energy and solar photovoltaics, the increasing relevance of power technologies,the role of storage technologies and the necessity of societal cost of energy are discussed in detail. Real scenarios for Finland, Europe and the World used as references.

Teaching Methods:

1st period lectures 14 h, exercises 14 h. 2ndperiod lectures 14 h, exercises 14 h, presentation/oral examination 1 h. Independent study 99 h. Total workload 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, presentation/oral examination 100 %

Course Materials:

Material handed out in class and made available on Moodle.

Prerequisites:

BL20A1300 Energy Resources and BL20A1400 Renewable Energy Technology (at least one of the two courses)

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

max 15

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

max 5

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

KeSoD500: Advanced Chemistry, 20 - 25 cr

Validity: 01.08.2018 -

Form of study:

Type: Study module

Unit: LUT School of Engineering Science

Grading: Study modules 0-5,P/F

Aims:

After the completion of the minor in Advanced Chemistry the student
• has acquired a basic knowledge of the fundamental concepts of chemistry relevant to the major
• can apply his/her knowledge to select and to evaluate analytical or instrumental methodology in chemical analysis
• demonstrates sufficient knowledge to be applied in analytical work.

Choose a min. of 20 ECTS

BJ02A1012: Concepts of Analytical and Inorganic Chemistry, 5 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:

The course is suitable for distance learning.

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Satu-Pia Reinikainen, D.Sc. (Tech.), Professor
Tiina Virtanen, M.Sc., Junior Researcher

Aims:

By the end of the course, the student is expected to
- have acquired a basic knowledge of the fundamental concepts of inorganic chemistry relevant to the major

- be able to apply analytical methodology or the principles of selected instrumental methods in chemical analysis.

Contents:

This course contains two independent modules.1) Inorganic chemistry module is designed to prepare students for further study in inorganic chemistry or, more generally, employment in physical ormaterials science fields. The content include advanced concepts in structure, bonding, and chemical/physical properties of inorganic compounds, understanding of which is central to the study of all areas of chemistry. 2) Analytical chemistry module covers design, operational principles and application of modern instrumental methods used in chemical analysis via case studies. There are literature recommended for each module, and online interactive assignments. Students will work in small groups on the topic selected. The course is suitable for distance learning.

Teaching Methods:

Module 1: Assignments 20 h, discussions 10 h, peer feedback 10 h, Moodle quiz 5 h, online independent study 20 h, Module 2: Assignments 40 h, peer feedback and Moodle quiz 5 h, online independent study 20 h. Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

Numerical assessment (0-5), Module 1/2 50 %/50 % of total (assignments 60 %, online quizzes, peer feedback 40 %).

Course Materials:

Module 1: List of text books available in Moodle, Module 2: online material via Moodle.

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

max 10

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

max 10

BJ02A1600: Biobased Materials and Advanced Organic Chemistry, 5 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

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Arto Pihlajamäki, D.Sc. (Tech.), Researcher/Teacher
Tiina Virtanen, M.Sc. (Tech.), Junior Researcher

Aims:

By the end of the course, a student is expected to:
- gain the basic chemical and technological understanding of the production of most important bioproducts from renewable resources
- be able to apply fundamental concepts of organic chemistry into application of biopolymers and their reactions.

Contents:

This course contains two modules. Biobased Materials module will introduce novel biomaterials and focus on properties of biobased polymers, their processing, reactions and applications. Advanced Organic Chemistry module gives extended knowledge in the structure and reactivity of organic biomolecules. There are lists of literature recommended for each module. Students will work in small groups on selected topics.

Teaching Methods:

Moodle lessons: Module 1 60 h, Module 2 60 h, 4th period. Quizzes and activities in Moodle 10 h. Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

0-5, Moodle exam, assignments and fulfilled activities in Moodle, project work reports in Modules 1 and 2.

Course Materials:

To be announced.

Prerequisites:

BJ01A1040 Orgaanisen kemian perusteet (Basic Organic Chemistry) or equivalent knowledge.

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

Yes, 50, Students in Chemical Engineering M.Sc. programme.

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

max 5

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

max 5

BJ02A1031: Solution Chemistry, 5 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:

Starting from the academic year 2019-2020.

Year:

M.Sc. (Tech.) 2

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

N.N.

Aims:

Upon completion of the module, the student has a deeper understanding on solution chemistry and the student is capable to evaluating the thermodynamic properties of electrolyte and nonelectrolyte solutions in the modern way.

Contents:

Ideal, ideally dilute, and real solutions. Experimental methods for measuring the activity and osmotic coefficients in solutions. The Debye-Hückel theory for electrolyte solutions. Pitzer equations for real electrolyte solutions. Concepts and equations needed in and associated with the thermodynamic formulation of the surface. Surfaces in electrolyte solutions and electrical double layer.

Teaching Methods:

Lectures 28 h, exercises 14 h, 1st period. Selfstudy 88 h. Total workload 130 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):

Yes

Examination in Exam (Yes/No):

No

Assessment:

Written examination 50%, Moodle assignments 50 %.

Course Materials:

Lecture notes and problems solution manuals based on the for example on the following textbooks:
Peter Atkins, Julio de Paula, and James Keeler. Atkins' Physical Chemistry, 11th Edition, 2017, Oxford University Press.
Kenneth Pitzer (edited), Activity Coefficients in Electrolyte Solutions, 2nd Edition, 2000, CRC Press, Boca Raton.

Prerequisites:

BJ01A3010 Kemiallinen termodynamiikka (Chemical Thermodynamics) or equivalent studies.

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

max 10

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

max 5

BJ02A4070: Principles of Thermal Gas-Liquid Processes, 5 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

Year:

M.Sc. (Tech.) 1

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Tuomas Koiranen

Aims:

Student understands distillation, evaporation and gas scrubbing technologies, including equipment structures and sizing principles. Student can design gas-liquid contactors by hand, is able to form mathematical calculation models, and can apply equations for computer simulation.

Contents:

Gas-liquid contactor theory, sizing principles and equations, calculation examples, computer exercises. Distillation, evaporation, gas scrubbing.

Teaching Methods:

Combined lectures and exercises 10 h, homeworks 72 h, self learning 48 h.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

Examination grading scale 0-5. minimum 75 % of homeworks correct, returning to moodle.

Course Materials:

Course books:
Niket S. Kaisare, Computational Techniques for Process Simulation and Analysis Using MATLAB®, Taylor&Francis, 2017
Hussein K. Abdel-Aal, Chemical Engineering Primer with Computer Applications, Taylor&Francis, 2016
Felder, R.M., Elementary Principles of Chemical Processes, Wiley, 2004

Prerequisites:

BM20A1501 Numerical Methods or equivalent, BM20A4301 Introduction to Technical Computation or equivalent

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

max 10

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

max 5

BJ03A1040: Advanced Materials in Adsorption and Ion Exchange, 5 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Engineering Science

Grading: Study modules 0-5,P/F

Teachers: Chaker Necibi, Mika Sillanpää

Note:

Suitable also for distance learning.

Year:

M.Sc. (Tech.) 1

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Mika Sillanpää
Post-doctoral researcher, D.Sc. (Tech.) Chaker Necibi

Aims:

By the end of the course, the student is expected to be able to: - describe the conventional and novel adsorption and ion-exchange materials - describe the conventional and novel applications of adsorption and ion-exchange - select a suitable adsorption/ion-exchange material for a particular purpose - understand the surface reactions in sorption processes - use theoretical models to describe adsorption kinetics, isotherms and thermodynamics - solve problems through PBL group work.

Contents:

Learning the types and properties of conventional and novel adsorption and ion-exchange materials and their applications in water treatment. Learning to evaluate the economic and environmental aspects of the production and use of different sorption materials. Learning the
surface reactions and theories behind the sorption phenomena. Both individual and group work including PBL-method, exercises and modeling calculations will be conducted.

Teaching Methods:

Lectures and exercises 20 h, PBL group work 12 h, 2nd period. Preparation for the exam, PBL work, independent workload 98 h.
Total workload 130 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

0-5, exam 50%, PBL group work 30% and homework 20%.

Course Materials:

Lecture notes. Moodle.

Prerequisites:

BJ03A1010 Introduction to Advanced Water Treatment

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

max 10

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

max 5

KoDSaMate: Advanced Materials Engineering, 20 - 30 cr

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

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

Obligatory Studies 25 ECTS cr

BK90C1900: Introduction to Materials Engineering, 4 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Timo Kärki

Year:
M.Sc. (Tech.) 1-2
Period:
2
Teaching Language:
English
Teacher(s) in Charge:
Professor, D.Sc. (Tech.) , D.Sc. (Agr. & For.) Timo Kärki
Aims:
Aim of the course is to introduce possibilities of Material Engineering to students. Diverse possibilities of different materials is taken into consideration when optimizing the variable possibilities in Product Designing. After having completed this course, the student should be able to: understand the influence of material selection to the product design recognize the variable possibilities of different materials show creative and innovative expertise in the field of Materials Engineering.
Contents:
Basics of Materials Engineering and Product Design. Principles of materials selection and introduction to materials selection procedures. Choice of fabrication techniques including case studies related to different materials. Selecting polymers and composites as raw materials: structure, properties, processing characteristics and applications for the commercially important polymers including general classes of polymers: commodity, engineering and specialty thermoplastics, thermosetting resins and rubbers. Introduction to specific metals, alloys and minerals: metallurgy, properties, applications and potentialities of metals, alloys and minerals in a wide variety of engineering environments. Wood materials.

Introduction to engineering ceramics. Properties and manufacturing of carbon based materials. Recycled Materials as a raw material source.

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, examination 70 %, seminar 30 %

Course Materials:

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

Prerequisites:

-

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

max 10

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

max 10

BK90C2000: Hybrid Materials, 3 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Ossi Martikka

Year:

M.Sc. (Tech.) 1-2

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

Organic–inorganic hybrids and composites have been playing a major role in research and society in recent years. This course aims to give the participants an understanding of the properties of the organic and inorganic components, preparation methods, characterisation techniques and also examples of functional hybrid materials. After having completed this course, the student should be able to: structure hybrid materials from separate raw material sources characterize hybrid materials with various testing methods can work in teams and solve problems related to hybrid materials

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, oral examination in evaluation panel 50 %, exercises and seminar 50 %.

Course Materials:

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

Prerequisites:

-

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

max 10

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

max 10

BK90C2100: Functional Properties of Nanomaterials, 3 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Irina Turku

Year:

M.Sc. (Tech.) 1-2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Tech.) Irina Turku

Aims:

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

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

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

Course Materials:

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

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

15–

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

max 10

BK90C2200: Sustainable Manufacturing of Advanced Materials, 5 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Marko Hyvärinen, Katriina Mielonen

Year:

M.Sc. (Tech.) 1-2

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

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

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

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

Course Materials:

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

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

max 10

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

max 10

BK90C2300: High Performance Products, 5 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Timo Kärki

Year:

M.Sc. (Tech.) 1-2

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

Aim of the course is to highlight the developments in the design of energy systems, aircraft, cars, electronic equipment, constructions, packaging, etc., which depend critically upon the

availability of novel materials. Of equal importance is an understanding of both advanced processing techniques, the latest computer based design procedures and environmental aspects essential for product commercialization from the concept phase. After having completed this course, the student should be able to: define concepts and entities related to high performance products have a good understanding about product range manufactured with various methods can solve real-life problems related to high performance products.

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

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

Course Materials:

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

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

max 10

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

max 10

BK90C2400: Project course in Material Engineering, 5 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Marko Hyvärinen

Year:

M.Sc. (Tech.) 1-2

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

Aim of the course is to get the students familiar to the project type working in materials engineering. Typical project will start with selection of materials and manufacturing method

for a certain end product. After having completed this course, the student should be able to: ability to build up material selection route from end product and manufacturing methods to raw materials ability to work in a project organisation in certain role can act and communicate in groups and networks.

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

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

Course Materials:

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

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

No

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

max 10

KeSoD400: Biobased Chemical Engineering, 20 - 30 cr

Validity: 01.08.2018 -

Form of study:

Type: Study module

Unit: LUT School of Engineering Science

Grading: Study modules 0-5,P/F

Aims:

After the completion of the minor in Biobased Chemical Engineering the student
• has knowledge of the modern bio-based industry, its processes and available raw materials
• has advanced knowledge of relevant unit processes used in bio-based industry
• has knowledge of sustainable solutions and technologies integrated to bio-refineries
• is able to seek out and understand scientific information to be applied in bio-based chemical engineering.

Choose a min. of 20 ECTS. This minor is suitable for distance learning.

BJ02A1090: Environmental and Industrial Analytics, 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: Maaret Paakkunainen, Satu-Pia Reinikainen, Eeva Jernström

Note:

The course is suitable for distance learning.

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Satu-Pia Reinikainen, D.Sc. (Tech.), Professor
Maaret Paakkunainen, D.Sc. (Tech.)
Eeva Jernström, D.Sc. (Tech.)

Aims:

By the end of the course, the student is expected to be able to
- understand role and state-of-art of analytics in environmental and industrial contexts
- understand the effect of digitalization as the 4th industrial revolution
- be able to apply process management skills in implementation of project work.

Contents:

Main themes addressed are reliable sampling, traceability of measurements, modern instrumentation, data handling, process and environmental control/monitoring, and license to operate. Students will carry out a project work on one of these topics, report and present it as the visual synthesis. In addition a study visit aiming at
improved understanding of analytics will be carried out with a problem based learning procedure. Course contains tutorial lectures on the topics, hands on workshops on sampling, statistical process monitoring, and study visits.

Teaching Methods:

8 h of Tutorials, 2 h Study visit, 20 h Online workshops, 30 h Project work, 70 h Independent work. Total workload 130 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):

Yes

Assessment:

Numerical assessment (0-5); 40 % Electronic or Moodle Exam, 30 % Project Work, 30 % Other Homework.

Course Materials:

To be announced.

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

max 15

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

max 5

BJ02A1100: Biorefineries, 5 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:

The course is suitable for distance learning.
This course is mainly directed to the students in the digital Master's Programme in Biorefineries.

Year:

M.Sc. (Tech.) 1

Period:

3

Teaching Language:

English

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.) Eeva Jernström

Aims:

By the end of the course, the student is expected to be able to
- Understand the basic concept of a biorefinery and the various alternative concepts
- Understand the main biorefining processes, e.g. kraft pulp process, production of biofuels, further processing of different bio-based raw materials.
- Have general knowledge of current biorefinery products, their applicability to different end-uses
- Apply management and cooperation skills in implementation of project work in combined virtual and f2f working environment.

Contents:

The course covers the most typical biorefining-processes currently in use as well as some selected future processes. Topics include raw materials for biorefineries, processes and process conditions, most common biorefinery products and their end-uses. The course includes Moodle assignments and project work. The project work will be carried out individually or in small groups that will define their own target, and working methodology. The course is suitable for distance learning.

Teaching Methods:

Tutorials and workshops 5 h, 2nd period. Project work 50 h. Self Study of predefined material 75 h. Total workload 130 h.
The course includes Moodle assignments and project work. The project work will be carried out individually or in small groups that will define their own target, and working methodology

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Moodle assignments 60 %, Project work 40 %.

Course Materials:

Will be announced later.

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

Yes, this course is mainly directed to the students in the digital Master's Programme in Biorefineries.

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

No

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

max 5

BJ02A1200: Bioeconomy, 5 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:

This course is suitable for distance learning.

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor, D.Sc. (Tech.), Eeva Jernström
Professor, D.Sc. (Tech.) Mika Sillanpää

Aims:

By the end of the course, the student is expected to
- gain the basic understanding of various perspectives of bioeconomy
- gain updated knowledge of modern biorefineries and the basic prerequisites for operation and sustainable business.

Contents:

The study entities are: The multidimensional impact of bioeconomy on Europe, The implementation of bioeconomy, the sustainability – all three dimensions - aspects of bioeconomy. The course is carried as assignments based on selected topics from the book and additional material. Course is planned for distance learning.

Teaching Methods:

Individual studying and assigments based on the book. Moodle is used as the learning platform.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Moodle assigments 100 %.

Course Materials:

Book: A Sustainable Bioeconomy The green industrial revolution by Professors Mika Sillanpää and Chaker Ncibi.
Other related material announced later.

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

No

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

max 5

BJ02A1500: Current Issues in Enabling Technologies for Circular Economy, 5 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:

The course is suitable for distance learning.

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Jutta Nuortila-Jokinen, Docent, D.Sc., Associate professor

Aims:

The aim of this new course is to familiarise students widely into circular economy with the focus on the current and novel technologies that enable the transformation from linear to circular economy.

Contents:

The detailed content will be announced later. The course will be executed in co-operation with Oulu University.

Teaching Methods:

The course is 100 % digitalized.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

0-5. Moodle exam and/or assignment. Details to be announced later.

Course Materials:

To be announced later.

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

15–

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

15–

BJ02A1600: Biobased Materials and Advanced Organic Chemistry, 5 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

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Arto Pihlajamäki, D.Sc. (Tech.), Researcher/Teacher
Tiina Virtanen, M.Sc. (Tech.), Junior Researcher

Aims:

By the end of the course, a student is expected to:
- gain the basic chemical and technological understanding of the production of most important bioproducts from renewable resources
- be able to apply fundamental concepts of organic chemistry into application of biopolymers and their reactions.

Contents:

This course contains two modules. Biobased Materials module will introduce novel biomaterials and focus on properties of biobased polymers, their processing, reactions and applications. Advanced Organic Chemistry module gives extended knowledge in the structure and reactivity of organic biomolecules. There are lists of literature recommended for each module. Students will work in small groups on selected topics.

Teaching Methods:

Moodle lessons: Module 1 60 h, Module 2 60 h, 4th period. Quizzes and activities in Moodle 10 h. Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

0-5, Moodle exam, assignments and fulfilled activities in Moodle, project work reports in Modules 1 and 2.

Course Materials:

To be announced.

Prerequisites:

BJ01A1040 Orgaanisen kemian perusteet (Basic Organic Chemistry) or equivalent knowledge.

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

Yes, 50, Students in Chemical Engineering M.Sc. programme.

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

max 5

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

max 5

BJ02A4070: Principles of Thermal Gas-Liquid Processes, 5 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

Year:

M.Sc. (Tech.) 1

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Tuomas Koiranen

Aims:

Student understands distillation, evaporation and gas scrubbing technologies, including equipment structures and sizing principles. Student can design gas-liquid contactors by hand, is able to form mathematical calculation models, and can apply equations for computer simulation.

Contents:

Gas-liquid contactor theory, sizing principles and equations, calculation examples, computer exercises. Distillation, evaporation, gas scrubbing.

Teaching Methods:

Combined lectures and exercises 10 h, homeworks 72 h, self learning 48 h.
Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

Examination grading scale 0-5. minimum 75 % of homeworks correct, returning to moodle.

Course Materials:

Course books:
Niket S. Kaisare, Computational Techniques for Process Simulation and Analysis Using MATLAB®,

Taylor&Francis, 2017
Hussein K. Abdel-Aal, Chemical Engineering Primer with Computer Applications, Taylor&Francis, 2016
Felder, R.M., Elementary Principles of Chemical Processes, Wiley, 2004

Prerequisites:

BM20A1501 Numerical Methods or equivalent, BM20A4301 Introduction to Technical Computation or equivalent

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

max 10

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

max 5

MaDSaCompu: Computer Vision and Pattern Recognition, 20 - 30 cr

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

Aims:
Learning Outcomes:
By the end of minor, the student:
- has knowledge in pattern recognition and in methods for intelligent computing
- is able to formulate and select approaches for problems in imaging
- is able to computationally solve problems and evaluate the solutions in data analysis
- understands the limitations in modelling and the computational challenges for applications in the analysis of real data
- is able to find innovative ways to solve practical problems
- is able to work with incomplete data, model innovative solutions and search for novel options
- understands the applicable area of the methods in intelligent computing
- is able to work in a team in various roles
- is able to communicate the methods, problems, applications, and solutions in various forums both orally and in written form
- is able to perform clustering, classification using neural networks with complex data
- is able to use modern computational technologies in data analysis

Obligatory Studies 12 ECTS cr

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

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

Choose enough courses to attain at least 20 ECTS cr together with obligatory courses

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: Jouni Sampo, Arto Kaarna, Erkki Lähderanta

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

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

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

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

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

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: Marita Rautiainen, Timo Pihkala

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

Year:

B.Sc. (Tech.) 3

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

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

Contents:

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

Teaching Methods:

Lectures (intensive teaching) and small group assignments during the lectures 5 h, case exercise to be given during the lectures 60 h, independent and/or group studies 60 h, presentation of case exercises in a closing seminar 10 h, personal learning diary 21 h = total 156 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

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

Course Materials:

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

Prerequisites:

None.

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

max 15

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

max 5

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: Suvi Konsti-Laakso, Timo Pihkala

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

YmDSaResp: Environmental Responsibility, 20 - 30 cr

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

Aims:
After completing this minor subject the student will be able to:
- understand the importance of sustainability to business
- understand the roles buildings and their technologies as part of a sustainable community
- recognize the most applicable waste treatment methods for waste fractions
- recognize possibilities for the utilization of energy content of waste

Obligatory Studies 23 ECTS cr

BH60A0252: Solid Waste Management Technology, 7 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Mika Horttanainen, Mika Luoranen, Jouni Havukainen

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Mika Horttanainen

Aims:

Upon completion of the course the student is expected to be able to
1. explain the most important generation mechanisms, properties, and collection and treatment systems of solid waste,
2. explain the operation of essential process technology and equipment,
3. compare and give grounded proposals for treatment methods and processes applicable to different situations,
4. calculate process parameters related to composting, digestion and energy utilization,
5. apply waste management legislation,
6. apply what he/she has learned to the environmental treatment and utilization of waste, and
7. describe the operation of regional waste management.

Contents:

Generation of solid waste and waste management in different parts of the world, properties of waste, legislation concerning waste management, source separation, collection and transport, pretreatment, composting, anaerobic digestion, waste-to-energy, landfilling, regional waste management, treatment of polluted soil.

Teaching Methods:

1st period: 14 h of lectures, 10 h of tutorials. 2nd period: 12 h of lectures, 8 h of tutorials. Assignment with literature and calculation part, presentation, individual work approx. 82 h. Field trip approx. 12 h. Lecture assignments approx. 10 h. Examination and preparation for it approx. 30 h. Total workload 182 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0 - 5. Examination 50 %, assignment 40 %, lecture assignments 10 %.

Course Materials:

Tchobanoglous, Theisen, Vigil: Integrated Solid Waste Management, 1993. Handouts provided by the lecturer, course environment on Moodle.

Prerequisites:

BH60A0001 Ympäristötekniikan perusteet, BH60A0901 Ympäristömittaukset or equivalent knowledge

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

max 15

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

max 10

BH60A2401: Energy Recovery from Solid Waste, 4 cr

Validity: 01.08.2010 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Mika Luoranen, Mika Horttanainen

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Mika Horttanainen

Aims:

Upon completion of the course the student is expected to be able to
1. describe the properties of waste as fuel,
2. explain the most common waste-to-energy technologies and their suitability for different energy recovery applications and materials,
3. determine the waste-to-energy recovery potential of a region,
4. describe the most important flue gas emissions and their reduction technologies characteristic for the combustion of waste, and
5. analyse the role of energy recovery in municipal waste management.

Contents:

Waste-to-energy in Finland and other countries, properties of waste as a fuel, waste handling before thermal conversion, preparation of recycled fuel, mass combustion of waste, combustion of recycled fuel, gasification of waste, energy recovery in combustion of waste, emission reduction during combustion, flue gas treatment, utilisation and treatment of ash, energy recovery in anaerobic digestion of waste, landfill gas utilisation in energy production.

Teaching Methods:

1st period: 14 h of lectures, 14 h of exercises.
2nd period: 4 h of lectures, assignment info (2 h). Group assignment including calculations, written group report (approx. 44 h). Excursion (approx. 6 h). Written examination and preparation for it, approx. 20 h. Total workload 106 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

0 - 5. Examination 50 %, practical assignment 50 %.

Course Materials:

Course book (to the appropriate extent): Niessen, W., 2002. Combustion and incineration processes. Marcel Dekker, Inc., New York. SBN: 0-8247-0629-3. Moodle.

Prerequisites:

Basic knowledge on thermodynamics, chemistry and power plant technology.

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

No

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

max 5

BH60A2701: Energy Efficient Environment, 6 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Risto Soukka, Mika Luoranen

Year:

M.Sc. (Tech.) 2

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Mika Luoranen, D.Sc. (Tech.), Associate professor

Aims:

Upon completion of the course the student is expected to be able to:
1. assess the energy related factors that affect areal planning,
2. compare the factors that affect the sustainability of energy solutions for individual buildings and areas, and
3. plan and execute a procedure for comparing relevant energy aspects of competing energy supply alternatives for a housing area.

Contents:

The lectures deal with the following topic areas: regional energy planning; legal and economic control factors; low energy buildings, regional energy supply and environmental performance criteria. Students will complete an assignment in which they assess energy supply alternatives for a given region, including life cycle perspective.

Teaching Methods:

3rd period: 7 x 2 h of lectures
3rd - 4th period: Independent work: individual assignment (approx. 102 h).
Examination and preparation for it (approx. 40 h). 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 50 %, assignment 50 %.

Course Materials:

Lecture material, Moodle.

Prerequisites:

Recommended: BH60A2101 Advanced Course in Life Cycle Assessment attended.

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

max 5

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

max 5

BH60A5700: Business and Sustainability, 6 cr

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

Note:

Replaces the course BH60A3001 Corporate Responsibility and Management 2.

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Econ. & Bus. Adm.), M.Sc. (Tech.) Lassi Linnanen
Associate Professor, D.Sc. (Agr. & For.) Mirja Mikkilä

Aims:

Upon the completion of the course the student is expected to be able to:
1. analyze decision making situations related to sustainable business,
2. propose solutions to challenging business situation within sustainable business,
3. understand various sustainable business and enterprise models,
4. evaluate critically responsible corporate communication,
5. discuss and argument on various perspectives of sustainable business based on the learned issues and on-going societal debate.
6. carry out self- and peer evaluations

Contents:

Familiarization with the sustainable business models and the strategic responsibility framework of a firm. Reorganization of dimensions of responsible business. Deepening the application skills of mechanisms and tools of sustainable management. Analysisof business and financial consequences of responsibility governance. Familiarization of basics of business ethics. Communication and reporting ofgoals and implementation of corporate responsibility to stakeholders. Learning of corporate responsibility reporting guidelines.

Teaching Methods:

Lectures 6 h, 3 period. Written report on Corporate Responsibility communication and preparation of seminar presentation, groupwork approximately 30 h, written report 3 period.
Seminar presentation 4. period. Case-assignments, group work, approximately 120 h, 3-4 period. The student mustparticipate in the case-assignments.
Total workload 156 h, of which independent work approximately 118 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

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

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

Evaluation 0 - 5. Written report 30 %, case-assignments 70 %.

Course Materials:

Caset: Hamschmidt, Jost (toim.): Case studies in sustainability management and strategy: the Oikos collection, 2007,
Pirson, Michael (toim.): Case studies in social entrepreneurship: the Oikos collection, 2015,
GRI yhteiskuntavastuun raportointiohjeisto, versiot 3.1 ja 4. Further course material will beannounced during the lectures,
Course material in Moodle

Prerequisites:

Sustainability transition and sustainable business (Kestävyysmuutos ja johtaminen) or Introduction to Sustainable Business
passed or equivalent knowledge studied earlier.

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

Max 5

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

Max 5

KaSOIbm: International Business and Management, 21 - 35 cr

Validity: 01.08.2016 -

Form of study:

Type: Study module

Unit: LUT School of Business and Management

Grading: Study modules 0-5,P/F

Note:
This minor is not allowed for the students of Business Administration.
The number of students attending to the courses in the minor can be limited. In these cases the priority is given to the students who have these courses in their compulsory studies.

Aims:
Minor in International Business and Management aims to provide basic knowledge on marketing and sales management as well as their idiosyncracies that arise from doing international business. After completion of this minor, the students are able to analyze, plan and develop the processes of marketing and sales in international business context. In addition, they understand the cultural issues that arise from international operating environment. The students possess good skills in communication, cooperation and project management.

Elective courses 21-24 cr

A370A0401: Case-Course of Business, 6 cr

Validity: 01.08.2012 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Business and Management

Grading: Study modules 0-5,P/F

Teachers: Jukka-Pekka Bergman

Year:

B.Sc. (Econ. & Bus. Adm.) 3

Period:

1-2, 3-4

Teaching Language:

English

Teacher(s) in Charge:

Post-Doctoral Researcher, D.Sc. (Tech.), Dos. Jukka-Pekka Bergman

Aims:

The aim of the course is to familiarize students with the case-writing through the self-oriented independent team work by making an exersice of a *business analysis of a real case firm*. The students are able to evaluate and describe firm's business practices, markets, and explain their development using the frameworks she or he has learned at previous courses. The student is able to construct a well-written description of a case-firm and its business environment as well as provide concluding suggestions for the development targets for the firm using different empirical materials collected during the exercise. In addition, students train to organize and study the group work by themselves being collectively/as a group responsible for the case process and results.

Contents:

Strategy analysis. Case study methodology. Case-writing.

Teaching Methods:

Lectures 4 h, selection of case-company and collection of data 40 h, reading of the literature needed in the analysis and description of the case 40 h, case-writing in English (international groups) or Finnish 76 h and possible final seminar (4 hours). Total workload for student 160 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

Grade 0-5, evaluation 0–100 p. Literary group assignment 100%.

Course Materials:

Lecture slides.

Prerequisites:

B. Sc. (Econ. & Bus. Adm.) 2 studies

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

15–

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

max 10

Description and DL of the company assignment:

Exercise is a real-life business case that can/recommended to be a project for a company.

A380A0000: Cross-Cultural Issues in International Business, 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: Igor Laine

Year:

B.Sc. (Econ. & Bus. Adm.) 2

Period:

3

LUT Winter School time:

Yes

Teaching Language:

English

Teacher(s) in Charge:

Post-doctoral researcher, D.Sc. (Econ. and Bus. Adm.) Igor Laine

Aims:

The goal of the course is to give an understanding of how the cultural environment affects management in international business, and advance students' global mindset by giving conceptual tools to increase their intercultural competence. After completing the course the students will be able to:
1. define and categorize culture
2. explain cultural orientations towards time, space and context
3. analyze and compare national cultures according to Hofstede's, Trompenaars' and GLOBE cultural dimensions
4. reflect upon the relationship between culture, organizations and management - evaluate the effects of the cultural environment on international marketing strategies
5. examine the sources of cultural conflicts in international organizations
6. identify the role of cultural factors in managing and leading international teams
7. apply studied theories and ideas to business situation

The general aim of the course is to improve following personal skills and abilities of the students:
- recognizing cultural differences
- interacting effectively with people from other cultures
- working in groups and international teams

Contents:

Concept and levels of culture, dimensions of culture in business (Hall, Hofstede, Trompenaars and GLOBE); The effect of culture on leadership and management in international business; The limits of globalization from the cultural perspective; Cross-cultural issues in virtual teams; Standardization and adaptation in international marketing; Country cases of cultural differences (term paper reports)

Teaching Methods:

15 hours of lectures, case study workshop (2 hours) and term paper presentation seminar (4 hours). Preparation for lectures 12 h. Writing of term paper, preparation for case study and term paper presentations, 63 h. Written exam and preparation for exam 65 h. Total workload for student 160 h.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

Grade 0-5, evaluation 0-100 points, written exam 60 %, term paper 25 %, peer group evaluation report 5 %; case assignment 10 %, all assignments must be passed to obtain a final grade.

Course Materials:

1.Browaeys & Price: Understanding Cross-Cultural Management (3rd ed), Pearson, 2015
2.Lecture slides
3.Additional material distributed in class and via Moodle

Prerequisites:

Basic course in management or marketing

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

15–

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

max 10

A380A0131: Business Relationships in International Value Networks, 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: Terhi Tuominen, Anni-Kaisa Kähkönen

Note:

If student has taken the course of A380A0130 Kansainväliset liikesuhteet arvoverkostoissa, the student is not able to participate to this course.

Year:

B.Sc. (Econ. & Bus. Adm.) 3

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Associate Professor, D.Sc. (Econ. & Bus. Adm.) Anni-Kaisa Kähkönen
Post-Doctoral Researcher, D.Sc. (Econ. & Bus. Adm.) Terhi Tuominen

Aims:

The aim of the course is to familiarize students with different business relationships in value networks, with the management of relationships and networks, and the characteristics of international business relationships and collaborative networks.
Upon completion the course students are able to
- understand the main concepts and theoretical backgrounds of collaboration and networks
- analyze the benefits and challenges of relationships and networks
- recognize and understand the characteristics of value networks
- define supplier and customer relationships
- participate to the development of relationships.

Contents:

The concepts and theories of collaboration and networking, characteristics of value networks, the benefits and challenges of collaboration, managing of collaboration and networks, vertical and horizontal collaboration, the management of supplier relationships and customer relationships.

Teaching Methods:

Online course, student driven content creation anddiscussion. Reading assignments and writing of essays 40 h. Case assignmentincluding written reports, 60 h, in small groups. Independent Moodle exam and preparation for exam 60 h, 1stperiod. Total workload for student 160 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

Yes

Examination in Exam (Yes/No):

No

Assessment:

Grade 0-5, evaluation 0-100 points. Exam 40 %, case assignment 40 %, essays 20 %, all assignments must be passed to obtain final grade.

Course Materials:

1. Selection of journal articles, 2. Assigned readings

Prerequisites:

B.Sc. (Econ. & Bus. Adm.) General studies

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

15–

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

15–

A380A0201: Sales and Marketing Communication, 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: Anssi Tarkiainen, Tommi Rissanen

Note:

Replaces the course A380A0200 Promotion and Sales Management 6 cr

Year:

B.Sc. (Econ. & Bus. Adm.) 3

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Associate Professor, D.Sc. (Econ. & Bus. Adm.) Anssi Tarkiainen
Doctoral Student, M.Sc. (Econ. & Bus. Adm.) Tommi Rissanen

Aims:

After completing the course the student will understand changes in the field of commerce, including buying behavior, marketing communication (MC) and sales management (SM). Student is able to create and design marketing and sales funnel that applies new, more productive technologies. This course will pay special emphasis on understanding the linkages between marketing communication and sales, and the challenges in their integrated management.
The learning outcomes of the course are the following:
- to understand the evolution of buying behavior, marketing and sales in the era of digital technologies
- to understand the role of MC and SM in marketing strategy
- to assess the usability of different forms of communication with regard to buyer behavior
- to be able to design, implement and manage marketing communication and sales as part of the marketing process
- to assess the challenges of integrating MC and sales strategies, and combining traditional tools with new technologies
- to evaluate the effectiveness of MC and sales in the changing business environment.

Contents:

Core contents:
- The evolution of buying behavior, marketing and sales in the era of digital technologies.
- The role of marketing communication (MC) and sales in marketing strategy.
- The role of buyer behavior and its effects on the nature of communication (mass vs interactive /personal).
- MC and sales process, message and media strategy.
- Strategic planning process of MC and sales; challenges of integrating MC and sales management strategies.
Additional knowledge:
- Sustainability in MC context.
Special knowledge:
- Digitalization of MC and sales.

Teaching Methods:

Combined lectures and exercises 28 h 2. period. Preparation for exercises 63 h (including written work) and preparation for the exam 71h. Written exam.
Total workload for student 160 h.

Examination in Exam (Yes/No):

Yes

Assessment:

Final grade 0-5, evaluation 0-100 points.Exercises 40 points, written exam 60 points.

Course Materials:

Lectures and selected articles.

Prerequisites:

A130A0250 Kansainvälisen markkinoinnin perusteet (or basic course in marketing).

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

Yes, 15-

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

Max 5

A380A6050: Introduction to International Business and Planning, 3 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: Toivo Äijö, Seyedsina Mortazavibabaheidari

Year:

B.Sc. (Econ. & Bus. Adm.) 3

Period:

1 (intensive)

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Econ.) Toivo S. Äijö, Top Trainers Group
Professor, D.Sc. (Econ. & Bus. Adm.) Sami Saarenketo
Junior Researcher Sina Mortazavi

Aims:

To familiarize the students with the fundamentals of international business in general and strategic planning for international business in particular. To provide the students with the analytical skills required for critical evaluation of actual international business strategies.

Contents:

- The changes in the international Business environment and their effect on strategic planning.
- Theories of international trade and business.
- The institutions of international trade and business.
- The essence of competitive strategy.
- Levels of strategic planning.
- International expansion strategy.
- Supporting research.
- International marketing strategy: entry modes, targeting, product, service, pricing, promotion, sales

and CRM.
- International functional strategies.
- Case studies.

Teaching Methods:

Intensive course during 1. period. 25 hours of lectures, interactive analyses, case exercises and assignments, carried out by the student, 55 hours, total course 80 h. Written examination.

Examination in Examination schedule (Yes/No):

Yes

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

Graded 0-5 on the basis of case studies and class participation 20 % and written examination 80 %, evaluation 0 – 100 points.
50 % class attendance and participation required.

Course Materials:

The study material will be distributed at the beginning of the lectures.

Prerequisites:

Basic course in marketing

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

max 5

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

max 10

CS10A0262: International Business Essentials, 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: Asta Salmi, Igor Laine, Juha Väätänen

Note:

This course is available only to students of candidate programs of LUT School of Business and Management.
Interchangeable with CS10A0261 Managing International Business.

Year:

B.Sc. (Econ. & Bus. Adm.)or B.Sc. (Tech.) 2, 3

Period:

2

Teaching Language:

English

Teacher(s) in Charge:

Post-doctoral researcher, D.Sc. (Econ. and Bus. Adm.) Igor Laine
Professor, D.Sc. (Econ. and Bus. Adm.) Asta Salmi
Professor, D.Sc. (Tech.) Juha Väätänen

Aims:

After successful completion of the course, students should be able to: 1. describe the key concepts in international business, 2. explain how international business differs from domestic business, 3. identify major participants in international business, 4. describe, discuss applicability and apply various internationalization theories, 5. describe strategy in international business, 6. describe various principles of market selection, 7. examine advantages and disadvantages of different entry modes, 8. discuss major features of global marketing program, 9. recognize the characteristics of international business relationships.

Contents:

International business theories. International competitiveness. Regional economic integration. International business strategy. Market selection and entry modes in international business. Global marketing. International business relationships and networking.

Teaching Methods:

15 h of lectures, 14 h preparation for lectures, 20 h assignments, 40 h written report, 3 h peer group evaluation, 14 h course literature and self-study, 50 h exam preparation. 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 40 %, written report 35 %, peer group evaluation 5%, home-work assignments 20%. Each of the components has to be passed acceptably.

Course Materials:

Cavusgil S.T., Knight G., Reisenberger J., 2017, International Business: The New Realities (4th edition), Harlow, UK: Pearson Education Ltd. Additional materials will be announced on lectures

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

Yes, 75

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

15–

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

15–

EnDMES: Modelling of Energy Systems, 21 cr

Validity: 01.08.2010 -

Form of study:

Type: Study module

Unit: LUT School of Energy Systems

Aims:

After the completion of the minor in Modelling of Energy Systems, the student:
• can use mathematical and physical models to model various processes and equipment, especially in energy technology context
• is able to use modelling tools and methods in design of various processes and equipment, especially in energy technology context
• understands the applicability of different modelling tools and their limitations.

Selectable courses, choose a min. of 20 ECTS

BH70A0101: Advanced Modelling Tools for Transport Phenomena, 5 cr

Validity: 01.08.2009 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Timo Hyppänen, Payman Jalali

Year:

M.Sc. (Tech.) 1-2

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Timo Hyppänen, Docent, D.Sc. (Tech.) Payman Jalali

Aims:

Transport phenomena are dealing with the heat, mass and momentum transfer in engineering and science. In this course, advanced modeling tools and methods are introduced for students of energy technology and other departments with related background in heat transfer and fluid dynamics. Students will learn how the related computer packages such as FLUENT, COMSOL Multiphysics and MATLAB can be used to solve and analyze heat transfer and fluid flow problems using computational fluid dynamics (CFD). This course provides a mathematical basis for problem formulation, and coding /solving using the above-mentioned computational packages. Students will learn how to solve simple transport problems using their own codes in MATLAB. Then more complex problems will be taught to solve using COMSOL and FLUENT packages. Upon completion of this course, they will be able to start working on various topics in heat and fluid flow engineering for advanced designs or analysis.

Contents:

Introduction to ‘transport phenomena’ and related problems, feeding problems into CFD algorithms and methods (discretization of equations and domains, transforming differential equations into algebraic equations etc.), diffusion and convection equations solved by finite
difference and finite volume methods, complexities due to property variation, geometry and boundary conditions, application of computational packages (such as MATLAB, FLUENT, COMSOL Multiphysics etc.) in solving transport phenomena problems.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of exercises. 4th period: 12 h of lectures, 12 h of exercises. 3 - 6 homeworks and 2 projects.
Total workload 130 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):

Yes

Assessment:

0 - 5. Examination 40 %, homeworks and projects 60 %.

Course Materials:

J.D. Anderson: Computational Fluid Dynamics, McGraw-Hill, Inc. 1995.
D.A. Anderson, J.C. Tannehill, R.H. Pletcher: Computational Fluid Mechanics and HeatTransfer, McGraw-Hill, Inc. 1984.
J.H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics, Springer-Verlag 1996.
C. Hirsch: Numerical Computation of Internal and External Flows, Volume 1: Fundamentals of Numerical Discretization, John Wiley & Sons, 1988.
MATLAB user manual. FLUENT user manual. COMSOL Multiphysics manual. Moodle.

Prerequisites:

Basic knowledge on programming using MATLAB or any other language. Basic Fluid Mechanics and Heat Transfer courses passed.

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

max 10

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

max 5

BH70A0200: Advanced Topics in Modelling of Energy Systems, 6 cr

Validity: 01.08.2010 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juha Kaikko, Tero Tynjälä, Juhani Vihavainen, Teemu Turunen-Saaresti, Timo Hyppänen, Jouni Ritvanen, Esa Vakkilainen

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Docent, D.Sc. (Tech.) Jouni Ritvanen

Aims:

Upon completion of the course the student will be able to: 1. create stationary and time dependent mass, momentum and energy balances for various kinds of energy systems, 2. perform design tasks, utilize mathematical software in calculation, and analyze the characteristics of
energy systems, 3. include material property definitions into mathematical software or into own code when simulating energy systems, 4. create, solve and analyze the set of stationary and time dependent balance equations using Excel and MATLAB, 5. create, solve and analyze stationary energy systems with IPSEpro software package, and 6. create, solve and analyze time dependent energy systems with APROS software package.

Contents:

Advanced problems in the modelling of energy systems needed by engineers and researchers. The course lectures provide mathematical basis for problem formulation, and exercises providing a chance to work with various computational packages.

Teaching Methods:

1st period: 14 h of lectures and 14 h of case exercises. 2nd period: 12 h of lectures, 12 h of case exercises and 4 h of seminars. Individual work: Written assignments 52 h. Seminar work 48 h. Total individual work

100 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. Written assignments 60 %, seminar work 40 %.

Course Materials:

Moodle.

Prerequisites:

BH20A0450 Heat Transfer, BH20A0800 Engineering Thermodynamics, BH40A1451 Fluid Dynamics II, or similar skills.

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

max 10

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

max 5

BH40A1501: Turbulence Models, 4 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Teemu Turunen-Saaresti

Year:

M.Sc. (Tech.) 2

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Associate professor (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti

Aims:

Upon completion of the course the student will be able to recognize the characteristics of turbulence models and to estimate the suitability of different turbulence models for various fluid mechanical problems. In addition, the student will be able to interpret the physical basis and the theory of turbulence models.

Contents:

Navier-Stokes equations, RANS equations, Reynolds stress, eddy viscosity, algebraic, one equation and two equation models and advanced models.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of tutorials. 4th period: 12 h of lectures, 12 h of tutorials. Homeworks 20 h, Project work 36 h.
Total workload 104 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. Homeworks 30%, project work 70%.

Course Materials:

David C. Wilcox: Turbulence models for CFD.

Prerequisites:

BH70A0001 Numerical Methods in Heat Transfer or equivalent knowledge.

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

max 5

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

max 5

BH30A2001: Computational Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Otso-Pekka Kauppinen, Juhani Vihavainen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

D.Sc. (Tech.) Juhani Vihavainen

Aims:

Upon completion of the course students will understand basic equations and special features in thermal hydraulic system code modelling. The students are able to use system codes introduced in this course, APROS and TRACE, and understand engineering design and modelling basis.

Contents:

Thermal hydraulic phenomena of nuclear power plant during normal operation and incident and accident situations. Calculation and modelling of a two phase flow in computer codes. Modelling of essential processes in nuclear power plants with APROS and TRACE software and CFD codes.

Teaching Methods:

Lectures 14 h, tutorials 14 h, assignment 40 h, preparation for the examination 7 h, written examination 3 h.
Total workload 78 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 50 %, assignment 50 %.

Course Materials:

Lecture materials. APROS and TRACE code manuals, as applicable.
Todreas, Kazimi: Nuclear Systems I & II, as applicable.

Prerequisites:

BH30A0201 Nuclear Reactor Design and BH30A1901 Theoretical Nuclear Thermal Hydraulics.

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

No

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

max 5

BH30A2200: Experimental Nuclear Thermal Hydraulics, 3 cr

Validity: 01.08.2014 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Juhani Hyvärinen, Juhani Vihavainen, Otso-Pekka Kauppinen

Note:

This course is available only to nationals of countries that have implemented adequate nuclear non-proliferation under the rules of the International Atomic Energy Agency (IAEA).

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Juhani Hyvärinen

Aims:

Upon completion of the course the students will be able to describe basic measurement techniques for one- and two-phase flows, understand similitude and scaling, perform engineering design of downscaled models, understand the interaction between experiments and computer code calculations, describe advanced flow structure mapping techniques (e.g. wire mesh sensing, particle image velocimetry).

Contents:

Temperature, pressure, pressure drop, liquid level and flow measurement techniques. Void fraction measurement. Similitude, scaling principles. Model design. Designing experiments for computer code validation. Advanced flow structure measurement techniques.

Teaching Methods:

Lectures 14 h, tutorials 14 h, laboratory demonstrations 16 h, computer calculations 4 h, quiz 8 h, writing reports 22 h.
Total workload 78 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5. Quiz 25%, reports of laboratory works 75%.

Course Materials:

Ghiaasian: Two-Phase Flow, Boiling and Condensation, as applicable.

Prerequisites:

BH40A0701 Measurements in Energy Technology or equivalent course experience.

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

max 5

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

max 5

BH40A1560: Fundamentals of Computational Fluid Dynamics, 6 cr

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

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Assoc. Prof. (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti
M.Sc. (Tech.) Alireza Ameli

Aims:

This course acquaints students with the basic procedures of conducting computational fluid dynamics (CFD) simulations and the key numerical methods in heat and mass transfer. Students will be able to mesh problems efficiently and detect problems related to meshing and computational grids/meshes. Students are also be able to use numerical software(s) for the computation of simple cases, interpret and analyze gained results and explaintheory and limitations of studied numerical methods. In addition, students areable to form equations using the finite volume method. A CFD software is used to design simple engineering flow problems.

Contents:

Numerical solution methods for the conservation of mass, momentumand energy. Solutions for heat transfer problems including conduction,radiation and convection. The finite volume method. Formulation of discretized conservation equations. Differentiation methods. The solution of equation sets. Setting boundary conditions. Physics of flow problem. Different types of grids. Setting up steady and transient CFD simulations. Meshing. Solution procedures and techniques.Visualization techniques and post-processing the results.

Teaching Methods:

1st period: 12 h of lectures, 12 h of exercises. 2nd period: 12 h of lectures, 12 h of exercises. Homeworks 24 h. Project work 73 h. Preparing for the examination 8 h. Written examination 3 h.
Total workload 156 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

Yes

Assessment:

0-5. Homework 30%, Project work 40%, Exam 30%.

Course Materials:

Versteeg, H.K.: An introduction to Computation al Fluid Dynamics, The Finite Volume Method.

Prerequisites:

BM20A5001 Principles of Technical Computing or equivalent knowledge.

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

Max. 10

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

Max 10

BH40A1570: Advanced Computational Fluid Dynamics, 5 cr

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

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Assoc. Prof. (tenure track), D.Sc. (Tech.) Teemu Turunen-Saaresti
M.Sc. (Tech.) Alireza Ameli

Aims:

The aim of the course is to acquaint students with the numerical simulations of multiphase and real gas flows, condensation, advance heat transfer (multi-fluid) and turbomachinery. After completing the course, students are able to simulate above-mentioned flow using a CFD software and write own functions to a CFD software. In addition, students are able to identify the limitations and simplifications of numerical simulations related to problems.

Contents:

Advanced topics of computational fluid dynamics. Multiphase flows. Real gasmodels. Condensation. Multi-fluid heat transfer. Turbomachinery. Meshing. Implementation of functions to a CFD software. Transient multi-domain simulation.

Teaching Methods:

3rd period: 12 h of lectures, 12 h of exercises. 4th period: 12 h of lectures, 12 h of exercises. Homeworks 24 h. Project works 58 h.
Total workload 130 h.

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5. Homeworks 50% and project works 50%.

Course Materials:

Material in course's Moodle page. Notes done by the lecturers.

Prerequisites:

BH40A1560 Fundamentals of Computational Fluid Dynamics or equivalent knowledge.

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

Max. 10

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

Max. 10

KoDSaManu: Modern Manufacturing, 20 - 30 cr

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

Aims:
After completing this minor subject the student will be able to:
- calculate manufacturing process parameter to metallic products to achieve successfully production in technically manner but also economically wise
- design total manufacturing order and overall process to achieve efficient production rate with old and new machines
- create total manufacturing chain from original distributor to end user
- listen, discuss, understand and negotiate with different people with different organizational level
- find and create new production solutions for rapidly changing world
After the studies, students:
- have a theoretical or practical capability to work international environment.
- will understand the importance of the production for the national economy.
- have a theoretical or practical understanding of overall manufacturing and supply chain process to understand deeply different workers role in production.
- have a theoretical or practical understanding of a queque, mathematical distribution and simulation theory used in job shops.
- have a theoretical or practical understanding of a normally used manufacturing process.

Obligatory Studies 25 ECTS cr

BK50A4000: Production Processes in Modern Job Shops, 5 cr

Validity: 01.08.2016 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Mika Lohtander, Juho Ratava

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

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

Contents:

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

Teaching Methods:

Lectures 24 h, lecture exercises 12 h. Independent work like assignments and learning diary 94 h. Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Lecture assignments 60 %, learning diary 40 %.

Course Materials:

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

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

No

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

max 5

BK50A4100: Manufacturing Systems and Scheduling, 5 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Esko Niemi, Mika Lohtander

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

After completing the course, the student:
1. is able to evaluate the most important production parameters like lead time and bottlenecks by means of simulation
2. is able to design fundamentals of the manufacturing systems
3. is able to evaluate manufacturing time and manufacturing costs based on manufacturing simulation
4. is able to make optimization for most common manufacturing environments.

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, activity during course 40 %, individual assigments 60 %.

Course Materials:

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

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

No

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

No

BK50A4200: Product Flow in Job Shops, 5 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Mika Lohtander

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

Yes, lecturing every socond year, next time in period 1. and 2. in year 2018-2019.

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

After having passed the course, the student will:
1. is able to act as a product manager in a manufacturing plant
2. is able to analyze production capacity and to make improvement for production
3. is able to take responsibility for the daily operations of a production plant
4. is able to respond plant investments

Contents:

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

Teaching Methods:

Lectures 24 h, Group assignment and individual work 106 h. Total workload 130 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, lecture activity 40 %, assignment and individual work 60 %.

Course Materials:

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

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

No

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

No

BK50A4300: Managing Job Shops, 5 cr

Validity: 01.08.2016 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Mika Lohtander

Note:

The course will be lectured for the next time during the academic year 2019-2020.

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

Yes, 2019-2020.

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

After having passed the course, the student will:
1. know the factory management duty and responsibility
2. is able to take responsibility for the daily operations of a production plant
3. know the stakeholders role for production

Contents:

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

Teaching Methods:

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

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, Activity during lectures and exercises 20 %, individual work 80 %.

Course Materials:

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

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

No

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

No

BK50A4401: Fabrication Laboratory, 5 - 10 cr

Validity: 01.08.2017 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Mika Lohtander

Note:

Suitable also for doctoral studies.

Year:

M.Sc. (Tech.) 1-2

Period:

1-4

Teaching Language:

English

Teacher(s) in Charge:

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

Aims:

After having passed the course, the student will:
1. get touch some important research topics in field of manufacturing
2. be familiar how to transfer research result to practice
3. is capable to create or build simple and practical solutions.

Contents:

The course lectures will discuss the annually changing research themes. During the course the students will plan, design and in some cases built industrial systems. Students
will present their Project Work results to a public audience.

Teaching Methods:

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

Suitability for doctoral studies (Yes/Leave empty):

Yes

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

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

Course Materials:

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

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

No

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

max 5

Description and DL of the company assignment:

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

SaDREE: Renewable Energy and Energy Efficiency, 20 cr

Validity: 01.08.2015 -
Form of study:
Type: Study module
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F

Aims:
The student completing the minor studies in renewable energy and energy efficiency is able to describe renewable energy technologies and recognise issues related to renewable energy production and economics. Moreover, the student is able to describe and explain renewable energy conversion processes and is capable of respective investment and system planning. Additionally, the student is able to estimate the overall energy efficiency of the energy conversion system.

Choose a min. of 20 ECTS cr. BL10A8400SS is a LUT Summer School course.

BL10A8400SS: Solar Economy and Smart Grids, 3 cr

Validity: 01.06.2014 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Satu Viljainen, Jarmo Partanen, Christian Breyer, Olli Pyrhönen

Year:

M.Sc. (Tech.) 1–2

Period:

INT. Summer School

LUT Summer School time:

6. – 10.8.2018

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

After having passed this course the student is able to:
- understand the basic processes of solar economy and Smart Grids
- recognize the key properties of global climate challenges, solar economy, electricity market models, wind and solar power technologies, energy storage technologies and smart grid concept
- recognize the most important aspects, chances and challenges of transformation from existing energy systems to sustainable energy systems.

Contents:

During the course the student will become familiar with the properties and application areas of:
- Climate change
- Solar economy
- Wind power technology
- Solar power technology
- Energy Storage Technologies
- New electricity market
- Demand response
- Smart Grid concept.

Teaching Methods:

- Introductory lectures and exercises 24 h
- Team work and a limited project work 20 h
- Presentations of the results of the team work/ project work 8 h
- Independent work is needed 26 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:

Final grade 0 –5, project work/presentation

Course Materials:

Lecture notes and other materials distributed during the course by email.

Prerequisites:

Previous studies either in electrical engineering, environmental engineering or energy engineering are recommended.

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

15–

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

max 5

BL20A1300: Energy Resources, 6 cr

Validity: 01.08.2014 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Christian Breyer, Michael Child

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Identify the constraints and potentials of all relevant energy sources in a global context. 2. Describe all relevant energy conversion technologies on the basis of their energy resource. 3. Analyse the principal structure of future energy systems on the basis of energy resource characteristics. 4. Describe the special relevance of wind energy and solar energy in the ongoing energy transformation.

Contents:

The course provides an overview on the availability of energy resources and related emissions and techno-economic maturity of related energy conversion technologies, which induces a fundamental structure for the future energy system and the related energy transformation pathway. The course comprises the main energy resources for the current and future energy system: crude oil,natural gas, coal, uranium, hydro power, bioenergy, solar energy, wind energy,geothermal energy, and ocean energy. These energy resources have different theoretical, technical and economic potentials as well as geographic variations in availability. The resources also differ considerably in the impact of the emissions related to the respective energy conversion technologies being relevant for the degree of sustainability. A broad variety of energy conversion technologies at different levels of maturity are used for utilizing the resources.

Teaching Methods:

Lectures 14 h, exercises 14 h, 1st period. Lectures 14 h,exercises 14 h, 2nd period. Examination 3h. Independent study 97 h.
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 100%.

Course Materials:

Material handed out in class and made available on Moodle.

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

15–

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

max 5

BL20A1400: Renewable Energy Technology, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 1

Period:

3-4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Identify the major renewable energy (RE) conversion technologies, mainly converting resources to electricity. 2. Describe the major characteristics of the technologies, in particular applications, efficiency, economics, industrial scale and future prospects. 3. Analyse the need for storage technologies and their different fields of application based on their key technical and economic features.

Contents:

The course is focused on the conversion of the resources to electricity. The RE technologies discussed in the course are: wind turbines, solar photovoltaics, solar thermal electricity generation and hydro powerplants. The storage technologies covered comprise a general overview and in particular include battery storage, pumped hydro storage and power-to-gas technologies. All technologies are classified with respect to their applications, efficiency, maturity, economics, industrial scaling and expected relevance for the ongoing energy transformation.

Teaching Methods:

3rd period lectures 14 h, exercises 14 h. 4thperiod lectures 14 h, exercises 14 h, examination 3 h.
Independent study 97 h.
Total workload 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:

Material handed out in class and made available on Moodle.

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

15–

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

max 5

BL20A1500: Energy Scenarios, 6 cr

Validity: 01.08.2015 -
Form of study: Basic studies
Type: Course
Unit: LUT School of Energy Systems
Grading: Study modules 0-5,P/F
Teachers: Michael Child, Christian Breyer

Year:

M.Sc. (Tech.) 2

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc. (Tech.) Christian Breyer

Aims:

Upon completion of the course the student will be able to: 1. Describe the sustainability requirements of future energy systems as the major guard rail for the energy transformation. 2. Analyse energy transformation scenarios and identify the key technologies and setups for sustainable energy progress. 3. Describe the energy transformation in all sectors, the major technologies, the required transformation period and entire system cost optimization. 4. Describe the special role of power technologies for the energy transformation. 5. Recognize the difference between standard levelized cost ofenergy and total societal cost of energy.

Contents:

The course comprises the key elements of energy scenarios: demand, supply, cost, constraints. Energy demand is an aggregate of power, heat, cooling, mobility, agriculture and industrial energy needs. The demand has tobe matched with supply of energy fulfilling sustainability criteria, safety requirements and societal acceptance for the least cost. A complete set of demand curves, technical characteristics of all major technologies, current and projected technology costs and emission factors are taken into account for sustainable energy transformation pathway formulation. The special relevance ofwind energy and solar photovoltaics, the increasing relevance of power technologies,the role of storage technologies and the necessity of societal cost of energy are discussed in detail. Real scenarios for Finland, Europe and the World used as references.

Teaching Methods:

1st period lectures 14 h, exercises 14 h. 2ndperiod lectures 14 h, exercises 14 h, presentation/oral examination 1 h. Independent study 99 h. Total workload 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, presentation/oral examination 100 %

Course Materials:

Material handed out in class and made available on Moodle.

Prerequisites:

BL20A1300 Energy Resources and BL20A1400 Renewable Energy Technology (at least one of the two courses)

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

max 15

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

max 5

BL40A2301: Energy Efficiency, 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, Antti Kosonen, Tero Kaipia, Tero Ahonen, Lasse Laurila

Note:

The course is suitable for distance learning.

Year:

M.Sc. (Tech.) 1

Period:

4

Teaching Language:

English

Teacher(s) in Charge:

Professor, D.Sc (Tech.) Jero Ahola

Aims:

Upon completion of the course the student will be able to: 1. determine actions for the energy efficiency of the energy conversion process, 2. estimate the overall energy efficiency of the energy conversion system, 3. identify applications of electric energy usage and apply
methods that can be used to improve the energy efficiency.

Contents:

The course provides the student with an introduction to the significance and development potential of energy efficiency in energy production, transmission, distribution and end use. The focus is on electric energy and systems approach. The lecture topics are the efficiency of
energy production processes, the efficiency of electricity transmission and distribution and the efficiency

of energy end use. The course is arranged as a series of lectures delivered by experts. The lecture topics may vary from year to year.

Teaching Methods:

Lectures 12 h, individual home works 141 h, examination 3 h. The course is suitable for distance learning. Total workload 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, examination 100%. In addition, 70 % of individual assignments have to be passed. It is also possible to receive additional points to the exam based on the individual assignments.

Course Materials:

Lecture material in Moodle.

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

15–

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

max 15

BH61A0600: Bioenergy, 3 cr

Validity: 01.08.2011 -

Form of study: Basic studies

Type: Course

Unit: LUT School of Energy Systems

Grading: Study modules 0-5,P/F

Teachers: Tapio Ranta

Year:

M.Sc. (Tech.) 1

Period:

1

Teaching Language:

English

Teacher(s) in Charge:

Tapio Ranta, D.Sc. (Tech.), Professor

Aims:

Upon completion of the course the student will be able to understand the meaning of bioenergy, alternative biomass resources,supply methods, refining and end-user applications; describe the quality properties of solid biofuels and how they are measured and evaluated by using standards; and explain the meaning of sustainability in bioenergy systems.

Contents:

The role of bioenergy in the EU energy policy,incentive programmes and future plans. Raw-material sources of bioenergy, potential resources and current use. Biomass supply systems and logistics. Refined biofuel commodities, biogas and liquid biofuels. Biomass international trade. Quality properties of solid biofuels, quality measurement and standards. Sustainable bioenergy.

Teaching Methods:

1st period: 12 h of lectures. Written examination 3 h. 63 h of self-study.
Total workload 78 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:

Energy Visions 2050, VTT. 2009. Chapters 2, 4.4, 5.2- 5.4.
Additional material will be announced later during lectures.

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

15–

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

max 5

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

FyDInt300: Technical Physics, 20 - 26 cr

Validity: 01.08.2009 -

Form of study:

Type: Study module

Unit: LUT School of Engineering Science

Aims:
By the end of minor, the student:
- knows basic phenomenon in physics

- understands dependences and interactions
- is able to make experimental work in physics
- knows basic definitions and most important methods in physics

A minimum of 20 ECTS cr should be selected from the courses below.

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

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, 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:

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

BM30A2100: Microelectronics Processing Technology, 2 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: Tuure Tuuva

Year:

M.Sc. (Tech.) 1

Period:

1-2

Teaching Language:

English

Teacher(s) in Charge:

Professor, Ph.D. Tuure Tuuva

Aims:

To provide the student with a basic knowledge of microelectronics processing technology and components. Oxidation, diffusion and metallization.

Contents:

Purification of semiconductor materials. Growth of semiconductor crystals and wafer preparation. Epitaxial layers, diffusion, ion implantation, oxidation, etching and photolithography. Semiconductor manufacturing and development.

Teaching Methods:

Special assignment 52 h.

Examination in Examination schedule (Yes/No):

No

Examination in Moodle (Yes/No):

No

Examination in Exam (Yes/No):

No

Assessment:

0-5, seminar and/or written assignment 100 %.

Course Materials:

Plummer, J. D., Deal, M. D., Griffin, P. B., Silicon VLSI Technology: Fundamentals, Practice and Modeling.

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: Erkki Lähderanta, Egor Fadeev

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: Igor Rozhanskiy, Anton Komlev, 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

MaDIntM300: Technomathematics, 20 cr

Validity: 01.08.2009 -

Form of study:

Type: Study module

Unit: LUT School of Engineering Science

Aims:
By the end of minor, the student is able to build mathematical models for some practical problems and is able to use computational methods to solve those.

Choose a minimum of 20 ECTS cr

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: Jouni Sampo, Arto Kaarna, Erkki Lähderanta

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

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

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

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

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

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