Opasraportti

ITEE - Electronics and Communications Engineering (2020 - 2021)

University’s new study guide for academic year 2020-2021 is published at https://opas.peppi.oulu.fi

The study guide includes information on degrees, curriculums, courses and course timetables. Course registrations are still done in Oodi.

If you have questions on information in the study guide, please contact the study field's Academic Affairs Service Team https://www.oulu.fi/forstudents/faculty-study-affairs

Degree Programme in Computer Science and Engineering

Programme Structure Diagram of Degree Programme in Electronics and Communications Engineering: Bachelor of Science (Technology) and Master of Science (Technology, 5 year),

Programme Structure Diagram of Master's Programme in Electronics and Communications Engineering (2 year) and

The International Master’s Degree Programme in Wireless Communications Engineering (WCE) (2 year), Programme Structure Diagrams are here.

Programme Directors of Degree Programme are Jari Hannu (Bachelor) and Matti Isohookana (Master).

Study Advising

In the Degree Programme in Computer Science and Engineering: study.itee(at)oulu.fi. More information about studying can be found on the website: https://www.oulu.fi/forstudents/

Tutor Teachers and Student Tutors

Everyone new student is appointed tutor teacher and student tutor in Univeristy of Oulu. Tutor Teachers of Degree Programme in Computer Science and Engineering and student tutors is here.

Courses and registering

University’s new study guide for academic year 2020-2021 is published at https://opas.peppi.oulu.fi. The study guide includes information on degrees, curriculums, courses and course timetables. Information about the courses can be found by adding course code or name to ‘Search box’.

During the first period (August 31- October 25) of the autumn semester, lectures will primarily be delivered remotely. PEPPI's study guide may still be information about the lecture hall, but the lectures are remote in the first period. Teachers send information about the course closer to the start of the course, when you are registered in the course.

Students still register for the courses in WebOodi.

Exams

Registration for the exam takes place via WebOodi or in the electronic exam system. It is not always mandatory to register teacher's the course exams.

Tutkintorakenteet

MSc. Engineering, Electronics and Communications Engineering

Tutkintorakenteen tila: published

Lukuvuosi: 2020-21

Lukuvuoden alkamispäivämäärä: 01.08.2020

Option (60 - 80 op)

Electronics Design

H451229: Module of the Option, Electronics Design, 60 - 87 op
- *Compulsory*
  - A451221: Module of the Option, Electronics Design, 30 - 38 op
    - *Compulsory studies, Total 33 ECTS cr*
      - 521401S: Electronics Design II, 6 op
      - 521405A: Electronic System Design, 5 op
      - 521088S: Optoelectronics, 5 op
      - 521326S: Radio Engineering 1, 5 op
      - 521423S: Embedded System Project, 5 op
      - 521406S: Digital Techniques 3, 7 op
  - A451289: Advanced module/Electronics design, electronics design (obligatory), 15 - 40 op
    - *Choose at least 15 ECTS cr in addition to Advanced Practical Training*
      - 521348S: Statistical Signal Processing 1, 5 op
      - 521435S: Electronics Design III, 6 op
      - 521457A: Software Engineering, 5 op
      - 521025S: Power Electronics, 5 op
      - 521453A: Operating Systems, 5 op
      - 521225S: RF Components and Measurements, 5 op
      - 521300S: Electronics Design and Construction Exercise, 6 op
      - 521402S: Telecommunications Circuit Design, 6 op
      - 521448S: Physical Design of Digital Integrated Circuits, 5 op
      - 521016A: Advanced Practical Training, 3 op
- *Choose optional Studies (39 ECTS cr or until the degree is 120 ECTS cr)*
  - 521410S: Special Course in Electronic Design, 4 - 7 op
  - 521327S: Radio Engineering II, 6 op
  - 521388S: Antennas, 5 op
  - 521089S: Printed Electronics, 5 op
  - 521124S: Electronic Sensors, 5 op
  - 521098S: Testing Techniques of Electronics and Printed Electronics, 5 op
  - 521328A: Simulations and Tools for Telecommunications, 5 op
  - 521279S: Signal Processing Systems, 5 op
  - 521281S: Application Specific Signal Processors, 5 op

Electronics materials and components

H451226: Module of the Option, Electronics Materials and Components, 60 - 80 op
- *Compulsory*
  - A451222: Module of the Option, Electronics Materials and Components, 35 - 41 op
    - *Module of the Option, Compulsory studies, 41 ECTS cr (Note: 521028S Small/medium power energy harvesting and storage devices will be lectured in odd years (-19, -21,…))*
      - 521401S: Electronics Design II, 6 op
      - 521124S: Electronic Sensors, 5 op
      - 521326S: Radio Engineering 1, 5 op

521075S: Microelectronics Packaging Technologies, 5 op
521074S: Microelectronics and Micromechanics, 5 op
521215S: Microelectronics project, 5 op
521225S: RF Components and Measurements, 5 op
521028S: Small/Medium Power Energy Harvesting and Storage Devices, 5 op
A451291: Advanced Module, Electronics Materials and Components, 10 - 52 op
Advanced module, Obligatory courses 23 ECTS cr. (Note: 521028S X-ray Diffraction will be lectured in even years (-20, -22,…)
521072S: Microsensors, 5 op
521089S: Printed Electronics, 5 op
521016A: Advanced Practical Training, 3 op
521079S: Introduction to Nanotechnology, 5 op
521080S: X-ray Diffraction, 5 op
Recommended optional studies 26 ECTS cr or until the degree is 120 ECTS cr
521435S: Electronics Design III, 6 op
521405A: Electronic System Design, 5 op
521406S: Digital Techniques 3, 7 op
521423S: Embedded System Project, 5 op
521300S: Electronics Design and Construction Exercise, 6 op
521096S: Measurement Systems, 5 op
521088S: Optoelectronics, 5 op
521098S: Testing Techniques of Electronics and Printed Electronics, 5 op
521115S: EMC Design, 5 op
521388S: Antennas, 5 op
521386S: Radio Channels, 5 op
521327S: Radio Engineering II, 6 op

Telecommunication Engineering

H453221: Module of the Option, Telecommunication Engineering, 60 - 80 op
Module of the option, Telecommunication, Obligatory Studies 40 ECTS cr
A451224: Module of the Option, Telecommunication Engineering, 40 - 41 op
Module of the Option. 40 ECTS cr
031051S: Numerical Matrix Analysis, 5 op
521348S: Statistical Signal Processing 1, 5 op
521395S: Wireless Communications I, 5 op
031025A: Introduction to Optimization, 5 op
521340S: Communications Networks I, 5 op
521324S: Statistical Signal Processing II, 5 op
521349S: Wireless Communications II, 5 op
521326S: Radio Engineering 1, 5 op
Advanced module, obligatory courses, min. 33 ECTS cr
A453273: Advanced module, Telecommunication Engineering, 10 - 47 op
Advanced module mandatory courses, choose min. 30 ECTS cr in addition to Advanced Practical Training 3 ECTS cr. These are alternative: 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise.
521386S: Radio Channels, 5 op
521328A: Simulations and Tools for Telecommunications, 5 op
521327S: Radio Engineering II, 6 op
521377S: Communications Networks II, 7 op
521388S: Antennas, 5 op
521279S: Signal Processing Systems, 5 op
521322S: Telecommunication Engineering Project, 5 op
521300S: Electronics Design and Construction Exercise, 6 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521389S: Wireless Body Area Networks, 5 op
521325S: Communication Signal Processing, 5 op
521390S: Information Theory, 5 op
521391S: Channel Coding and Modulation, 5 op
521392S: Convex Optimization, 7 op
521393S: Statistical Communication Theory, 7 op
521394S: Multiantenna Communications, 5 op
521016A: Advanced Practical Training, 3 op

Optional Studies

A453295: Advanced Module, Telecommunication Engineering (optional studies), 11 - 37 op

Optional studies, until the degeree is full (120 ECTS cr)

521401S: Electronics Design II, 6 op
521406S: Digital Techniques 3, 7 op
555285A: Project management, 5 op
555391S: Advanced Course in Project Management, 5 op

RF-engineering

H453222: Modules of the option RF Engineering, 70 - 90 op

Compulsory

A451226: Module of the option, RF Engineering, 36 - 71 op

Obligatory studies: basic and advanced module, tot. 36 ECTS cr

521401S: Electronics Design II, 6 op
521348S: Statistical Signal Processing 1, 5 op
521395S: Wireless Communications I, 5 op
521326S: Radio Engineering 1, 5 op
521324S: Statistical Signal Processing II, 5 op
521225S: RF Components and Measurements, 5 op
521405A: Electronic System Design, 5 op

A451297: Advanced Module, Radio engineering, 36 - 42 op

Radio engineering - advanced module

521435S: Electronics Design III, 6 op
521327S: Radio Engineering II, 6 op
521075S: Microelectronics Packaging Technologies, 5 op
521388S: Antennas, 5 op
521402S: Telecommunications Circuit Design, 6 op
521016A: Advanced Practical Training, 3 op

Obligatory, Radio engineering - advanced module, Choose 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise

521322S: Telecommunication Engineering Project, 5 op
521300S: Electronics Design and Construction Exercise, 6 op

Optional studies: please select courses so that the minimum extent is 120 ECTS.

521386S: Radio Channels, 5 op
521328A: Simulations and Tools for Telecommunications, 5 op
521340S: Communications Networks I, 5 op
521349S: Wireless Communications II, 5 op
521289S: Machine Learning, 5 op
521279S: Signal Processing Systems, 5 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521325S: Communication Signal Processing, 5 op

Photonics and Measurement Techniques

H451227: Module of the Option, Photonics and Measurement Technology, 60 - 80 op

Module of the option, compulsory studies, 30 ECTS cr

A451223: Module of the Option, Photonics and Measurement Techniques, 30 - 41 op

Compulsory courses, 30 ECTS cr

521088S: Optoelectronics, 5 op
521096S: Measurement Systems, 5 op
521124S: Electronic Sensors, 5 op
521089S: Printed Electronics, 5 op
521097S: Wireless Measurements, 5 op
521176A: Laboratory Works of Electronic Measurement Techniques, 5 op

A451298: Advanced Module, Photonics and Measurement Techniques, 18 - 45 op

select at least three courses in addition to Advanced Practical Training.

521092A: Electronic Measurement Techniques, 5 op
521242A: Introduction to Biomedical Engineering, 5 op
521240S: Biophotonics and Biomedical Optics, 5 op
521093S: Biomedical Instrumentation, 5 op
521079S: Introduction to Nanotechnology, 5 op
521098S: Testing Techniques of Electronics and Printed Electronics, 5 op

521115S: EMC Design, 5 op
521108S: Optical Measurement Technology Exercise, 5 - 10 op
521175S: Printed electronics design and construction exercise, 5 op
521016A: Advanced Practical Training, 3 op
Optional Studies (42 ECTS cr): Photonics and measurement techniques. You must take the optional studies to make total 120 ECTS cr
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521395S: Wireless Communications I, 5 op

Master's Thesis (30 op)

The Master's Thesis requires seminar and written maturity test.

521362S: Electonics and Communications Engineering Seminar, 0 op
521976S: Master's Thesis in Electronics and Communications Engineering, 30 op
521011S: Maturity Test for Master's Degree, Electronics and Communications Engineering, 0 op

Master's Programme in Wireless Communications Engineering

Tutkintorakenteen tila: published

Lukuvuosi: 2020-21

Lukuvuoden alkamispäivämäärä: 01.08.2020

Module of the option (40 op)

Choose one of the available options. All courses are compulsory.

A451225: Module of the Option, Wireless Communications Engineering, 40 - 65 op
obligatory studies of the RAN stydy option
031051S: Numerical Matrix Analysis, 5 op
521348S: Statistical Signal Processing 1, 5 op
521395S: Wireless Communications I, 5 op
031025A: Introduction to Optimization, 5 op
521340S: Communications Networks I, 5 op
521324S: Statistical Signal Processing II, 5 op
521349S: Wireless Communications II, 5 op
521326S: Radio Engineering 1, 5 op
A451226: Module of the option, RF Engineering, 36 - 71 op
Obligatory studies: basic and advanced module, tot. 36 ECTS cr
521401S: Electronics Design II, 6 op
521348S: Statistical Signal Processing 1, 5 op
521395S: Wireless Communications I, 5 op
521326S: Radio Engineering 1, 5 op
521324S: Statistical Signal Processing II, 5 op
521225S: RF Components and Measurements, 5 op
521405A: Electronic System Design, 5 op

Advanced Module (vähintään 30 op)

Radio Access Networks (WCE-RAN)

A453273: Advanced module, Telecommunication Engineering, 10 - 47 op
Advanced module mandatory courses, choose min. 30 ECTS cr in addition to Advanced Practical Training 3 ECTS cr. These are alternative: 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise.
521386S: Radio Channels, 5 op

521328A: Simulations and Tools for Telecommunications, 5 op
521327S: Radio Engineering II, 6 op
521377S: Communications Networks II, 7 op
521388S: Antennas, 5 op
521279S: Signal Processing Systems, 5 op
521322S: Telecommunication Engineering Project, 5 op
521300S: Electronics Design and Construction Exercise, 6 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521389S: Wireless Body Area Networks, 5 op
521325S: Communication Signal Processing, 5 op
521390S: Information Theory, 5 op
521391S: Channel Coding and Modulation, 5 op
521392S: Convex Optimization, 7 op
521393S: Statistical Communication Theory, 7 op
521394S: Multiantenna Communications, 5 op
521016A: Advanced Practical Training, 3 op

Radio engineering (WCE-RF)

A451297: Advanced Module, Radio engineering, 36 - 42 op
Radio engineering - advanced module
521435S: Electronics Design III, 6 op
521327S: Radio Engineering II, 6 op
521075S: Microelectronics Packaging Technologies, 5 op
521388S: Antennas, 5 op
521402S: Telecommunications Circuit Design, 6 op
521016A: Advanced Practical Training, 3 op
Obligatory, Radio engineering - advanced module, Choose 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise
521322S: Telecommunication Engineering Project, 5 op
521300S: Electronics Design and Construction Exercise, 6 op

Supplementary module/Electives, WCE (16 - 31 op)

Choose from the set courses to reach the minimum of 120 ECTS degree (including the thesis and practical training).

A453246: Supplementary module/Electives, Wireless Communications Engineering, 10 - 41 op
Radio engineering (WCE-RF): Optional courses
521386S: Radio Channels, 5 op
521328A: Simulations and Tools for Telecommunications, 5 op
521340S: Communications Networks I, 5 op
521349S: Wireless Communications II, 5 op
521325S: Communication Signal Processing, 5 op
WCE-RAN and WCE-RF
900017Y: Survival Finnish, 2 op
900013Y: Beginners' Finnish Course 1, 3 op
900053Y: Beginners' Finnish Course 2, 5 op
521225S: RF Components and Measurements, 5 op
521097S: Wireless Measurements, 5 op
521389S: Wireless Body Area Networks, 5 op
813621S: Research Methods, 5 op
521273S: Biosignal Processing I, 5 op
521282S: Biosignal Processing II, 5 op
521467A: Digital Image Processing, 5 op
521145A: Human-Computer Interaction, 5 op
521045S: Mobile Computing, 5 op
521043S: Internet of Things, 5 op
521140S: Computer Graphics, 5 op
521290S: Distributed Systems, 5 op
521466S: Machine Vision, 5 op
521156S: Towards Data Mining, 5 op
521260S: Programmable Web Project, 5 op
521479S: Software Project, 7 op

521283S: Big Data Processing and Applications, 5 op
521158S: Natural Language Processing and Text Mining, 5 op
521289S: Machine Learning, 5 op
521161S: Multi-Modal Data Fusion, 5 op
521285S: Affective Computing, 5 op
521153S: Deep Learning, 5 op
521155S: Computer Security, 5 op
521495A: Artificial Intelligence, 5 op
521042S: Creative Design, 5 op
521288S: Multiprocessor Programming, 5 op
521281S: Application Specific Signal Processors, 5 op
521423S: Embedded System Project, 5 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521322S: Telecommunication Engineering Project, 5 op
521300S: Electronics Design and Construction Exercise, 6 op

Advanced practical training (3 op)

521016A: Advanced Practical Training, 3 op

Master's Thesis (30 op)

The Master's Thesis requires a written maturity test and a seminar.

521362S: Electonics and Communications Engineering Seminar, 0 op
521975S: Master's Thesis / Master's Degree Programme in Wireless Communications Engineering, 30 op
521011S: Maturity Test for Master's Degree, Electronics and Communications Engineering, 0 op

Degree Programme in Electronics and Communications Engineering, B.Sc.

Tutkintorakenteen tila: published

Lukuvuosi: 2020-21

Lukuvuoden alkamispäivämäärä: 01.08.2020

Basic and Intermediate Studies

A451120: Basic and Intermediate Studies, Electrical Engineering, 150 - 170 op
Choice of second domestic language, written and spoken. Basic and Intermediate Studies are 144 ECTS cr (includes 2 ECTS cr Swedish and 4 ECTS cr English)
901048Y: Second Official Language (Swedish), Written Skills, 1 op
901049Y: Second Official Language (Swedish), Oral Skills, 1 op
900081Y: Second Official Language (Finnish), Written Skills, 1 - 2 op
900082Y: Second Official Language (Finnish), Oral Skills, 1 - 3 op
Choose the minimum of 4 ects ofEnglish or German modules
902150Y: Professional English for Technology, 2 op
902142Y: Business Correspondence, 2 op
902145Y: Working Life Skills, 2 op
902147Y: Academic Vocabulary for Science and Technology, 2 op
902149Y: Mechanics of Writing, 2 op
903024Y: Elementary Course in German 1, 3 - 4 op
903025Y: Elementary Course in German 2, 3 - 4 op
903029Y: Intermediate Course in German 1, 3 - 4 op
903030Y: Intermediate Course in German 2, 3 - 4 op
Compulsory to all
521007P: Orientation to Electronics and Communications Engineering, 3 op
031010P: Calculus I, 5 op

521077P: Introduction to Electronics, 5 op
521109A: Electrical Measurement Principles, 5 op
521141P: Elementary Programming, 5 op
031078P: Matrix Algebra, 5 op
031075P: Calculus II, 5 op
031021P: Probability and Mathematical Statistics, 5 op
521301A: Digital Techniques 1, 8 op
031076P: Differential Equations, 5 op
521150A: Introduction to Internet, 5 op
031077P: Complex analysis, 5 op
521302A: Circuit Theory 1, 5 op
521287A: Introduction to Computer Systems, 5 op
031080A: Signal Analysis, 5 op
521303A: Circuit Theory 2, 5 op
521071A: Principles of Semiconductor Devices, 5 op
521337A: Digital Filters, 5 op
521431A: Principles of Electronics Design, 5 op
521070A: Introduction to Microfabrication Techniques, 5 op
521330A: Telecommunication Engineering, 5 op
521432A: Electronics Design I, 5 op
761312A: Electromagnetism 2, 5 op
521404A: Digital Techniques 2, 5 op
521307A: Laboratory Exercises on Analogue Electronics, 5 op
521241A: Optical systems, 5 op
521384A: Basics in Radio Engineering, 5 op
030005P: Information Skills, 1 op

BSc thesis and related studies (10 op)

The extent of the BSc thesis in Electrical Engineering is 8 credits. Choose 523990A Electrical Engineering. Maturity exam and seminar presentation are also required.

523990A: Bachelor's Thesis / Electronics and Communications Engineering, 8 op
521010A: Maturity Test for Bachelor's Degree, Electronics and Communications Engineering, 0 op
521036A: Seminar for Bachelor`s Degree, Electronics and Communications Engineering, 0 op
900060A: Technical Communication, 2 op

Supplementary Studies (15 - 55 op)

Choose a supplementary module (15-20 ECTS cr). Courses that are not found in the suplementary modules can be added to the optional studies.

H453223: Supplementary Module (Electronics and Communications Engineering), 15 - 55 op
Supplementary Module: 1. Electronics and Communications Engineering
521329A: Hands-on Course in Wireless Communication, 5 op
521328A: Simulations and Tools for Telecommunications, 5 op
521304A: Filters, 5 op
521210A: Electronics Materials, 5 op
521092A: Electronic Measurement Techniques, 5 op
521405A: Electronic System Design, 5 op
521015A: Practical Training, 3 op
Supplementary Module: 2. Computer Science and Engineering
521159P: Principles of Digital Fabrication, 5 op
521160P: Introduction to Artificial Intelligence, 5 op
031023P: Mathematical Structures for Computer Science, 5 op
521457A: Software Engineering, 5 op
521453A: Operating Systems, 5 op
521467A: Digital Image Processing, 5 op
521495A: Artificial Intelligence, 5 op
521157A: Introduction to Social Network Analysis, 5 op
521040A: 3D Virtual Environments and Applications, 5 op
Supplementary Module: 3. Biomedical Engineering

080925A: Anatomy and Physiology for Biomedical Engineering, 5 op
764327A: Virtual measurement environments, 5 op
080901A: Introduction to Technology in Clinical Medicine, 5 op
521242A: Introduction to Biomedical Engineering, 5 op
080926A: Introduction to Biomedical Imaging Methods, 1 - 3 op

Supplementary Module: 4. Information Processing Science, Can choose freely from the courses below.

810136P: Introduction to Information Processing Sciences, 5 op
811168P: Information Security, 5 op
811174P: Introduction to Software Business, 5 op
811325A: Databases, 5 op
811322A: Programming 2, 5 op
811367A: Programming 3, 5 op
811368A: Programming 4, 5 op
811391A: Requirements Engineering, 5 op
811306A: Software Quality and Testing, 5 op
811319A: Data Modeling and Design, 5 op
815345A: Software Architectures, 5 op
811379A: Basics of Human Computer Interaction, 5 op
812332A: Information Systems Design, 5 op
811375A: User Interface Programming, 5 op
813316A: Business Process Modeling, 5 op

Supplementary Module: 5. Industrial Engineering and Management

555225P: Basics of industrial engineering and management, 5 op
555285A: Project management, 5 op
555242A: Product development, 5 op
555286A: Process and quality management, 5 op
555264P: Managing well-being and quality of working life, 5 op

Supplementary Module: 6. Physics

761108P: Physical world view, 5 op
761118P: Mechanics 1, 5 op
761119P: Electromagnetism 1, 5 op
761313A: Atomic physics 1, 5 op
761314A: Thermophysics, 5 op
761310A: Wave motion and optics, 5 op
763343A: Solid state physics, 5 op

Supplementary Module: 7. Chemistry

780117P: General and Inorganic Chemistry A, 5 op
780118P: General and Inorganic Chemistry B, 5 op
780116P: Introduction to Organic Chemistry, 5 op
780127P: Principles of Chemistry Labwork, 5 op
780119P: Introduction to Analytical Chemistry, 5 op

Supplementary Module: 8. Basic Business Studies

724835P: Basics of Management and Organizations, 5 op
724836P: Introduction to Corporate Social Responsibility, 5 op
724830P: Introduction to Accounting and Financial Management, 5 op
724832P: Economics and The Business Environment, 5 op
724833P: Introduction to Entrepreneurship, 5 op
724834P: Basics of Marketing and Sales, 5 op
724837P: Understanding and managing a business as a dynamic whole - business simulation game, 5 op
724831P: Introduction to Business Law, 5 op

Supplementary Module: 9. Entrepreneurship

724814P: Introduction to Business Development, 5 op
724813P: Entrepreneurship in Action, 5 op
724815P: Entrepreneurial Assignment, 5 op
724811P: Entrepreneuring for Sustainability, 5 op
724812P: Building Change Through Entrepreneurship, 5 op
724816P: Building Business Through Creativity and Collaboration, 5 op

Supplementary Module: 0. Exchange Studies and Supplementary Module: 10. OAMK - Sähkövoimatekniikka (15 -20 op) and Supplementary Module: 11. OAMK - tieto ja viestintätekniikka (15 op)

030009M: Studies in Other Universities/Institutes, 0 - 60 op

Optional Studies (enintään 30 op)

Suitable courses are chosen so that the total degree of the degree is 180 ECTS cr.

Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

521026S: Advanced practical training, 5 op
521299S: Competence demonstration in electronics and telecommunication technology, 5 op
521907S: Fab Lab Digital Fabrication, 5 op
521905A: Fab Lab Electronics, 5 op
521906A: Fab Lab Programming, 5 op
521904A: Fab Lab Project Management, 5 op
521908S: Fab Lab Project Work, 5 op
521006P: Glimpse into ICT, 2 op
521018A: Practical training, 5 op
521229A: Principles of repurposing of electronics, 5 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuuluvien opintokohteiden kuvaukset

H451229: Module of the Option, Electronics Design, 60 - 87 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Other Entity
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory

A451221: Module of the Option, Electronics Design, 30 - 38 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Module of the Option
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory studies, Total 33 ECTS cr

521401S: Electronics Design II, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: English

Leikkaavuudet:

521443S	Electronics Design II	5.0 op

ECTS Credits:

6 ECTS

Language of instruction:

In Finnish (In English if needed).

Timing:

Autumn, period 1

Learning outcomes:

1. should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies
2. should be able to analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits
3. should be able to estimate and minimize the effects of noise in electrical circuits
4. should be able to explain the terminology used with DA and AD conversion and converters
5. should be able to analyze and outline the main architectural principles and also to evaluate the characteristics of DA and AD converters

Contents:

Modeling of BJT and MOS transistors, CMOS and BJT building blocks especially as IC-realizations, noise and analysis of noise, internal structure of operational amplifiers, critical parameters, comparators, S/H-circuits, structures and properties of A/D and D/A converters.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching: Lectures 30h, exercises 20h. Self study: a small design work 20h. Learning without guidance either privately or in a group 60h.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Principles of electronics design, Electronics design I

Recommended optional programme components:

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Recommended or required reading:

Lecture handout,T. C. Carusone, D. A. Johns & K.W. Martin: Analog integrated circuit design , Wiley cop. 2012. 2nd ed., chapters 1, 3, 6, 9, 10, 15, 16 and 17, parts of 4 ja 11; P.E. Allen & D.R. Holberg: CMOS Analog Circuit Design, Oxford University Press 2002, chapters 1,3,4,5, 6, 8 and 10.

Assessment methods and criteria:

The course unit is passed by a final exam and a passed design work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Määttä
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English/Finnish.

Timing:

Period 1

Learning outcomes:

1. is able to choose the optimum method of the choices presented in the course in the field of power supply, thermal design, grounding, and routing of the high speed signals.
2. is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components.
3. can calculate reliability of an electrical device or system.
4. The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.

Contents:

Power supplies, thermal design, grounding, transmission of fast signals by using transmission lines, electrical disturbances, crosstalk, non-idealities of electrical components.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 30 h of lectures and 20 h of exercises.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course.

Prerequisites and co-requisites:

Both Principles of Electronics Design and Analogue Electronics I must have been accepted.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Lecture notes. Ward & Angus: Electronic Product Design, Hall&Hall&McCall: High speed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques. Eric Bogatin: Signal and Power Integrity – Simplified, 2. ed.

Assessment methods and criteria:

The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No.

Other information:

-

521088S: Optoelectronics, 5 op

Voimassaolo: 01.01.2014 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Määttä
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn, period 1

Learning outcomes:

1. is able to explain the principles of operation of optical fibres and wavequides

2. is able to explain the principles of operation of semiconductor light sources and photo detectors, and knows the factors affecting their performance

3. is able to outline the circuit-level structures for optical transmitter circuits and photo detector preamplifiers

4. is able to compare their performance in terms of the main performance parameters

Contents:

Wave/particle dualism of optical radiation, optical waveguides and their properties, sources of radiation (LED- and laser structures), photo detectors (PIN- and AP-diodes,SPAD), light source modulation, preamplifiers and their bandwidth/stability/noise analysis.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h and exercises 20 h, may include a seminar.

Target group:

This course is targeted mainly for the students of electrical engineering degree program, but available for other students as well.

Prerequisites and co-requisites:

Principles of semiconductor devices.

Recommended optional programme components:

This course is independent, no other components are recommended simultaneously.

Recommended or required reading:

Lecture notes, S. Kasap: Optoelectronics and Photonics, Principles and Practices, Prentice Hall 2013, 2nd Ed.

Assessment methods and criteria:

Final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Kari Määttä

Working life cooperation:

Does not apply.

Other information:

-

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S-01	Radio Engineering	0.0 op
521326S-02	Radio Engineering	0.0 op
521335S	Radio Engineering	6.0 op
521335S-01	Radio engineering, partial credit	0.0 op
521335S-02	Exercise work, Radio engineering 1	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.
A student can also explain factors, which are limiting the bandwidth of impedance matching networks. Smith chart (admittance/impedance chart).
3. will be able to design a low noise RF amplifier. The amplifier is designed that the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.
4. knows single sideband and double sideband noise in mixers. A student will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.
5. will be able to design passive microwave components like a Wilkinson power divider, a directional coupler and hybrids.
6. can explain basic priciples of RF-oscillators. A student can design a cross-coupled oscillator and voltage controlled oscillator.

7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.
8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.

Contents:

Noise, non-linearity, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers design, Wilkinson power dividers, directional couplers, hybrids, automatic gain control (AGC), cross-coupled oscillator, voltage controlled oscillators, power amplifier design.

Mode of delivery:

The lectures and the exercises are organized as remote sessions.

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).

Target group:

1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521423S: Embedded System Project, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Tokola

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

Lecturing in Finnish, material available in English

Timing:

Spring, periods 3-4.

Learning outcomes:

1. After passing the course, the student is familiar with the design process of an embedded system, from specifying the application leading to the requirement specification for the device, and then to having produced a functional prototype of the defined system.
2. The student is more familiar with the roles of the client and the system developer during the requirement specification, and the role of the iterations as a part of the whole design process. From the specifications, the student is familiar with the process of choosing the suitable hardware components, circuit design and implementation. In the end, the student is also able to know the factors arising from the SW/HW partitioning process of the actual implementation, and the concept of SW/HW dualism. The student can then better utilize the basic development tools used for embedded system design and recognize their possible advantages and disadvantages.
3. The student is more familiar with the testing and problem solving methodology related to the prototype implementation of an embedded system, to have the prototype working correctly according to the specifications.

Contents:

The embedded system design process, from initial specification to implementation of a first functional prototype and demonstrating its functionality in practice. The application can be suggested by the student group, or chosen from the topics suggested by the course organizers. During the work, the students familiarize themselves with modern design tools and methodologies related to embedded system design (according to the microcontroller the student group has chosen to utilize in their work). Most commonly used platforms on the course include STM, Atmel and Microchip based platforms.

Mode of delivery:

Online teaching. Lectures, tutoring and self-study.

Learning activities and teaching methods:

The course is run as a project work in groups of three with progress follow-up reporting meetings. Lectures 10 h, laboratory exercise in period 3-4 120 h.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

811122P Introduction to Programming
521412A Digital Techniques I
Also recommended; 521275A Embedded Software Project, 521432A Electronics Design I.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

-

Assessment methods and criteria:

Project work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning

Working life cooperation:

None.

521406S: Digital Techniques 3, 7 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Jukka Lahti
Opintokohteen kielet: Finnish

ECTS Credits:

7 ECTS

Language of instruction:

In Finnish. Exams can be arranged in English on demand.

Timing:

Spring, peridos 3-4

Learning outcomes:

1. knows the phases of the design process of hardware parts of digital system implemented in FPGA or ASIC technologies, and understands their purpose, and the problems and aims associated with different design tasks

2. is able to use the tools needed in industrial design projects.

Contents:

1. Digital systems design process. 2. Assertion-based verification, 3. Universal verification methodology (UVM) 4. ASIC design and verification (technology choice, logic synthesis, physical synthesis, timing analysis, power analysis, design for testability). 5. Use of SystemC language in the modeling of digital circuits. 6. Architecture-level synthesis of digital circuits.

Mode of delivery:

Classroom

Learning activities and teaching methods:

Lectures 20h/ exercises 20h (group work)/ independent work 120h.

Target group:

Primarily electrical and computer science and engineering students. Also other student of University of Oulu can take the course.

Prerequisites and co-requisites:

Digital techniques 1 and Digital techniques 2

Recommended optional programme components:

-

Recommended or required reading:

Lecture textbook (in finnish) and literature announced during course.

Assessment methods and criteria:

Final exam and a design excercise, or weekly assignments consisting of theoretical and design exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5, The grade is the average of the exam and the design exercise.

Person responsible:

Jukka Lahti

Working life cooperation:

-

Other information:

-

A451289: Advanced module/Electronics design, electronics design (obligatory), 15 - 40 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Choose at least 15 ECTS cr in addition to Advanced Practical Training

521348S: Statistical Signal Processing 1, 5 op

Voimassaolo: 01.08.2016 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Janne Lehtomäki, Juntti, Markku Johannes
Opintokohteen kielet: Finnish
Leikkaavuudet:

521484A	Statistical Signal Processing	5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the key tools of linear algebra and quadratic optimization and can apply them in solving signal processing problems.
2. understands how to handle complex valued random variables and processes.
3. understands the key concepts in estimation theory such as the classical and Bayesian philosophies.
4. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
5. can derive an estimator for a given criterion and basic data models.
6. can use the methodology of estimation theory to analyze the performance of estimators and compare to performance benchmarks such as the Cramer-Rao lower bound.
7. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.

Contents:

Review of probability, complex valued random variables and stochastic processes; linear algebra, eigenvalue decomposition, SVD (Singular value decomposition), use of Matlab; estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, least squares estimation, Bayesian estimation, linear Bayesian estimation; statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching and e-learning tool usage

Learning activities and teaching methods:

Face-to-face-teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521330A. The recommended prerequisite is the completion of Telecommunication Engineering.

Recommended optional programme components:

521323S Wireless communications I and 031051S Numerical Matrix Analysis are recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory."vol 1 Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory, vol. 2." Prentice Hall 1999.
3. Peter Selinger, “Matrix Theory and Linear Algebra”, Creative Commons.
4. Paolo Prandoni & Martin Vetterli, Martin, “Signal Processing for Communications”, CRC Press 2008.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.7 and that of project report 0.3.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Janne Lehtomäki and Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle https://moodle.oulu.fi/course/view.php?id=4203.

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish (English as a book examination)

Timing:

Autumn, period 2

Learning outcomes:

1. On completion of the study module students should be able to detail the advantages of differential signal processing in IC realizations and

2. to analyze and design differential amplifiers and other electronic blocks for implementation in an IC environment.
3. They should be able to explain how an SC (switched capacitor) technology functions and to apply such a technology to sampling and filtering.
4. They should also be able to describe the principles for realizing continuous filters in IC technologies, to explain the principles of the delta–sigma technology
5. and to apply it for realizing integrated DA and AD converters.
6. They should be able to account for the functioning, use and architecture of a phase-locked loop,
7. to explain the functioning of an MOS transistor in the area of weak inversion and to indicate how use can be made of this functional area in circuit design.

Contents:

Advanced operational amplifier topologies, especially differential ones, bandgap and PTAT bias circuits and references, problems related to the design of multi-stage amplifiers (output stages, LP /LV implementations), signal sampling and error sources related to it, SC-techniques (especially in filters), implementation principles of continuous time IC filters, DS techniques in general and particularly in AD/DA converters, operations with frequency/phase domain signals, design of IC layout.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h and Exercises 20 h; Self-study or in a group of two persons: laboratory exercise 40 h (CAD tools used in IC design and familiarization into the complete analogue IC design flow) and learning without guidance either privately or in a group 69 h.
The course is organized remotely and Zoom links for lectures and exercises can be found from Moodle under the topics lectures and exercises.

Target group:

Electrical Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

Electronics Design II, Filters, Introduction to Microfabrication Techniques (recommended).

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

Lecture notes: D. A. Johns & K. Martin: Analog integrated circuit design, Wiley & Sons 1997 chapter 6, chapter 8 partially, 9, 10, 14, 15 and 2. Also P. E. Allen & D. R. Holberg: CMOS Analog Circuit Design, Oxford university press 2002, chapters 2, 7, and 9, proper parts of other chapters of the book.

Assessment methods and criteria:

Passed final exam and exercise work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521457A: Software Engineering, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Röning

Opintokohteen kielet: English

Leikkaavuudet:

ay521457A	Software Engineering (OPEN UNI)	5.0 op

ECTS Credits:

5

Language of instruction:

Finnish. Material available in English.

Timing:

Spring, period 3.

Learning outcomes:

1. After finishing the course, the student knows the basic concepts of software engineering
2. The student also knows the different areas of project management, the phases of software development
3. The student can defines goals and tasks for each phase of development
4. The student knows the principles of secure software development
5. The student knows the metrics used in software engineering and is able to apply them
6. The student is familiar with tools commonly used in software engineering.

Contents:

Problematics of software development and the special features of real-time systems in this regard. Software development is viewed in regard to project management and actual implementation: 1. process models, 2. requirements specification, 3. project management basics: design, metrics, risk management, resource management, follow up, quality control, product control, 4. software testing methods and strategies, 5. introduction to object-oriented analysis and design. 6. Agile software development. 7. Secure software engineering

Mode of delivery:

Online course

Learning activities and teaching methods:

The course consists of lectures and independent practical exercises. The course is completed by a final exam or learning diaries and successfully completed practical exercises. Lectures 30 h, laboratory design (in period 3) 8 h, the rest of the self-study.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521141P Elementary Programming, 521286A Computer Systems or 521142A Embedded Systems Programming.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

R.S. Pressman: Software Engineering - A Practitioner's Approach. Eight Edition. McGraw-Hill 2010. Older editions (6. and 7.) can also be used with some additional material.

Assessment methods and criteria:

Final exam and accepted laboratory exercise.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning

Working life cooperation:

-

521025S: Power Electronics, 5 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Määttä
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish.

Timing:

Period 3

Learning outcomes:

1. is able to discuss and write on the subject by using the terminology in the field of switching power supplies.

2. can analyze the operation of different switching power supplies in continuous and discontinuous conduction mode and in steady state operation.

3. is able to design various switching power supplies different dc-dc -applications.

4. can calculate loss mechanisms in design and estimate their effect on the efficiency of the switching converter. He or she is able to explain the basics of the ac-modeling of switching.

5. The course provides the basic knowledge on switched-mode power supplies so that the student recognizes the typical terminology and different topologies.

Contents:

Introduction to switched-mode converters, Steady-state analysis in continuous and discontinuous conduction modes, Transformer isolated converters. Power factor.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 30 h lectures and 20 h of exercises.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Courses Circuit Theory I-II, Electronics Design I-II or equivalent.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

R. W. Erickson, D. Maksimovic: Fundamentals of Power Electronics, 2nd ed. Kluwer Academic Publishers, 2004. Chapters 1-3, 5, 6, 7, 13 and chapter 16.
Lecture notes.

Assessment methods and criteria:

The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

Other information:

-

521453A: Operating Systems, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Röning

Opintokohteen kielet: English

Leikkaavuudet:

ay521453A	Operating Systems (OPEN UNI)	5.0 op

ECTS Credits:

5

Language of instruction:

In Finnish, material available in English

Timing:

Spring, period 4

Learning outcomes:

1. is capable of explaining the basic structure and functioning of operating system

2. is able to point the problems related to process management and synchronization as well as is able to apply learned methods to solve basic problems

3. is capable of explaining the cause and effect related to deadlocks and is able to analyse them related to common circumstances in operating systems

4. is able to explain the basics of memory management, the use of virtual memory in modern operating systems as well as the structure of the most common file-systems.

Contents:

Operating system structure and services, process management, process synchronization, deadlocks, memory management, virtual memory, file-systems

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

Lectures 36 h, laboratory exercise 4 h, the rest as independent work. The laboratory work, including pre-exercise and guided exercise performed in a group of one or two students in the unix environment, covers core topics of the course.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521141P Elementary Programming, 521286A Computer Systems or 521142A Embedded Systems Programming and 521267A Computer Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes (in Finnish) and exercise material. Silberschatz A., Galvin P., and Gagne G.: Operating System Concepts, 6th edition (or newer), John Wiley & Sons, Inc., 2003. Chapters 1-12.

Assessment methods and criteria:

The course is passed the final examination and accepted laboratory working.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning (lectures)
Anna-Mari Wartiainen (exercises)

Working life cooperation:

-

Other information:

-

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish. English, if there are at least 3 international students in class.

Timing:

The course is held in the 4^{th} period. It is recommended to complete the course during Master level studies.

Learning outcomes:

1. After completing the course the student has knowledge of the behavior of passive components at RF frequencies, knows the fabrication methods of components and is also able to apply the knowledge to practical applications.

2. The student also knows the operating principles of transfer lines, antennas and filters and of their design.

3. The student can apply the fundamentals of RF and microwave techniques to measurements, is able to make the measurements of RF components, has knowledge of the operating principles of RF region measurement equipment and is able to compare the usability of d

4. The student knows how to perform typical measurements of RF region magnitudes (power, frequency, impedance and noise).

Contents:

Fundamentals of RF and microwave techniques, components in microwave circuits, measurement instruments, measuring of power, frequency, impedance and noise, time-domain and active circuit measurements.

Mode of delivery:

Face-to-face teaching, independent design exercises and laboratory exercises.

Learning activities and teaching methods:

Lectures 24 h, design execises 20 h, laboatory exercises 20 h, independent work 68,5 h.

Target group:

Masters students on electrical engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronic Components and Materials, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handout, Lecture notes. A. Lehto, A. Räisänen: Mikroaaltomittaustekniikka (in Finnish), I. Bahl: Luped Elements for RF and Microwave circuits, R. Ludvig, P.Bretchko: RF circuit Desing: Theory ans Applications, Prentice Hall 2000 and literature announced at the beginning of the lectures.

Assessment methods and criteria:

Final exam, design exercises and laboratory exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Merja Teirikangas

Working life cooperation:

No.

Other information:

-

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.

3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

521402S: Telecommunications Circuit Design, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rahkonen, Timo Erkki

Opintokohteen kielet: Finnish

ECTS Credits:

6 ects / 42 contact hours + design excercise

Language of instruction:

English/Finnish

Timing:

Autumn, 1st period of the last year of studies

Learning outcomes:

After completing the course the student
- knows the most usual schematic structures and dimensioning principles of typical telecommunication circuit blocks
- can sketch the spectral effects of non-linear and time-varying circuit blocks
- can evaluate the performance of the available IC process node

Contents:

The course gives the background needed in the design of RFICs and other analog telecommunication circuit blocks.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 hours of lectures, 14 of excercises, and a relatively large design task.

Target group:

Last year MSc students with strong analog design background

Prerequisites and co-requisites:

Strong background in analog transistor level design is required.

Recommended optional programme components:

Needs electronics design 2-3 background

Recommended or required reading:

Handouts

Assessment methods and criteria:

Graded based on the final exam. The design excercise needs to be passed.

Grading:

Numerical scale 0-5. 0 is fail, 5 the best.

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

The topics are strongly related to the skills needed in the industry

Other information:

The course is the last advanced course in analog design, and requires the basic knowledge of transistor level analog design and IC design.

521448S: Physical Design of Digital Integrated Circuits, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held on spring semesters, but can in addition be held on autumn semesters on demand.

Learning outcomes:

Upon completion of the course the student
- understands the technologies and the physical design and verification flow of digital integrated circuit
- knows how a digital integrated circuit is implemented using logic synthesis and layout design electronic design automation tools.

Contents:

1. Technologies and libraries
2. Design and verification flow overview
3. Layout-driven, power-optimized logic synthesis process
4. Standard cell layout design, including power-network and clock-tree synthesis
5. Post-layout verification

Mode of delivery:

Blended teaching that consists of lectures, laboratory exercises in computer classes and independent design exercises. Mode of delivery varies between course implementations based on the design tools used.

Learning activities and teaching methods:

1. Lectures 16 hours.
2. Design tool exercises in computer class or own computer 32 h
3. Independent work (design exercise, course report) 87 h

Target group:

Master and doctoral students in electrical and computer engineering

Prerequisites and co-requisites:

521301A Digital techniques 1, 521404A Digital techniques 2 or equivalent skills

Recommended optional programme components:

The course 521406S Digital techniques 3 that covers the logical design of digital integrated circuits is recommended for students specializing in digital circuits and systems design.

Recommended or required reading:

Recommended reading:
Khosrow Golshan: Physical design essentials: an ASIC design implementation perspective (Springer, 2007)
Other reading material will be delivered during the course.

Assessment methods and criteria:

Students must complete the laboratory exercises and write a report that describes the digital integrated circuit deign flow as it was implemented in the laboratory exercises. Grading is based on the report.
Read more about assessment criteria at the University of Oulu web page.

Grading:

The course utilizes a numerical grading scale 1 – 5. In the numerical scale zero stands for a fail.

Person responsible:

Jukka Lahti

Working life cooperation:

The course may include guest lecturers from electronics design automation software companies.

Other information:

-

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S Advanced practical training 5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

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Choose optional Studies (39 ECTS cr or until the degree is 120 ECTS cr)

521410S: Special Course in Electronic Design, 4 - 7 op

Voimassaolo: 01.08.2006 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Rahkonen, Timo Erkki
Opintokohteen kielet: Finnish

ECTS Credits:

4-7 ECTS cr, depending on the yearly contents.

Language of instruction:

Finnish or English (if there are at least two foreign students) .

Timing:

Varies, intensive implementation periods 1-4

Learning outcomes:

Vary depending on the content.

Contents:

The contents will be fixed yearly during the spring semester. It may be related to RFIC design, or non-linear circuit analysis, for example.

Mode of delivery:

Classroom

Learning activities and teaching methods:

Varies yearly. The course may contain excercises or a design exercise.

Target group:

Electrical Engineering MSc students

Prerequisites and co-requisites:

Background in circuit theory and analog and RF design.

Recommended optional programme components:

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Recommended or required reading:

Depends on the contents.

Assessment methods and criteria:

Depends on the implementation. May contain design exercise.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

Other information:

-

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: English

Leikkaavuudet:

521375S Design of Tranceivers 5.0 op

521375S-01 Design of tranceivers, partial credit 0.0 op

521375S-02 Design of tranceivers, partial credit 0.0 op

ECTS Credits:

6 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

3. can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them.

4. will be able to define parameters used in the transceiver system level design and can design a transceiver at the system level so that the requirements for the system are fulfilled.

5. knows nonlinear distortion and can design the automatic gain control in the system level.

6. will be able to explain factors, which are important for the selection of D/A- and A/D-converters and can derive various methods to create the in phase and the quadratute components of a received signal.

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.

Contents:

Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A/D-converter in a receiver, frequency synthesis, design and implementation examples.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (54 h).

Target group:

1st year M.Sc. and WCE-RF students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

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Recommended or required reading:

Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

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521388S: Antennas, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg

Opintokohteen kielet: English

Leikkaavuudet:

521380S	Antennas	4.0 op
521380S-01	Antennas, partial credit	0.0 op
521380S-02	Antennas, partial credit	0.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring, period 4

Learning outcomes:

After completing the course, student
1. knows antenna terminology and understands the role of antennas as a part of different radio systems.

2. is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays.

3. will be able to design wire antennas, micro strip antennas and antenna arrays for different radio systems.

4. will be able to design and analyze various antenna types and arrays using 3D electromagnetic simulation software.

Contents:

Introduction to different antenna types. Fundamental parameters of antennas. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas. Loop antennas. Microstrip antennas. Antenna arrays. Antennas for wireless devices. Antenna - human body interaction. Base station antennas. 3D electromagnetic simulation.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures and exercises 40 h / Compulsory antenna design work with an electromagnetic simulation 25 h / Self-study 70 h

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering 521384A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Recommended literature: C.A. Balanis: Antenna Theory, Analysis and Design (3rd or 4th Ed). John Wiley & Sons, 2005 or 2016. Chapters 1-6 and 14.

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. In the final grade of the course, the weight for the examination is 0.5 and that for the design work 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg

Working life cooperation:

No

Other information:

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521089S: Printed Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

Leikkaavuudet:

521217S	Printed Electronics	4.0 op
521095S	Advanced Course of Printed Electronics	3.0 op

ECTS Credits:

5

Language of instruction:

Finnish. English if more than two international students in the course.

Timing:

Period 3.

Learning outcomes:

1. Knows the most typical materials and printing methods suitable for their processing
2. Can explain the principles of materials and printing methods
3. Can utilize the material and manufacturing process knowledge to design fabrication processes for electrical components
4. Can analyse how the selected materials and printing methods influence on the performance of electrical components

Contents:

Materials (conductive and semi-conductive polymers, photoactive polymers, dielectrics, particle based inks) and processing methods (screen printing, gravure printing, flexo printing, inkjet) utilized in printed electronics, surface wetting and film formation, printed electrical components (passive components, solar cells, light emitting diodes, transistors) and their fabrication. Possibilities and challenges of printing based processing methods and how to take them into account in the printed electronics fabrication.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Combined lectures and exercises 30 h and self-study 100 h

Target group:

Primarily for the students of electrical engineering

Prerequisites and co-requisites:

None.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

D.R. Gamota, P. Brazis, K. Kalyanasundaram and J. Zhang, "Printed organic and molecular electronics", handout

Assessment methods and criteria:

Course is completed by final examination.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Tapio Fabritius

Working life cooperation:

Not included.

521124S: Electronic Sensors, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Alexey Popov, Aliaksandr Bykau

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English.

Timing:

Period 2.

Learning outcomes:

After the course the student is capable to explain the operating principles of different sensors and can select a right sensor for each measuring target. He/she is able to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition the student is able to plan and design sensor signal conditioning circuits.

Contents:

Methods for measuring displacement, velocity, acceleration, torque, liquid level, pressure, flow, humidity, sound and temperature. Ultrasound, optical and nuclear measurement techniques and applications, material analyses such as pH measurement and gas concentration, pulp and paper measurements and smart sensors.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 26h, exercises 12h and self-study 100h.
The information about the course 521124S - Anturit ja mittausmenetelmät/Electronic Sensors has been added to the Moodle page:
https://moodle.oulu.fi/course/view.php?id=5357

Course description: "The course is aimed at students willing to be capable of explaining the operating principles of different sensors and selecting the right sensor for each measuring target. We will focus on how to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition, we will go into questions on how to plan and design sensor signal conditioning circuits."

The lectures and seminars will be organized remotely via Zoom environment. The corresponding link will be published on the page of the course in Moodle prior to the lecture.

Target group:

4 year students.

Prerequisites and co-requisites:

No.

Recommended optional programme components:

No.

Recommended or required reading:

H. N. Norton: Handbook of Transducers, Prentice Hall P T R, 1989 or 2002; lecture and exercise notes.

Assessment methods and criteria:

The course is passed by a final exam and passed exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Aliaksandr Bykau ja Alexey Popov

Working life cooperation:

No.

521098S: Testing Techniques of Electronics and Printed Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Period 4.

Learning outcomes:

1. After completing the course the student is able to analyze different kinds of testing strategies, and is able to enhance the testability of electronics through the use of design for testability.
2. The student can also compare different testing techniques of analogue and digital electronics, which have been implemented using either embedded testing methods or external automatic testing equipment.
3. Additionally, the student is able to analyze tests made using an automatic test instrument, compare different test interfaces and data busses, and recognizes principles of design of a high-quality printed test circuit board.
4. The Student understands the specific features of printed electronics having an influence on electronics testing and reliability.

Contents:

Overview of different testing methods, constructions of testers, test fixtures, test signal generation and measurement, mixed-signal test buses, DC- and parametric measurements, dynamic tests, AD/DA converter tests, DSP-based tests, data analysis, embedded testing, design for testability, Boundary scan, test applications.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 26h/Exercises 14h and self-studying 100 h.

Target group:

Course is compulsory for the Electrical engineering students in the advanced module of Testing techniques and printed electronics.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronics Design I, Electronic Measurement Techniques.

Recommended optional programme components:

This course compensates 521098S Testing Techniques of Electronics if the student hasn't got credits from it.

Recommended or required reading:

M. Burns, G. W. Roberts: An Introduction to Mixed-Signal IC Test and Measurement, Lecture slides. Additional material will be announced at the beginning of the course.

Assessment methods and criteria:

Exam and passed lab exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Tapio Fabritius

Working life cooperation:

No.

521328A: Simulations and Tools for Telecommunications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Johanna Vartiainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521369A Simulations and Tools for Telecommunications 3.0 op

521369A-01 Simulations and Tools for Telecommunications, exam 0.0 op

521369A-02 Simulations and Tools for Telecomm. exercise 0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, period 2

Learning outcomes:

1. A student recognizes problems and limitations related to simulations.

2. She/he can select a suitable simulation method and knows how to validate the model.

3. Student knows how to generate signals, random numbers and noise.

4. She/he knows how to model fading channels.

5. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results.

6. She/he can explain principles of network level simulations.

7. A student knows basics of one or two fundamental simulation programs

Contents:

Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs/availability).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h (including program introductions), and the compulsory assignment with a simulation program (40 h).

Target group:

3rd year bachelor’s degree students and M.Sc. students

Prerequisites and co-requisites:

Telecommunication Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition. Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Johanna Vartiainen

Working life cooperation:

No

Other information:

In 2020, the whole course including compulsory exercise and exam is organized in Moodle https://moodle.oulu.fi/enrol/index.php?id=3757 (opens no later than one week before the start of the course)

521279S: Signal Processing Systems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Sangi

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period II. For master students of Computer Science and Engineering specializing in Computer Engineering, it is recommended to complete the course at the first autumn semester.

Learning outcomes:

Learning outcomes of the course are:

1. The student understands common real number formats used in digital signal processing.
2. The student can implement a digital filter using fixed-point computations. He can optimize word lengths so that the required performance goals are fulfilled.
3. The student knows the CORDIC algorithm and can utilize it in the implementation of function and transform (e.g. DCT) computations.
4. The student knows the principles, which allow computationally efficient implementation of decimation and interpolation operations. Related to this, he can implement narrow-band digital filters.
5. The student can explain how a modulated filter bank works and knows its polyphase decomposition based implementation.
6. The student can implement convolution for long data sequences and filters. He also knows, how the same principles are used in the implementation of correlation.
7. The student can explain the general operational principles of adaptive filters and knows some of their applications. He knows operation of some common adaptive algorithms. He can study behaviour of adaptive filters with simulation.

Some exercise tasks of the course are done in the Matlab environment utilizing also its Simulink tool. The student learns how it can be used in the modelling of signal processing systems.

Contents:

Fixed-point and floating-point arithmetics, fixed-point filter implementation, CORDIC, DCT, FFT, polyphase decomposition, multirate signal processing, modulated filter banks, sectioning, adaptive filters and algorithms, Matlab and Simulink tools in DSP modelling.

Mode of delivery:

The tuition will be implemented as face-to-face teaching and web-based teaching. Moodle is used as the learning environment.

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available from October 16 in Moodle.

Learning activities and teaching methods:

Lectures 28 h / Group work 42 h / Self-study 65 h. The group work consists of six weekly design tasks.

Target group:

The course is primarily targeted to the students of Computer Science and Engineering specializing to Computer Engineering.

Prerequisites and co-requisites:

A recommended prerequisite is the completion of "521337A Digital Filters".

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course provides lecture notes for reading. In addition, the following books provide useful information:
E.C. Ifeachor, B.W. Jervis. Digital Signal Processing - A Practical Approach. Second Edition. Prentice-Hall, 2002.
W.T. Padgett, D.V. Anderson. Fixed-Point Signal Processing. Morgan&Claypool Publishers, 2009.

Assessment methods and criteria:

The course uses continuous assessment, which is based on evaluation of the weekly group works and exams arranged during lectures.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pekka Sangi

Working life cooperation:

The course does not contain working life cooperation. There may be guest lectures.

Other information:

The web page of the course arranged at Autumn 2020 will be https://moodle.oulu.fi/course/view.php?id=3212

521281S: Application Specific Signal Processors, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mehdi Safarpour

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English.

Timing:

Autumn, period 1

Learning outcomes:

After completing the course, student

1. Can distinguish the main types of signal processors
2. Can design basic customized transport triggered architecture processors
3. Is capable of assembling a signal processor out of basic entities

4. Can match the processor performance and the application requirements
5. Applies the TTA codesign environment and Altera's FPGA tools to synthesize a system

Contents:

Examples of modern signal processing applications, main types of signal processors, parallel signal processing, transport triggered architectures, algorithm-architecture matching, TCE design environment and Altera FPGA tools.

Mode of delivery:

Lectures, exercises, independent work, group work.

Learning activities and teaching methods:

Lectures 12h (participation mandatory); Instructed labs 12h. Independent work 111h

Target group:

Computer Science and Engineering students + other Students of the University of Oulu. This is an advanced-level course intended for masters-level students and post-graduate students, especially to those who are specializing into signal processing.

Prerequisites and co-requisites:

521267A Computer Engineering or 521286A Computer Systems (8 ECTS cr) or 521287A Introduction to Computer Systems (5 ECTS cr) and 521337A digital filters, programming skills

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handouts.

Assessment methods and criteria:

Participation in mandatory classes and approved lab exercises and project works.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5; zero stands for a fail.

Person responsible:

Mehdi Safarpour

Working life cooperation:

No.

H451226: Module of the Option, Electronics Materials and Components, 60 - 80 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Other Entity

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory

A451222: Module of the Option, Electronics Materials and Components, 35 - 41 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Module of the Option

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Module of the Option, Compulsory studies, 41 ECTS cr (Note: 521028S Small/medium power energy harvesting and storage devices will be lectured in odd years (-19, -21,...))

521401S: Electronics Design II, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: English

Leikkaavuudet:

521443S	Electronics Design II	5.0 op

ECTS Credits:

6 ECTS

Language of instruction:

In Finnish (In English if needed).

Timing:

Autumn, period 1

Learning outcomes:

1. should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies
2. should be able to analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits
3. should be able to estimate and minimize the effects of noise in electrical circuits
4. should be able to explain the terminology used with DA and AD conversion and converters
5. should be able to analyze and outline the main architectural principles and also to evaluate the characteristics of DA and AD converters

Contents:

Modeling of BJT and MOS transistors, CMOS and BJT building blocks especially as IC-realizations, noise and analysis of noise, internal structure of operational amplifiers, critical parameters, comparators, S/H-circuits, structures and properties of A/D and D/A converters.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching: Lectures 30h, exercises 20h. Self study: a small design work 20h. Learning without guidance either privately or in a group 60h.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Principles of electronics design, Electronics design I

Recommended optional programme components:

-

Recommended or required reading:

Lecture handout,T. C. Carusone, D. A. Johns & K.W. Martin: Analog integrated circuit design , Wiley cop. 2012. 2nd ed., chapters 1, 3, 6, 9, 10, 15, 16 and 17, parts of 4 ja 11; P.E. Allen & D.R. Holberg: CMOS Analog Circuit Design, Oxford University Press 2002, chapters 1,3,4,5, 6, 8 and 10.

Assessment methods and criteria:

The course unit is passed by a final exam and a passed design work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521124S: Electronic Sensors, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Alexey Popov, Aliaksandr Bykau
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English.

Timing:

Period 2.

Learning outcomes:

After the course the student is capable to explain the operating principles of different sensors and can select a right sensor for each measuring target. He/she is able to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition the student is able to plan and design sensor signal conditioning circuits.

Contents:

Methods for measuring displacement, velocity, acceleration, torque, liquid level, pressure, flow, humidity, sound and temperature. Ultrasound, optical and nuclear measurement techniques and applications, material analyses such as pH measurement and gas concentration, pulp and paper measurements and smart sensors.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 26h, exercises 12h and self-study 100h.
The information about the course 521124S - Anturit ja mittausmenetelmät/Electronic Sensors has been added to the Moodle page:
https://moodle.oulu.fi/course/view.php?id=5357

Course description: "The course is aimed at students willing to be capable of explaining the operating principles of different sensors and selecting the right sensor for each measuring target. We will focus on how to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition, we will go into questions on how to plan and design sensor signal conditioning circuits."

The lectures and seminars will be organized remotely via Zoom environment. The corresponding link will be published on the page of the course in Moodle prior to the lecture.

Target group:

4 year students.

Prerequisites and co-requisites:

No.

Recommended optional programme components:

No.

Recommended or required reading:

H. N. Norton: Handbook of Transducers, Prentice Hall P T R, 1989 or 2002; lecture and exercise notes.

Assessment methods and criteria:

The course is passed by a final exam and passed exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Aliaksandr Bykau ja Alexey Popov

Working life cooperation:

No.

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S-01	Radio Engineering	0.0 op
521326S-02	Radio Engineering	0.0 op
521335S	Radio Engineering	6.0 op
521335S-01	Radio engineering, partial credit	0.0 op
521335S-02	Exercise work, Radio engineering 1	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.
A student can also explain factors, which are limiting the bandwidth of impedance matching networks. Smith chart (admittance/impedance chart).
3. will be able to design a low noise RF amplifier. The amplifier is designed that the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

4. knows single sideband and double sideband noise in mixers. A student will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.
5. will be able to design passive microwave components like a Wilkinson power divider, a directional coupler and hybrids.
6. can explain basic priciples of RF-oscillators. A student can design a cross-coupled oscillator and voltage controlled oscillator.
7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.
8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.

Contents:

Noise, non-linearity, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers design, Wilkinson power dividers, directional couplers, hybrids, automatic gain control (AGC), cross-coupled oscillator, voltage controlled oscillators, power amplifier design.

Mode of delivery:

The lectures and the exercises are organized as remote sessions.

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).

Target group:

1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521075S: Microelectronics Packaging Technologies, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Sami Myllymäki

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

3rd period

Learning outcomes:

1. Upon completing the course student can explain how electronics packaging technology has since invention of transistors to current date and can estimate how this development is going to continue in future.
2. The student can describe can explain what is meant by microjoining techniques and what are the pros and cons of these.
3. The student can tell what different kind of materials, and why, are used in IC packaging technology.
4. The student can explain what is meant with system level packaging and how the strong miniaturization on IC requires new system level packaging techniques to be developed.
5. He can explain why active and passive components are being, more and more, embedded to be a part of the circuit board.
6. In addition, he can explain why and how radio electronics will be migrate towards circuit board and components on it.

Contents:

Radio technology applications are emphasized. Trends of packaging and component technologies. Area array packaging techniques. BGA-components. Micro joining and bonding. Multi-chip-modules: MCM-L, MCM-D and MCM-C modules. Fine line techniques. System level packaging (SOC, SOP). Multilayer substrates and integration of passive components. 3-D packaging. radio electronics modules. MEMS components. Electronics applications to nanotechnology.

Mode of delivery:

Face to face teaching

Learning activities and teaching methods:

Lecturing 24 h, practical work 12 h.

Target group:

Primarily major students of electrical engineering.

Prerequisites and co-requisites:

Recommended Introduction to Microfabrication Techniques.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Rao R. Tummala(edit): Fundamentals of microsystems packaging, New York, McGraw-Hill, 2001. R. R. Tummala and M. Swaminathan, Introduction to System-on-Package (SOP), McGraw-Hill, 2008.

Assessment methods and criteria:

The course is completed with the final exam and finished course work.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Sami Myllymäki

Working life cooperation:

No

Other information:

-

521074S: Microelectronics and Micromechanics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Krisztian Kordas

Opintokohteen kielet: English

Leikkaavuudet:

521224S	Microelectronics and Micromechanics	6.0 op
521224S-01	Microelectronics and Micromechanaics, exam	0.0 op
521224S-02	Microelectronics and Micromechanics, exercise	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

3rd period

Learning outcomes:

Objective: The course provides advanced knowledge on the semiconductor techniques of VLSI and on special topics of micromechanics and hybrid fabrication. Especially recent progress on the field is introduced in application point of view.
Learning outcomes: After completing the course the student can give account on correlations between basic physics/chemistry and materials processing/technology in microelectronics, micromechanics and nanotechnology. The student can describe design aspects and operation principles of micro and nano-devices. The students get acquainted with working in laboratory environment similar to those in academic and industrial research labs. Laboratory work practice on either (i) thin film fabrication in clean room, (ii) inkjet printing and electrical characterization of thin film devices with nanopartciles or (iii) synthesis of carbon nanotubes and characterization by electron microscopy techniques will provide a good opportunity also to learn how to design and run experiments safely and manage laboratory reports.

Contents:

Theory and practice of VLSI semiconductor fabrication technologies to support and deepen the understanding of general fabrication and operation principles introduced during previous courses. The state-of-the-art semiconductor devices and circuits: pushing the limits of dimensions and speed. Implementation of VLSI technologies in fabrication of components for micromechanics. Sensors (flow, pressure) and actuators (valves, pumps, motors, switches and components for micro-optics) using MEMSs. Devices on the nanoscale and integration of nanomaterials in microsystems: new concepts of design, fabrication and operation.

Mode of delivery:

Lectures, laboratory exercise with supervision and guidance.

Learning activities and teaching methods:

Though the course is primarily based on lectures, the communication channel is open in both directions enabling continuous comments, questions and feedback from the students. Critical explanations and think alouds are also applied to motivate thinking and active learning.

Target group:

Students of the University of Oulu.

Prerequisites and co-requisites:

Passing the basic course “521070A Introduction to microfabrication techniques” before the advanced course is recommended.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes and references therein.

Assessment methods and criteria:

Examination and completion of both laboratory exercise and report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading 1-5.

Person responsible:

Krisztian Kordas

Working life cooperation:

-

Other information:

-

521215S: Microelectronics project, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Juuti

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish or English

Timing:

The course is held in the spring semester, durin periods 3 and 4. It is recommended to complete the course at the 4th spring semester (1. year of MSc studies)

Learning outcomes:

After completing the course, the student
1. Is able to carry out all the stages needed to develop electronics components or materials beginning from design the material or component to realization and characterization.
2. Student is able to use independently professional and research methods, software, equipment and tools.
3. Student is able to do technical documentation of the work and keep laboratory work book during the work.

Contents:

Independent manufacturing, design, characterization or modelling work for electronics materials or components.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Project work for 132,5 hours

Target group:

Masters students on Electrical engineering

Prerequisites and co-requisites:

Bachelors degree in electrical engineering or equivalent.

Recommended optional programme components:

The course is an independent entity.

Recommended or required reading:

Given in the beginning of the course.

Assessment methods and criteria:

Project work is assessed by the achievement of the project targets and quality of the report.

Grading:

The course utilizes verbal grading scale ”Laudatur/pass/fail”.

Person responsible:

Jari Juuti

Working life cooperation:

Some of the project work can be made in cooperation with companies.

Other information:

-

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish. English, if there are at least 3 international students in class.

Timing:

The course is held in the 4^{th} period. It is recommended to complete the course during Master level studies.

Learning outcomes:

1. After completing the course the student has knowledge of the behavior of passive components at RF frequencies, knows the fabrication methods of components and is also able to apply the knowledge to practical applications.

2. The student also knows the operating principles of transfer lines, antennas and filters and of their design.

3. The student can apply the fundamentals of RF and microwave techniques to measurements, is able to make the measurements of RF components, has knowledge of the operating principles of RF region measurement equipment and is able to compare the usability of d

4. The student knows how to perform typical measurements of RF region magnitudes (power, frequency, impedance and noise).

Contents:

Fundamentals of RF and microwave techniques, components in microwave circuits, measurement instruments, measuring of power, frequency, impedance and noise, time-domain and active circuit measurements.

Mode of delivery:

Face-to-face teaching, independent design exercises and laboratory exercises.

Learning activities and teaching methods:

Lectures 24 h, design execises 20 h, laboatory exercises 20 h, independent work 68,5 h.

Target group:

Masters students on electrical engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronic Components and Materials, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handout, Lecture notes. A. Lehto, A. Räisänen: Mikroaaltomittaustekniikka (in Finnish), I. Bahl: Luped Elements for RF and Microwave circuits, R. Ludvig, P.Bretchko: RF circuit Desing: Theory ans Applications, Prentice Hall 2000 and literature announced at the beginning of the lectures.

Assessment methods and criteria:

Final exam, design exercises and laboratory exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Merja Teirikangas

Working life cooperation:

No.

Other information:

-

521028S: Small/Medium Power Energy Harvesting and Storage Devices, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Yang Bai

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English

Timing:

The course is held in the period 2.

Learning outcomes:

1. The students will understand the energy requirements and design principles of self-powered and autonomous electronic systems for various sensing applications.
2. The students will understand different energy harvesting and conversion techniques and thus be able to select appropriate methods according to available energy sources in defined application cases.
3. The students will understand the materials, fabrication processes and characterization methodologies of different energy harvesters and corresponding sensor systems.
4. The students will understand advanced energy storage options used for autonomous systems.

Contents:

Wireless devices and sensor networks; Solar, kinetic, thermal and electromagnetic wave energy harvesting; Power management circuitry and energy storage; Component and system fabrication and characterization; Hands on learning – private demonstrator manufacturing and testing.

Mode of delivery:

The course will be implemented as online lectures and online experimental practice (lab demonstrations via video recordings). The Zoom link for all the lectures is https://oulu.zoom.us/j/61305833338. The videos will be uploaded to Moodle learning environment during the course.

Learning activities and teaching methods:

The implementation methods of the course vary. The course will be arranged utilizing activating teaching methods agreed on together with the students. There will be 30 hours of guided teaching events and 102.5 hours of teaching without guidance either privately or in a group.

Target group:

Master's level students.

Prerequisites and co-requisites:

The recommended prerequisite is to familiarize with the course 521104P Introduction to Materials Physics.

Recommended optional programme components:

In-depth investigation of novel energy harvesters and integrated self-powered sensor systems.

Recommended or required reading:

Required:
Lecture notes;
Textbook S. Beeby and N. White, Energy Harvesting for Autonomous Systems, Artech House, 2010
Recommended (optional):
Textbook S. Priya and D. J. Inman, Energy Harvesting Technologies, Springer, 2008
Textbook C. R. Bowen, V. Y. Topolov and H. A. Kim, Modern Piezoelectric Energy-Harvesting Materials, Springer, 2016
Textbook J. W. Matiko and S. Beeby, Applications of Energy Harvesting Technologies in Buildings.

Assessment methods and criteria:

Continuous assessment will be implemented. There is no final exam. Assessment criteria will be explained during the course. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The assessment utilizes a numerical grading scale of 1-5.

Person responsible:

Bai Yang

Working life cooperation:

No.

A451291: Advanced Module, Electronics Materials and Components, 10 - 52 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Advanced module, Obligatory courses 23 ECTS cr. (Note: 521028S X-ray Diffraction will be lectured in even years (-20, -22,…)

521072S: Microsensors, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Hannu

Opintokohteen kielet: Finnish

Leikkaavuudet:

521228S	Microsensors	4.0 op

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

English. Guidance and exams also possible in Finnish.

Timing:

The course is held in the 2nd period. Teaching is available every second year. The next time course is arranged on autumn 2020.

Learning outcomes:

1. After completing the course, student can explain the basic concepts of sensor theory and technology, classification of sensors, properties of ideal and real sensors, pros and cons of integrated smart sensor systems, and the interface between sensor and pro

2. Student can explain the main fabrication methods, including thin-film technologies, micromachining methods, wet and dry etching techniques, and both laser and ion beam milling methods and their applications in microsensor fabrication.

3. Students can explain the basic structures, physical operation principles, and fabrication processes of main sensor types for different forms of energy.

Contents:

The principles of microsensors, physical magnitudes which can be measured and manufacturing technologies for microsensors.

Mode of delivery:

Blended teaching (web-based and face-to-face teaching).

Learning activities and teaching methods:

The course will be arranged utilizing activating teaching methods agreed on together with the students. There will be 14 hours of guided teaching events and 118,5 hours of teaching with web-based guidance either privately or in a group.

Target group:

Master students in electronics and communications engineering.

Prerequisites and co-requisites:

Recommended prerequisite is Bachelors degree in Electrical Engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Will be informed at the beginning of the course.

Assessment methods and criteria:

This course utilizes continuous assessment. The method will be informed at the beginning of the course.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Hannu

Working life cooperation:

No

Other information:

-

521089S: Printed Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

Leikkaavuudet:

521217S	Printed Electronics	4.0 op
521095S	Advanced Course of Printed Electronics	3.0 op

ECTS Credits:

5

Language of instruction:

Finnish. English if more than two international students in the course.

Timing:

Period 3.

Learning outcomes:

1. Knows the most typical materials and printing methods suitable for their processing
2. Can explain the principles of materials and printing methods
3. Can utilize the material and manufacturing process knowledge to design fabrication processes for electrical components
4. Can analyse how the selected materials and printing methods influence on the performance of electrical components

Contents:

Materials (conductive and semi-conductive polymers, photoactive polymers, dielectrics, particle based inks) and processing methods (screen printing, gravure printing, flexo printing, inkjet) utilized in printed electronics, surface wetting and film formation, printed electrical components (passive components, solar cells, light emitting diodes, transistors) and their fabrication. Possibilities and challenges of printing based processing methods and how to take them into account in the printed electronics fabrication.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Combined lectures and exercises 30 h and self-study 100 h

Target group:

Primarily for the students of electrical engineering

Prerequisites and co-requisites:

None.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

D.R. Gamota, P. Brazis, K. Kalyanasundaram and J. Zhang, "Printed organic and molecular electronics", handout

Assessment methods and criteria:

Course is completed by final examination.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Tapio Fabritius

Working life cooperation:

Not included.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

-

521079S: Introduction to Nanotechnology, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Krisztian Kordas

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English

Timing:

4^{th} period

Learning outcomes:

1. The students will acquire the basic principles of nanoscience and technology.

2. The course will also help understanding and rational thinking concerning strategies towards practical synthesis and safe utilization of nanomaterials.

Contents:

Nanotechnology definitions and the nanomaterials around us. Health concerns. Synthesis methods; morphological, structural, electrical, optical and spectroscopic characterization of nanomaterials. Properties on the nanoscale. Integration and device development with nanomaterials. Current and future applications.

Mode of delivery:

Lectures

Learning activities and teaching methods:

Though the course is primarily based on lectures, the communication channel is open in both directions enabling continuous comments, questions and feedback from the students. Critical explanations and think alouds are also applied to motivate thinking and active learning.

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Lecutre notes and parts of following books Springer Handbook of Nanotechnology, (Ed.) B. Bhushan. Springer Handbook of Nanomaterials, (Ed.) R. Vajtai. Nano-Age: How Nanotechnology Changes Our Future, M. Pagliaro. Applied Nanotechnology: The Conversion of Research Results to Products, J. Ramsden. Introduction to Nanotechnology, C.P. Poole, Jr.,F.J. Owens.

Assessment methods and criteria:

Examination.

Grading:

Numerical grading 1-5.

Person responsible:

Krisztian Kordas

Working life cooperation:

-

Other information:

-

521080S: X-ray Diffraction, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Hagberg, Jani Peräntie

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish, English if needed

Timing:

Autumn semester period 2. Lectured every other year. The next course will be held in autumn 2021.

Learning outcomes:

1. explain the general principles of interaction between X-rays and solid matter and the physics underlying behind these phenomena

2. explain how the crystal structure, phase ratio, grain size and stress state in a solid material with X-ray diffraction (XRD) method can be experimentally determined

Contents:

Generation, detection and properties of x-rays. X-ray scattering and diffraction methods. Determination of crystal structure and phase composition. Analysis of grain size, texture and stresses. Electron and neutron diffraction.

Mode of delivery:

Lectures, exercises and laboratory work.

Learning activities and teaching methods:

Lectures and exercises altogether 32 h / laboratory work 18 h / self-access writing of work report 30 h / self-access learning 52,5 h.

Target group:

Primarily for students in Electronics and Communications Engineering.

Prerequisites and co-requisites:

Basic physics and mathematics.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. For reference, parts from books B.E. Warren: X-ray diffraction, Addison-Wesley, 1969., B.D. Cullity and S.R. Stock: Elements of X-Ray Diffraction, 3rd Edition, 2001, Prentice Hall and some other books informed by lecturer.

Assessment methods and criteria:

Final grade of the course will be a weighted average of theoretical examination (2/3) and laboratory exercises (1/3).
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Hagberg

Working life cooperation:

No

Other information:

The course is held next in autumn 2019.

Recommended optional studies 26 ECTS cr or until the degree is 120 ECTS cr

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish (English as a book examination)

Timing:

Autumn, period 2

Learning outcomes:

1. On completion of the study module students should be able to detail the advantages of differential signal processing in IC realizations and
2. to analyze and design differential amplifiers and other electronic blocks for implementation in an IC environment.
3. They should be able to explain how an SC (switched capacitor) technology functions and to apply such a technology to sampling and filtering.
4. They should also be able to describe the principles for realizing continuous filters in IC technologies, to explain the principles of the delta–sigma technology
5. and to apply it for realizing integrated DA and AD converters.
6. They should be able to account for the functioning, use and architecture of a phase-locked loop,

7. to explain the functioning of an MOS transistor in the area of weak inversion and to indicate how use can be made of this functional area in circuit design.

Contents:

Advanced operational amplifier topologies, especially differential ones, bandgap and PTAT bias circuits and references, problems related to the design of multi-stage amplifiers (output stages, LP /LV implementations), signal sampling and error sources related to it, SC-techniques (especially in filters), implementation principles of continuous time IC filters, DS techniques in general and particularly in AD/DA converters, operations with frequency/phase domain signals, design of IC layout.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h and Exercises 20 h; Self-study or in a group of two persons: laboratory exercise 40 h (CAD tools used in IC design and familiarization into the complete analogue IC design flow) and learning without guidance either privately or in a group 69 h.
The course is organized remotely and Zoom links for lectures and exercises can be found from Moodle under the topics lectures and exercises.

Target group:

Electrical Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

Electronics Design II, Filters, Introduction to Microfabrication Techniques (recommended).

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

Lecture notes: D. A. Johns & K. Martin: Analog integrated circuit design, Wiley & Sons 1997 chapter 6, chapter 8 partially, 9, 10, 14, 15 and 2. Also P. E. Allen & D. R. Holberg: CMOS Analog Circuit Design, Oxford university press 2002, chapters 2, 7, and 9, proper parts of other chapters of the book.

Assessment methods and criteria:

Passed final exam and exercise work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English/Finnish.

Timing:

Period 1

Learning outcomes:

1. is able to choose the optimum method of the choices presented in the course in the field of power supply, thermal design, grounding, and routing of the high speed signals.
2. is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components.
3. can calculate reliability of an electrical device or system.
4. The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.

Contents:

Power supplies, thermal design, grounding, transmission of fast signals by using transmission lines, electrical disturbances, crosstalk, non-idealities of electrical components.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 30 h of lectures and 20 h of exercises.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course.

Prerequisites and co-requisites:

Both Principles of Electronics Design and Analogue Electronics I must have been accepted.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Lecture notes. Ward & Angus: Electronic Product Design, Hall&Hall&McCall: High speed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques. Eric Bogatin: Signal and Power Integrity – Simplified, 2. ed.

Assessment methods and criteria:

The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No.

Other information:

-

521406S: Digital Techniques 3, 7 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

7 ECTS

Language of instruction:

In Finnish. Exams can be arranged in English on demand.

Timing:

Spring, peridos 3-4

Learning outcomes:

1. knows the phases of the design process of hardware parts of digital system implemented in FPGA or ASIC technologies, and understands their purpose, and the problems and aims associated with different design tasks

2. is able to use the tools needed in industrial design projects.

Contents:

1. Digital systems design process. 2. Assertion-based verification, 3. Universal verification methodology (UVM) 4. ASIC design and verification (technology choice, logic synthesis, physical synthesis, timing analysis, power analysis, design for testability). 5. Use of SystemC language in the modeling of digital circuits. 6. Architecture-level synthesis of digital circuits.

Mode of delivery:

Classroom

Learning activities and teaching methods:

Lectures 20h/ exercises 20h (group work)/ independent work 120h.

Target group:

Primarily electrical and computer science and engineering students. Also other student of University of Oulu can take the course.

Prerequisites and co-requisites:

Digital techniques 1 and Digital techniques 2

Recommended optional programme components:

-

Recommended or required reading:

Lecture textbook (in finnish) and literature announced during course.

Assessment methods and criteria:

Final exam and a design excercise, or weekly assignments consisting of theoretical and design exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5, The grade is the average of the exam and the design exercise.

Person responsible:

Jukka Lahti

Working life cooperation:

-

Other information:

-

521423S: Embedded System Project, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Tokola

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

Lecturing in Finnish, material available in English

Timing:

Spring, periods 3-4.

Learning outcomes:

1. After passing the course, the student is familiar with the design process of an embedded system, from specifying the application leading to the requirement specification for the device, and then to having produced a functional prototype of the defined system.
2. The student is more familiar with the roles of the client and the system developer during the requirement specification, and the role of the iterations as a part of the whole design process. From the specifications, the student is familiar with the process of choosing the suitable hardware components, circuit design and implementation. In the end, the student is also able to know the factors arising from the SW/HW partitioning process of the actual implementation, and the concept of SW/HW dualism. The student can then better utilize the basic development tools used for embedded system design and recognize their possible advantages and disadvantages.
3. The student is more familiar with the testing and problem solving methodology related to the prototype implementation of an embedded system, to have the prototype working correctly according to the specifications.

Contents:

The embedded system design process, from initial specification to implementation of a first functional prototype and demonstrating its functionality in practice. The application can be suggested by the student group, or chosen from the topics suggested by the course organizers. During the work, the students familiarize themselves with modern design tools and methodologies related to embedded system design (according to the microcontroller the student group has chosen to utilize in their work). Most commonly used platforms on the course include STM, Atmel and Microchip based platforms.

Mode of delivery:

Online teaching. Lectures, tutoring and self-study.

Learning activities and teaching methods:

The course is run as a project work in groups of three with progress follow-up reporting meetings. Lectures 10 h, laboratory exercise in period 3-4 120 h.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

811122P Introduction to Programming
521412A Digital Techniques I
Also recommended; 521275A Embedded Software Project, 521432A Electronics Design I.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

-

Assessment methods and criteria:

Project work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning

Working life cooperation:

None.

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.
3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

521096S: Measurement Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Christian Schuss

Opintokohteen kielet: Finnish

Leikkaavuudet:

521110S	Measuring and Testing Systems	6.0 op
521110S-01	Measuring and Testing Systems, exam	0.0 op
521110S-02	Measuring and Testing Systems, exercise work	0.0 op

ECTS Credits:

5 ECTS credits / 128h

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Guided course is on period 2. The course can be completed independently in during spring semester. Ask responsible person for instructions.

Learning outcomes:

1. is able to design a multisensor measurement systems which store the measurement data.
2. is able to assembly a multisensor measurement systems which store the measurement data.
3. is able to program with LabView.

Contents:

Basics of measurement and testing systems, especially wired and wireless data transmission. Data acquisition cards. Basics of LabView programming.

Mode of delivery:

The course can be completed independently during spring semester. Ask instructions from responsible person.

Learning activities and teaching methods:

The course includes 28h lectures and guided exercises. 100 h self-studies.

Target group:

Master level students regardless of master's programme.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

This course compensates earlier courses with same core content but different course code or credit named Measuring and Testing Systems.

Recommended or required reading:

Course material is in English and Finnish and can be found in Moodle.

Assessment methods and criteria:

Final exam and passed laboratory works.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

No.

521088S: Optoelectronics, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn, period 1

Learning outcomes:

1. is able to explain the principles of operation of optical fibres and wavequides

2. is able to explain the principles of operation of semiconductor light sources and photo detectors, and knows the factors affecting their performance

3. is able to outline the circuit-level structures for optical transmitter circuits and photo detector preamplifiers

4. is able to compare their performance in terms of the main performance parameters

Contents:

Wave/particle dualism of optical radiation, optical waveguides and their properties, sources of radiation (LED- and laser structures), photo detectors (PIN- and AP-diodes,SPAD), light source modulation, preamplifiers and their bandwidth/stability/noise analysis.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h and exercises 20 h, may include a seminar.

Target group:

This course is targeted mainly for the students of electrical engineering degree program, but available for other students as well.

Prerequisites and co-requisites:

Principles of semiconductor devices.

Recommended optional programme components:

This course is independent, no other components are recommended simultaneously.

Recommended or required reading:

Lecture notes, S. Kasap: Optoelectronics and Photonics, Principles and Practices, Prentice Hall 2013, 2nd Ed.

Assessment methods and criteria:

Final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Kari Määttä

Working life cooperation:

Does not apply.

Other information:

-

521098S: Testing Techniques of Electronics and Printed Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Period 4.

Learning outcomes:

1. After completing the course the student is able to analyze different kinds of testing strategies, and is able to enhance the testability of electronics through the use of design for testability.
2. The student can also compare different testing techniques of analogue and digital electronics, which have been implemented using either embedded testing methods or external automatic testing equipment.
3. Additionally, the student is able to analyze tests made using an automatic test instrument, compare different test interfaces and data busses, and recognizes principles of design of a high-quality printed test circuit board.
4. The Student understands the specific features of printed electronics having an influence on electronics testing and reliability.

Contents:

Overview of different testing methods, constructions of testers, test fixtures, test signal generation and measurement, mixed-signal test buses, DC- and parametric measurements, dynamic tests, AD /DA converter tests, DSP-based tests, data analysis, embedded testing, design for testability, Boundary scan, test applications.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 26h/Exercises 14h and self-studying 100 h.

Target group:

Course is compulsory for the Electrical engineering students in the advanced module of Testing techniques and printed electronics.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronics Design I, Electronic Measurement Techniques.

Recommended optional programme components:

This course compensates 521098S Testing Techniques of Electronics if the student hasn’t got credits from it.

Recommended or required reading:

M. Burns, G. W. Roberts: An Introduction to Mixed-Signal IC Test and Measurement, Lecture slides. Additional material will be announced at the beginning of the course.

Assessment methods and criteria:

Exam and passed lab exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Tapio Fabritius

Working life cooperation:

No.

521115S: EMC Design, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannu Sorvoja

Opintokohteen kielet: Finnish

Leikkaavuudet:

521172S	EMC Design	4.0 op
521172S-02	EMC Design, Exercise work	0.0 op
521172S-01	EMC Design, Exam	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Period 4.

Learning outcomes:

1. is able to name common EMC standards

2. is able to use EMC testing equipment and methods

3. can explain the noise coupling mechanisms

4. is able to use good design practices related to analogue and digital electronics design

5. is able to use good design practices related to analogue and digital electronics grounding

6. is able to use good design practices related to analogue and digital electronics filtering

7. is able to use good design practices related to analogue and digital electronics shielding

Contents:

EMC standards for emission and susceptibility, interference coupling, circuit design and grounding, connections, filtering, shielding, EMC testing laboratories, EMC tests and their background.

Mode of delivery:

face-to-face teaching

Learning activities and teaching methods:

The course includes 30 h lectures and 100 h self-studies.

Target group:

Primarily students studying electrical engineering. In addition, other students studying in the University of Oulu can carry out the course.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronics Design I, Digital Techniques I, Electronic Measurement Techniques, Measuring and Testing Systems, RF Components and Measurements.

Recommended optional programme components:

The course replaces previous courses with same name, but different credits and code.

Recommended or required reading:

Tim Williams: EMC for Product Designers, 5th edition, Oxford: Newnes, 2017.
Lecture slides.

Assessment methods and criteria:

Final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Hannu Sorvoja

Working life cooperation:

Company visits if possible.

Other information:

-

521388S: Antennas, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg

Opintokohteen kielet: English

Leikkaavuudet:

521380S	Antennas	4.0 op
521380S-01	Antennas, partial credit	0.0 op
521380S-02	Antennas, partial credit	0.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring, period 4

Learning outcomes:

After completing the course, student
1. knows antenna terminology and understands the role of antennas as a part of different radio systems.

2. is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays.

3. will be able to design wire antennas, micro strip antennas and antenna arrays for different radio systems.

4. will be able to design and analyze various antenna types and arrays using 3D electromagnetic simulation software.

Contents:

Introduction to different antenna types. Fundamental parameters of antennas. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas. Loop antennas. Microstrip antennas. Antenna arrays. Antennas for wireless devices. Antenna - human body interaction. Base station antennas. 3D electromagnetic simulation.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures and exercises 40 h / Compulsory antenna design work with an electromagnetic simulation 25 h / Self-study 70 h

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering 521384A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Recommended literature: C.A. Balanis: Antenna Theory, Analysis and Design (3rd or 4th Ed). John Wiley & Sons, 2005 or 2016. Chapters 1-6 and 14.

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. In the final grade of the course, the weight for the examination is 0.5 and that for the design work 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg

Working life cooperation:

No

Other information:

-

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Kyösti, Markus Berg

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

Autumn, period 2.

Learning outcomes:

After completing the course, student
1. will be able to define what the radio channel is and is able to distinguish it into modellable parts.

2. knows different radio wave propagation mechanisms.

3. can apply physical and empirical radio channel models.

4. is able to analyse which are the dominating propagation mechanisms in different environments.

5. will know how to measure the properties of different radio channels.

Contents:

The radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radio wave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Statistical description of fading radio channel. Principles of the radio channel modelling. Noise calculations. Radio wave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modelling for outdoor mobile systems. Radio wave propagation inside or into buildings. Radio channels of mobile satellite links. Slow fading. Multipath propagation and its effects on narrowband and wideband radio channels. MIMO radio channels. Measurement methods of radio channels. Atmospheric attenuation on terahertz frequency bands.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h / Exercises 8 h / compulsory laboratory work 25 h / Self-study 74 h.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Andreas Molisch. "Wireless Communications", 2012. Wireless Communications. Wiley-IEEE Press. Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007.

Assessment methods and criteria:

The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Pekka Kyösti

Working life cooperation:

No

Other information:

-

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: English

Leikkaavuudet:

521375S	Design of Tranceivers	5.0 op
521375S-01	Design of tranceivers, partial credit	0.0 op
521375S-02	Design of tranceivers, partial credit	0.0 op

ECTS Credits:

6 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

3. can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them.

4. will be able to define parameters used in the transceiver system level design and can design a transceiver at the system level so that the requirements for the system are fulfilled.

5. knows nonlinear distortion and can design the automatic gain control in the system level.

6. will be able to explain factors, which are important for the selection of D/A- and A/D-converters and can derive various methods to create the in phase and the quadratute components of a

received signal.

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.

Contents:

Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A /D-converter in a receiver, frequency synthesis, design and implementation examples.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (54 h).

Target group:

1st year M.Sc. and WCE-RF students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

H453221: Module of the Option, Telecommunication Engineering, 60 - 80 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Other Entity
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Module of the option, Telecommunication, Obligatory Studies 40 ECTS cr

A451224: Module of the Option, Telecommunication Engineering, 40 - 41 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Module of the Option

Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Module of the Option. 40 ECTS cr

031051S: Numerical Matrix Analysis, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Applied Mathematics and Computational Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Marko Huhtanen
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish or English.
The course can be completed in English by intermediate exams or by a final exam.

Timing:

Fall semester, period 1

Learning outcomes:

After completing the course the student knows the most efficient and numerically stable methods to solve the basic problems in linear algebra. He/she knows the basic matrix factorizations and their approximations. The student has the capability to solve very large and sparse problems with the iterative solutions methods and understands the significance of preconditioning.

Contents:

Theory of matrix decompositions, SVD-decomposition, LU-decomposition, QR-decomposition, Schur-decomposition, FFT, eigenvalue- and generalized eigenvalue problems, matrix functions, GMRES, MINRES, Preconditioning.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 14 h / Self-study 93 h.

Target group:

-

Prerequisites and co-requisites:

Completion of courses Calculus I and II, a course on Differential Equations and a Course on Linear Algebra and Numerical analysis

Recommended optional programme components:

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Recommended or required reading:

Material posted on the web-page of the course.

Assessment methods and criteria:

Intermediate exams or a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Marko Huhtanen

Working life cooperation:

-

Other information:

-

521348S: Statistical Signal Processing 1, 5 op

Voimassaolo: 01.08.2016 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Janne Lehtomäki, Juntti, Markku Johannes

Opintokohteen kielet: Finnish

Leikkaavuudet:

521484A	Statistical Signal Processing	5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the key tools of linear algebra and quadratic optimization and can apply them in solving signal processing problems.
2. understands how to handle complex valued random variables and processes.
3. understands the key concepts in estimation theory such as the classical and Bayesian philosophies.
4. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
5. can derive an estimator for a given criterion and basic data models.
6. can use the methodology of estimation theory to analyze the performance of estimators and compare to performance benchmarks such as the Cramer-Rao lower bound.
7. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.

Contents:

Review of probability, complex valued random variables and stochastic processes; linear algebra, eigenvalue decomposition, SVD (Singular value decomposition), use of Matlab; estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, least squares estimation, Bayesian estimation, linear Bayesian estimation; statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching and e-learning tool usage

Learning activities and teaching methods:

Face-to-face-teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521330A. The recommended prerequisite is the completion of Telecommunication Engineering.

Recommended optional programme components:

521323S Wireless communications I and 031051S Numerical Matrix Analysis are recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory."vol 1 Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory, vol. 2." Prentice Hall 1999.
3. Peter Selinger, “Matrix Theory and Linear Algebra”, Creative Commons.
4. Paolo Prandoni & Martin Vetterli, Martin, “Signal Processing for Communications”, CRC Press 2008.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.7 and that of project report 0.3.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Janne Lehtomäki and Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle https://moodle.oulu.fi/course/view.php?id=4203.

521395S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti, Timo Kokkonen

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S-02	Wireless Communications I, Exercise	0.0 op
521323S	Wireless Communications 2	5.0 op
521323S-02	Wireless Communications I, Exercise	0.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 2	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op
521323S-01	Wireless Communications I, Exam	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

Student
1. can analyze the performance of multilevel digital modulation methods in AWGN channel
2. can explain the effect of fading channel on the performance of the modulation method and can analyze the performance
3. recognizes and understand suitable diversity methods for fading channel and related combining methods
4. can understand and explain coding methods for wireless channels
5. recognizes different wideband systems
6. understands the cellular system principle

Contents:

Radio channel models, digital modulation and detection methods, carrier and symbol synchronization, performance of digital modulation in AWGN and fading channel, diversity techniques, coding for wireless channel, multicarrier modulation, spread spectrum, cellular systems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program.

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering

Recommended optional programme components:

-

Recommended or required reading:

Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.

Assessment methods and criteria:

The course is passed with minor exams (only during lecture period) or with final exam; and the accepted design work report. In the final grade of the course, the weight for the examination(s) is 0.6 and that for the design work report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Iinatti / Timo Kokkonen

Working life cooperation:

Visiting lecturers from industry.

Other information:

-

031025A: Introduction to Optimization, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held in the autumn, during period 1.

Learning outcomes:

After completing the course the student is able to solve optimization convex optimization problems with the basic optimization algorithms. The student is also able to form the necessary and sufficient conditions for the optimality.

Contents:

Linear optimization, Simplex-algorithm, nonlinear optimization, KKT-conditions, duality, conjugate gradient method, penalty and barrier function methods.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 14 h / Self-study 93 h.
The course, Introduction to Optimization, will be lectured remotely through the ZOOM video conferencing tool. The more detailed instructions and access to ZOOM lectures can be found in the Moodle work space of the course. The link is here: https://moodle.oulu.fi/course/view.php?id=5350.

Target group:

Students in Wireless Communication Engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses Calculus I and II, Matrix algebra

Recommended optional programme components:

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Recommended or required reading:

P. Ciarlet; Introduction to numerical linear algebra and optimization, M. Bazaraa, H. Sherali, C.M. Shetty; Nonlinear programming

Assessment methods and criteria:

The course can be completed by a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail

Person responsible:

Keijo Ruotsalainen

Working life cooperation:

-

Other information:

The course, Introduction to Optimization, will be lectured remotely through the ZOOM video conferencing tool. The more detailed instructions and access to ZOOM lectures can be found in the Moodle work space of the course. The link is here: https://moodle.oulu.fi/course/view.php?id=5350.

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. Students understand how the modern communications networks have evolved and how the architecture has changed through the recent paradigm shift towards software-centric communications.
2. Students are able to describe the basic system architecture elements of mobile networks, and understands the significance of emerging technologies such as Network Function Virtualization (NFV), Software Defined Networking (SDN), and core network functionalities such as Evolved Packet Core (EPC).
3. Students can describe the main principles of mobility management, network management and orchestration, and network security, and can apply and solve related engineering problems.
4. Students know the basic properties of routing algorithms, and can use graph theory to solve network routing problems.
5. Students are able to simulate different types of networks in simulation environments and solve basic network programming problems. Upon completing the required coursework, students understand the basic functionalities in TCP/IP protocol stack.

Contents:

Communications architecture in mobile, wireless local area and personal area networks. Introduction to cloud and edge computing, network function virtualization and software defined networking. Basic principles of mobility management, network security, network management and orchestration. The goal is to present the basics of the modern communications architectures, and their technical implementation.

Mode of delivery:

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available in Moodle. https://moodle.oulu.fi/course/view.php?id=1454

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work (15 h). Design work can be done alternatively either as NS-2 simulation or TCP/IP programming exercise. Design work instructions are provided in digital learning environment (Moodle).

Target group:

1st year M.Sc. and WCE students

Prerequisites and co-requisites:

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Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015; A comprehensive Guide to 5G Security, M Liyanage, I Ahmad, A Abro, A Gurtov, M Ylianttila – 2018; In addition, selected supportive online reading materials from recent standards and publications are provided in digital learning environment (Optima / Moodle).

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Mika Ylianttila

Working life cooperation:

No

Other information:

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521324S: Statistical Signal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521373S	Statistical Signal Processing 2	6.0 op
521373S-01	Statistical Signal Processing 2, exam	0.0 op
521373S-02	Statistical Signal Processing 2, exercise work	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course at the 1st spring semester of the master studies.

Learning outcomes:

Upon completion the student will

1. understand the key design problems and constraints of the typical estimation problems in statistical signal processing.
2. have the skills to apply estimation, detection and other statistical signal processing methods to solve practical problems in signal processing applications.
3. can use linear algebra, basics of optimization and statistical signal processing to derive algorithms with statistical models.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including adaptive algorithms.
5. understands the basic requirements for the convergence of an iterative and adaptive algorithm.
6. can model the operation of a transceiver using Matlab and other simulators to assess the performance of transceiver algorithms.
7. can solve simple composite hypothesis testing problems with unknown parameters

Contents:

Linear Bayesian estimators and filters, sequential Bayesian and least squares algorithms, Wiener and Kalman filtering, iterative algorithms, adaptive filtering and algorithms, statistical decision theory for signals with unknown parameters, application examples: equalization in communications engineering, array processing and beamforming, spectral analysis and estimation, delay estimation and positioning.

Mode of delivery:

Online teching and e-learning tool usage

Learning activities and teaching methods:

Online teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521348S Statistical Signal Processing I. The recommended prerequisite is the completion of 521330A Telecommunications Engineering, 521323S Wireless Communications I, 031025A Introduction to Optimization and 031051S Numerical Matrix Analysis.

Recommended optional programme components:

521317S Wireless communications II is recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory," vol. 1. Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory," vol. 2. Prentice Hall 1998.
3. Simon Haykin, “Adaptive Filter Theory”, 3rd ed. or newer, Prentice Hall 1996.
4. Gene H. Golub & Charlers F. Van Loan, “Matrix computations”, 3rd ed. or newer, Johns Hopkins University Press 1996.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.6 and that of project report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle: https://moodle.oulu.fi/course/view.php?id=6010

521349S: Wireless Communications II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti-Heikki Tölli

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. The student is familiarised with the channel capacity as the fundamental performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna scenarios.
2. The student understands the basic principles for multiuser communications in fading channels, apprehends the notion of capacity region for multi-access and broadcast channels, and is familiarised with different practical multiple access, random access and scheduling methods.
3. The student is acquainted with core principles of adaptive transmission, which requires accurate channel estimates at the receiver and a reliable information exchange mechanisms between the receiver and transmitter. Practical variable-rate variable-power MQAM modulation techniques for fading channels are introduced.
4. The student understands the principles of transmitter and receiver design in the presence of channel distortion. The student is familiarised with various (adaptive) equalization solutions to combat intersymbol interference.
5. Finally, the student is acquainted with the capacity optimal multi-antenna transmission and reception scheme, as well as, with basic multiantenna space-time coding schemes in a single-user multiple-input multiple-output (MIMO) communications scenario.

Contents:

Capacity of wireless channels, multiuser communications, adaptive modulation and coding, equalization, point-to-point MIMO communications and space-time coding.

Mode of delivery:

Fully remotely,
https://moodle.oulu.fi/course/view.php?id=2086

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program (20 h).

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme).

Prerequisites and co-requisites:

In addition to courses “521395S Wireless Communications I”, 521348S “Statistical Signal Processing I”, 031025A “Introduction to optimization” and 031051S “Numerical matrix analysis”, a working knowledge in digital communications, random processes, linear algebra, matrix manipulation and detection theory is required.

Recommended optional programme components:

Prior knowledge of 521390S Information Theory and 521392S Convex Optimisation is very useful but not mandatory. The course 521324S Statistical Signal Processing II is recommended to be taken in parallel.

Recommended or required reading:

D. N. C. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005, Chapters 3-7.
Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005, Chapters 4, 9-11. 14. Upamanyu Madhow: Fundamentals of Digital Communication, Cambridge University Press, 2008, Chapter 5 (Equalization).
Supporting material: Cover & Thomas, "Elements of Information Theory", John Wiley & Sons; Boyd & Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is a weighted sum of exam (70%), homework (20%), and work report (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Antti Tölli

Working life cooperation:

No

Other information:

Course replaces the old course 521317S Wireless Communications II (8cr).

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S-01	Radio Engineering	0.0 op
521326S-02	Radio Engineering	0.0 op
521335S	Radio Engineering	6.0 op
521335S-01	Radio engineering, partial credit	0.0 op
521335S-02	Exercise work, Radio engineering 1	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.
A student can also explain factors, which are limiting the bandwidth of impedance matching networks. Smith chart (admittance/impedance chart).
3. will be able to design a low noise RF amplifier. The amplifier is designed that the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.
4. knows single sideband and double sideband noise in mixers. A student will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.
5. will be able to design passive microwave components like a Wilkinson power divider, a directional coupler and hybrids.
6. can explain basic priciples of RF-oscillators. A student can design a cross-coupled oscillator and voltage controlled oscillator.
7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.
8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.

Contents:

Noise, non-linearity, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers design, Wilkinson power dividers, directional couplers, hybrids, automatic gain control (AGC), cross-coupled oscillator, voltage controlled oscillators, power amplifier design.

Mode of delivery:

The lectures and the exercises are organized as remote sessions.

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).

Target group:

1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

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Recommended or required reading:

Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

Advanced module, obligatory courses, min. 33 ECTS cr

A453273: Advanced module, Telecommunication Engineering, 10 - 47 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Advanced module mandatory courses, choose min. 30 ECTS cr in addition to Advanced Practical Training 3 ECTS cr. These are alternative: 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Kyösti, Markus Berg

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

Autumn, period 2.

Learning outcomes:

After completing the course, student
1. will be able to define what the radio channel is and is able to distinguish it into modellable parts.

2. knows different radio wave propagation mechanisms.

3. can apply physical and empirical radio channel models.

4. is able to analyse which are the dominating propagation mechanisms in different environments.

5. will know how to measure the properties of different radio channels.

Contents:

The radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radio wave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Statistical description of fading radio channel. Principles of the radio channel modelling. Noise calculations. Radio wave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modelling for outdoor mobile systems. Radio wave propagation inside or into buildings. Radio channels of mobile satellite links. Slow fading. Multipath propagation and its effects on narrowband and wideband radio channels. MIMO radio channels. Measurement methods of radio channels. Atmospheric attenuation on terahertz frequency bands.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h / Exercises 8 h / compulsory laboratory work 25 h / Self-study 74 h.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Andreas Molisch. "Wireless Communications", 2012. Wireless Communications. Wiley-IEEE Press. Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007.

Assessment methods and criteria:

The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Pekka Kyösti

Working life cooperation:

No

Other information:

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521328A: Simulations and Tools for Telecommunications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Johanna Vartiainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521369A Simulations and Tools for Telecommunications 3.0 op

521369A-01 Simulations and Tools for Telecommunications, exam 0.0 op

521369A-02 Simulations and Tools for Telecomm. exercise 0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, period 2

Learning outcomes:

1. A student recognizes problems and limitations related to simulations.

2. She/he can select a suitable simulation method and knows how to validate the model.

3. Student knows how to generate signals, random numbers and noise.

4. She/he knows how to model fading channels.

5. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results.

6. She/he can explain principles of network level simulations.

7. A student knows basics of one or two fundamental simulation programs

Contents:

Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs /availability).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h (including program introductions), and the compulsory assignment with a simulation program (40 h).

Target group:

3rd year bachelor’s degree students and M.Sc. students

Prerequisites and co-requisites:

Telecommunication Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition. Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Johanna Vartiainen

Working life cooperation:

No

Other information:

In 2020, the whole course including compulsory exercise and exam is organized in Moodle https://moodle.oulu.fi/enrol/index.php?id=3757 (opens no later than one week before the start of the course)

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: English

Leikkaavuudet:

521375S	Design of Tranceivers	5.0 op
521375S-01	Design of tranceivers, partial credit	0.0 op
521375S-02	Design of tranceivers, partial credit	0.0 op

ECTS Credits:

6 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

3. can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them.

4. will be able to define parameters used in the transceiver system level design and can design a

transceiver at the system level so that the requirements for the system are fulfilled.

5. knows nonlinear distortion and can design the automatic gain control in the system level.

6. will be able to explain factors, which are important for the selection of D/A- and A/D-converters and can derive various methods to create the in phase and the quadratute components of a received signal.

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.

Contents:

Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A /D-converter in a receiver, frequency synthesis, design and implementation examples.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (54 h).

Target group:

1st year M.Sc. and WCE-RF students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521377S: Communications Networks II, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:

7 ECTS cr

Language of instruction:

English

Timing:

Spring, periods 3-4

Learning outcomes:

1. Upon completing the required coursework, the students understand basic principles of programmable networking. The students understand the challenges in existing architectures and how Software Defined Networking (SDN) can solve those challenges.
2. Students understand the idea of SDN network control and data planes, and what it means in practice. The students learn how the network control-data plane separation is possible with SDN. The students have knowledge of how different control plane architectures can be developed or used for different networked environments.
3. Students understand the novel features in the 5G architecture, such as Multi-Access Edge Computing (MEC) and Network Function Virtualization (NFV) and the benefits of MEC and NFV for mobile networks. Students understand the importance of edge computing and virtualization techniques in achieving the low-latency and reliability requirements of 5G standard. Students know the planned use cases of multi-access edge computing in 5G systems and can describe some of the system architecture components.
4. Students understand the significance of network security, network load-balancing and network slicing in modern and emerging communications networks and how they need to be taken into consideration when using SDN and NFV.
5. Students understand the dynamics of simple programmable networks, the importance of queuing systems in the current model of programmable networks such as OpenFlow-based SDNs. The student is also able to design a queuing system for SDN-based network control plane to provide services in a balanced way to the underlying data plane the control plane is responsible for.
6. Students understand the basic principles of queueing theory, such as Birth and Death Process, the M/M/1, M/M/c, M/M/c/K and queuing networks models. Students understand concept of Markov model and its application in communication network analysis. Students can apply queueing theory to model SDN or virtualized networks.
7. Students learn skills to design and implement simple SDNs and analyze performance in network emulation and simulation environments.

Contents:

Introduction to the concepts of Software Defined Networking (SDN): the OpenFlow based SDN architecture, SDN control plane and data plane (OpenFlow switches), Software Defined Monitoring, SDN and Network Function Virtualization (NFV) integration in cellular systems. Introduction to Multi-Access Edge computing (MEC), and the use cases of MEC in 5G, and MEC-IoT integration. Introduction to queueing theory and queueing systems and application of queueing theory to model software defined mobile network or virtualized networks (Jackson network). Furthermore, the course discusses the significance of network security, network load-balancing and network slicing in modern and emerging communications networks. Course provides hands-on experience on virtual networks using SDN with Mininet network emulator.

Mode of delivery:

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available in Moodle. https://moodle.oulu.fi/course/view.php?id=1457

Learning activities and teaching methods:

Lectures 30 h, exercises 15 h and the compulsory design work with a simulation program (30 h). Description of Mininet exercises and Simulink simulation design work are provided in digital learning environment (Moodle).

Target group:

1 st year M.Sc. and WCE students.

Prerequisites and co-requisites:

Communications Networks I

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture" M Liyanage, A Gurtov, M Ylianttila – 2015.; A comprehensive Guide to 5G Security, M Liyanage, I Ahmad, A Abro, A Gurtov, M Ylianttila – 2018; In addition, selected supportive online reading materials from recent standards and publications are provided in digital learning environment (Optima / Moodle).

Assessment methods and criteria:

The course is passed with a final examination and the accepted emulation/simulation work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Mika Ylianttila

Working life cooperation:

No

Other information:

-

521388S: Antennas, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg

Opintokohteen kielet: English

Leikkaavuudet:

521380S	Antennas	4.0 op
521380S-01	Antennas, partial credit	0.0 op
521380S-02	Antennas, partial credit	0.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring, period 4

Learning outcomes:

After completing the course, student
1. knows antenna terminology and understands the role of antennas as a part of different radio systems.

2. is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays.

3. will be able to design wire antennas, micro strip antennas and antenna arrays for different radio systems.

4. will be able to design and analyze various antenna types and arrays using 3D electromagnetic simulation software.

Contents:

Introduction to different antenna types. Fundamental parameters of antennas. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas. Loop antennas. Microstrip antennas. Antenna arrays. Antennas for wireless devices. Antenna - human body interaction. Base station antennas. 3D electromagnetic simulation.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures and exercises 40 h / Compulsory antenna design work with an electromagnetic simulation 25 h / Self-study 70 h

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering 521384A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Recommended literature: C.A. Balanis: Antenna Theory, Analysis and Design (3rd or 4th Ed). John Wiley & Sons, 2005 or 2016. Chapters 1-6 and 14.

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. In the final grade of the course, the weight for the examination is 0.5 and that for the design work 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg

Working life cooperation:

No

Other information:

-

521279S: Signal Processing Systems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Sangi

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period II. For master students of Computer Science and Engineering specializing in Computer Engineering, it is recommended to complete the course at the first autumn semester.

Learning outcomes:

Learning outcomes of the course are:

1. The student understands common real number formats used in digital signal processing.
2. The student can implement a digital filter using fixed-point computations. He can optimize word lengths so that the required performance goals are fulfilled.
3. The student knows the CORDIC algorithm and can utilize it in the implementation of function and transform (e.g. DCT) computations.
4. The student knows the principles, which allow computationally efficient implementation of decimation and interpolation operations. Related to this, he can implement narrow-band digital filters.
5. The student can explain how a modulated filter bank works and knows its polyphase decomposition based implementation.
6. The student can implement convolution for long data sequences and filters. He also knows, how the same principles are used in the implementation of correlation.
7. The student can explain the general operational principles of adaptive filters and knows some of their applications. He knows operation of some common adaptive algorithms. He can study behaviour of adaptive filters with simulation.

Some exercise tasks of the course are done in the Matlab environment utilizing also its Simulink tool. The student learns how it can be used in the modelling of signal processing systems.

Contents:

Fixed-point and floating-point arithmetics, fixed-point filter implementation, CORDIC, DCT, FFT, polyphase decomposition, multirate signal processing, modulated filter banks, sectioning, adaptive filters and algorithms, Matlab and Simulink tools in DSP modelling.

Mode of delivery:

The tuition will be implemented as face-to-face teaching and web-based teaching. Moodle is used as the learning environment.
Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available from October 16 in Moodle.

Learning activities and teaching methods:

Lectures 28 h / Group work 42 h / Self-study 65 h. The group work consists of six weekly design tasks.

Target group:

The course is primarily targeted to the students of Computer Science and Engineering specializing to Computer Engineering.

Prerequisites and co-requisites:

A recommended prerequisite is the completion of "521337A Digital Filters".

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course provides lecture notes for reading. In addition, the following books provide useful information:
E.C. Ifeachor, B.W. Jervis. Digital Signal Processing - A Practical Approach. Second Edition. Prentice-Hall, 2002.
W.T. Padgett, D.V. Anderson. Fixed-Point Signal Processing. Morgan&Claypool Publishers, 2009.

Assessment methods and criteria:

The course uses continuous assessment, which is based on evaluation of the weekly group works and exams arranged during lectures.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pekka Sangi

Working life cooperation:

The course does not contain working life cooperation. There may be guest lectures.

Other information:

The web page of the course arranged at Autumn 2020 will be https://moodle.oulu.fi/course/view.php?id=3212

521322S: Telecommunication Engineering Project, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Saarnisaari, Harri Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

521387S	Telecommunication Engineering Project	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English/Finnish

Timing:

Fall or Spring, periods 1-4

Learning outcomes:

After completing the course student can
1. depending on the work subject, either solve, design, construct, measure, simulate, test or analyze limited telecommunication and radio system and sub-system problems.
2. apply the technical knowledge acquired from advanced sources into practical engineering tasks.
3. document technical and scientific results.

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work.
If you would like to take the course, you can contact the course person responsible.

Learning activities and teaching methods:

The design exercise is done in a group of one or two students depending of work's difficulty. The design exercise can be simulation or implementation work. The work can be defined by the Department of Communications Engineering or by industry. In the later case a proposal must be submitted to the teacher before beginning of the work. Also, student must meet the schedule and deadlines given by a supervisor before starting the work. In preparing the work report document the writing instructions of DCE department's diploma thesis must be followed.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Depending on the subject: advanced courses dealing with telecommunication systems, digital communications, digital signal processing or/and radio engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Varies depending on the topic.

Assessment methods and criteria:

Written work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Harri Saarnisaari

Working life cooperation:

No

Other information:

-

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.
3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Opettajat: Jari Iinatti

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-4

Learning outcomes:

After completing the course the student understand and is able to analyze basic principles of the topic which has been presented in the course. The final outcomes will be defined based on the contents.
Objective: Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

Varies yearly based on actual topics in telecommunications and radio engineering.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and/or exercises and/or design exercise and/or seminars depending on the topic of the year. The start and implementation of the course will be informed separately. The course can be given several times with different contents during the academic year and it can be included into the degree several times.

Target group:

1 st and 2 nd year M.Sc. and WCE students.

Prerequisites and co-requisites:

Will be defined based on the contents.

Recommended optional programme components:

-

Recommended or required reading:

Will be defined in the beginning of the course.

Assessment methods and criteria:

Depends on the working methods.

Grading:

The course unit utilizes a numerical grading scale 1-5.
Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

-

521389S: Wireless Body Area Networks, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Hämäläinen

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3-4

Learning outcomes:

Upon completing of the course, the student will be able to
1. distinguish the basic short range communications technologies used in the wireless body area network context,
2. understand the most relevant standards,
3. differentiate and compare the key points behind these standardized technologies and what are their advantages and disadvantages.
4. understand the major characteristics and applications utilizing WBAN and
5. understand the impact of wireless channels on the WBAN system and how channel affects to the WBAN system performance.

Contents:

Introduction, existing short range radio technologies, application, WBAN architecture, sensors & actuators & wearables, WBAN protocols, signal propagation within a human, WBAN antennas, WBAN transceivers, conclusion.

Mode of delivery:

Face-to-face teaching, compulsory seminar presentation

Learning activities and teaching methods:

Lectures 28 h + compulsory seminar presentation

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in EE degree programme). Special target group is students focusing on medical information and communications technologies.

Prerequisites and co-requisites:

-

Recommended optional programme components:

This course is an independent entity.

Recommended or required reading:

There is no recommended textbook for this course. Course material consists of lecture notes and selected publications.

Assessment methods and criteria:

Passing the course requires an accepted final exam and given seminar presentation.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Matti Hämäläinen

Working life cooperation:

No

Other information:

Course will be given every second year in even years. Will be held next time in Spring 2022.

521325S: Communication Signal Processing, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521360S	Communication Signal Processing II	4.0 op
521360S-01	Synchronization for Digital Receivers, exam	0.0 op
521360S-02	Synchronisation for Digital Receivers, exercise work	0.0 op

ECTS Credits:

5 ECTS cr / 130 hours of work

Language of instruction:

English

Timing:

The course is held bi-annually in the spring semester, during period 4. It is recommended to complete the course at the 1st or 2nd spring semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the functional structure of communications transceiver and understands the requirements

for various wireless systems for the transceiver.
2. knows the architectural and functional design of (all-)digital transceiver with synchronization, channel estimation, encoding/decoding, multiantenna processing and connection establishment.
3. understands the requirements of the current wireless communications standards and related multiplexing and multiple access on transceiver design.
4. can derive digital domain algorithms for separate functionalities and match them to operate together via agreed interfaces.
5. can model the operation of the algorithms and the whole transceiver using Matlab and C other to assess their performance by computer simulations.

Contents:

Wireless transceiver functional split, digital parts and architecture, multirate filtering and filter banks, transceiver digital front-end architecture and design, synchronization and channel estimation, equalization and soft detection, algorithm-architecture co-simulation, multiantenna transceivers.

Mode of delivery:

Remote teaching and e-learning tool usage.

Learning activities and teaching methods:

Remote teaching (lectures, exercises and seminar presentations) 30 h, Simulation and design exercises and presentation preparation in groups 80 h, independent work & passed assignment 20 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 521348S Statistical signal processing I, 521324S Statistical Signal Processing II, 521323S Wireless communications I, 521317S Wireless communications II.

Recommended optional programme components:

-

Recommended or required reading:

Parts from books:
1. P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, “Signal Processing and Optimization for Transceiver Systems”, Cambridge University Press, 2010.
2. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
3. H. Meyr, M. Moeneclaey & S. A. Fechtel, “Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing”. John Wiley, 1998.
4. F. Ling, “Synchronization in Digital Communication Systems”, Cambridge University Press, 2017.
5. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory,” vol. 2. Prentice Hall 1998.
6. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the design and simulation projects, giving a seminar presentation on those, and a final exam. In the final grade of the course, the weight for the examination is 0.5 and that of project report 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

The project focuses on timely design problems in wireless industry. Industrial visiting lectures are organized. The project can be done as true industrial design project.

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2021.

521390S: Information Theory, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Hirley Alves, Markus Leinonen

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1, will be lectured on even years (2020, 2022, ...)

Learning outcomes:

Upon completing the required coursework, the student is able to use the basic methodology of information theory to calculate the capacity bounds of communication and data compression systems. He can estimate the feasibility of given design tasks before the execution of the detailed design. What is more, she can independently search for information and knowledge related to communication engineering, system design and signal processing.

Contents:

Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, rate distortion theory, quantization methods, introduction to network information theory, introduction to network coding, modern topics in information theory, compressed sensing, and information theory tools for machine learning.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises 50 h, homework, seminar and compulsory lab assignments 30 h, independent work 50 h.

Target group:

2nd year M.Sc. electrical and communications engineering, WCE as well as computer science and engineering students

Prerequisites and co-requisites:

Signal Analysis, Telecommunication Engineering, Probability and Mathematical Statistics.

Recommended optional programme components:

Wireless Communications I and II, Statistical Signal Processing I and II.

Recommended or required reading:

Parts from books
Thomas M. Cover & Joy A. Thomas: Elements of Information Theory, 2nd ed. John Wiley & Sons, 2006 ISBN-13 978-0-471-24195-9, ISBN-10 0-471-24195-4,
Raymond W. Yeung, Information Theory and Network Coding, Springer; 2008 edition, ISBN-13: 978-0387792330
Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with two mid-term exams or with a final exam, and the accepted lab exercise report. The final grade is a weighted sum of exam (70%), homework and seminars (20%), and lab exercise (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Hirley Alves/Markus Leinonen

Working life cooperation:

No

Other information:

Objective: To learn the information theory as a discipline and its most important applications in information technology in general and in communications engineering.

521391S: Channel Coding and Modulation, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rajatheva Rajatheva

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1, next time in year 2021

Learning outcomes:

1. Student is fully conversant with commonly used error control coding techniques – block, convolutional, TCM, Lattice, Turbo, LDPC, Polar: code construction and decoding algorithms.
2. Student is able to evaluate the performance of a given code by analytical or computational-simulation methods.
3. Student is able to read and understand peer reviewed publications in Coding.

Contents:

Introduction: Groups, Rings, Fields, Construction of higher level Galois Fields, Factoring
Linear, Cyclic and Convolutional codes – Viterbi and Sequential decoding
Golay code, Reed Muller, Non binary BCH, Reed Solomon (RS) Codes and Decoding with Berlekamp Massey (BM) Algorithm
Lattice Codes: Introduction to Coded Modulation, Ungerboeck and Forney Constructions, Packing, Covering, Vornoi Constellations
Turbo Codes: BCJR Algorithm, Extrinsic Information, EXIT Chart
Soft-input Soft-output (SISO) Decoding, Serial and Parallel concatenated codes, Application in 3G and 4G systems
LDPC Codes: Low density parity check matrices, encoding, Decoding in a graph, QC-LDPC, Application in WiFi and enhanced mobile broadband (eMBB) in 5G
Polar Codes: Successive Cancellation decoding, List decoding, Short frame codes, Control channel in 5G
Applications and Developments: Satisfying latency and reliability in 5G through coding, Application of coding in Distributed Computing, Storage, Application of learning methods in coding

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises 50 h and compulsory homework and lab assignments 35 h.

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Probability and Statistics

Recommended optional programme components:

-

Recommended or required reading:

Parts from books
Error Control Codes, Shu Lin and Costello, Pearson, 2005, 2nd Edition
Theory and Practice of Error Control Codes, Richard Blahut, Addison-Wesley, ISBN-13: 978-0201101027.
Fundamentals of Convolutional Coding, 2nd Edition, Rolf Johannesson, Kamil Sh. Zigangirov ISBN: 978-0-470-27683-9, 688 pages, June 2015, Wiley-IEEE Press
Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with two mid-term exams or with final exam.
The final grade is a weighted sum of exams (50%), homeworks (45%), and lab exercise (5%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Nandana Rajatheva

Working life cooperation:

No

Other information:

Objective: Comprehensive course on coding techniques, including non binary constructions based on higher level Galois Fields, codes based on graphs and new applications The course will start on Galois field constructions based on integer rings and continue with detailed Berlekamp-Massey Algorithm, Lattice Codes based on David Forney papers, Turbo, LDPC and Polar Codes as applied in 4G and 5G.

521392S: Convex Optimization, 7 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Italo Atzeni, Antti-Heikki Tölli

Opintokohteen kielet: Finnish

ECTS Credits:

7 ECTS cr (521392S Convex Optimization) or
10 ECTS cr (522010J Convex Optimization)

Language of instruction:

English

Timing:

Autumn 2020 (periods 1 and 2).

Learning outcomes:

- The students will be able to recognize, formulate, reformulate, and solve various engineering problems as convex optimization problems, both analytically and algorithmically.
- The students will be able to identify convex sets, convex functions, and different types of convex optimization problems.
- The students will learn the necessary and sufficient conditions for optimality, as well as the essential concepts of duality.
- The students will be able to write basic MATLAB solvers based on CVX and disciplined convex programming.
- The students will learn high-level algorithmic optimization aspects and will be able to write basic MATLAB solvers.

Contents:

- Convex sets
- Convex functions
- Convex optimization problems: linear problems, quadratic problems, second-order cone programming, geometric programming, semidefinite programming
- Duality
- CVX and disciplined convex programming
- Optimization algorithms: unconstrained minimization (Newton´s methods), equality-constrained minimization, inequality-constrained optimization (interior-point methods)
- Applications: regression and fitting, beamforming, primal and dual decomposition, linear programming/geometric programming applications, sparse and low-rank optimization

Mode of delivery:

Face-to-face teaching (F2F) teaching

Learning activities and teaching methods:

F2F lectures, self-lectures, homework, and final project.

Target group:

Primarily ITEE Master’s and PhD students, but other students from the University of Oulu are also welcome. The course should benefit anyone who uses or will use scientific computing or optimization in engineering or related fields (e.g., communications, signal processing, machine learning and control).

Prerequisites and co-requisites:

- Required: solid knowledge of linear algebra (e.g., 031051S “Numerical matrix analysis”) and random processes, good knowledge of MATLAB programming.
- Desirable: exposure to numerical computing/optimization (e.g., 031025A “Introduction to optimization”) and digital communications.

Recommended or required reading:

- S. Boyd and L. Vandenberghe, “Convex Optimization”. Cambridge, U.K., Cambridge Univ. Press, 2004.
- The course reader, homework with solutions, and other material by Prof. S. Boyd are available on his web page: http://web.stanford.edu/class/ee364a/
- The video lectures by Prof. S. Boyd are available on YouTube: https://www.youtube.com/watch?v=McLq1hEq3UY&list=PL3940DD956CDF0622
- IEEE journal papers related to convex optimization and its applications.

Assessment methods and criteria:

521392S: written exams 50%, homework 25%, and final project 25%; 522010J: written exams 40%, homework 20%, and final project 40%. A passing grade is required for each of the assessment items (exam, homework, and final project).

- Written exam. The written exam consists of either two mid-term exams or one final exam (no notes and no book allowed).
- Homework. All the homework assignments must be completed. The students are allowed, and even encouraged, to work in small groups, but each student is required to write and submit his/her own homework.
- Final project. The topic of the final project must be agreed upon between the teachers and the students by 31/01/2021 (it is each student's responsibility to contact the teachers before this date). The final project must be completed by 31/05/2021.
    - PhD and Master's students that are already involved in research are required to propose a topic related with their current research work.
    - Other Master's students will be assigned a topic by the teachers.

Grading:

(1-5).

Person responsible:

- Teachers: Italo Atzeni and Antti Tölli
- Teaching assistants: Bikshapathi Gouda and Hamidreza Bakshad Mahmoodi

Working life cooperation:

No

Other information:

The course content, F2F lectures, self-lectures, homework, and written exams are the same for 521392S (7 ECTS credits) and 522010J (10 ECTS credits). A larger and more involved project work is required for 522010J with respect to 521392S.

- The first period focuses on the basic theoretical aspects and consists of self-lectures and F2F lectures (one per week).
    - Self-lectures. The students are required to watch a video lecture by Prof. S. Boyd, aided by the corresponding material.
    - F2F lectures. It consists of a recap of the self-lecture with questions from the students, as well as practical examples and exercises.
- The second period focuses on high-level algorithmic aspects and relevant applications, and consists of F2F lectures (two per week).

521393S: Statistical Communication Theory, 7 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rajatheva Rajatheva

Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

English

Timing:

Fall, period 1-2, every other year, next time in 2020

Learning outcomes:

1. Student is conversant with commonly used estimation and detection techniques: receiver design and algorithms.
2. Student is able to evaluate the performance of a wireless receiver by analytical or simulation methods.
3. Student is able to read and understand peer reviewed publications in relevant topics.
4. Student is familiar with the novel applications in physical layer and new directions including 5G and beyond
5. Student can observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise – Vienna simulator.

Contents:

Detection of Signals – general Gaussian, ROC curves – performance, Estimation, Representation of Random Processes: Homogeneous Integral Equations and Eigenfunctions, Signals with unwanted parameters, Multiple channels, Mobility in Detection, Correlation functions: Bello functions – derivations, Waveforms for mm-wave and higher frequencies, Application of learning methods in Physical layer

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises 70 h and compulsory home assignments and lab 50 h

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Signals and Systems, Probability, Random Variables and Processes, Linear Algebra

Recommended optional programme components:

Wireless Communications I, Statistical Signal Processing I

Recommended or required reading:

Parts from books
Detection, Estimation, and Modulation Theory, Part I, 2nd Edition by Harry L. Van Trees, Kristine L. Bell, and Zhi Tian, Wiley, 2013.
Principles of Mobile Communications, G. Stuber, Springer, 2012. Wireless Communications, A. Molisch, John Wiley & Sons, 2nd Edition, 2011. Lecture notes and other literature.
Principles of Communication Engineering,John M. Wozencraft, Irwin Mark Jacobs, McGraw Hill. Lecture notes and other literature.

Assessment methods and criteria:

The course is passed two mid-term exams or with final exam.
The final grade is a weighted sum of exam (50%), home assignments (45%), and lab exercise (5%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Nandana Rajatheva

Working life cooperation:

No

Other information:

Objective is to develop a theoretical understanding of statistical communication theory.

521394S: Multiantenna Communications, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti-Heikki Tölli

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

1. Upon completing the coursework, the student will have a deep understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless systems.
2. The student understands and can derive the channel capacity for various multiple-input multiple-output (MIMO) communication scenarios, can explain the effect of having the channel state information at the transmitter, and is acquainted with physical modelling of MIMO channels.
3. The student have knowledge of generalized MIMO transmitter and receiver structures for scenarios with and without channel state information. Both linear and non-linear transceiver structures are covered. The Massive MIMO foundations are reviewed including a brief introduction to the its analysis via random matrix theory.
4. After learning the basics in a single-user MIMO communications, the student is acquainted with the basic principles for multiuser multiantenna communications in fading channels and can derive the capacity region for MIMO multi-access and broadcast channels.
5. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication and interference management schemes in realistic multi-cell scenarios,

and how these technologies are deployed in current and future wireless systems and standards. In addition, hybrid beamforming and low precision quantization schemes are covered especially intended for mmWave and TeraHz communication scenarios.

Contents:

Point-to-point MIMO communications, multiuser multiple antenna communications in uplink and downlink, opportunistic communications, massive MIMO, beamforming for mmWave, scheduling and interference management, coordinated multi-cell transmission.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program (20 h).

Target group:

Target group 2nd year WCE students and M.Sc. students (i.e., 5th year in ECE degree programme).

Prerequisites and co-requisites:

“521317S Wireless Communications II”, 521348S “Statistical Signal Processing I”, 031025A “Introduction to optimization” and 031051S “Numerical matrix analysis”, a working knowledge in digital communications, random processes, linear algebra, matrix manipulation and detection theory is required.

Recommended optional programme components:

Recommended optional programme components Prior knowledge of 521390S Information Theory, 521324S Statistical Signal Processing II and 521392S Convex Optimisation is very useful but not mandatory.

Recommended or required reading:

D. N. C. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005, Chapters 7-10, as well as, a few recent journal publications related to multiuser MIMO, massive MIMO, cooperative transmission reception, interference management and mmWave beamforming.
Supporting material: Cover & Thomas, "Elements of Information Theory", John Wiley & Sons; Boyd & Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is a weighted sum of exam (70%), homeworks (20%), and work report (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Antti Tölli

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in Fall 2021.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

-

Optional Studies

A453295: Advanced Module, Telecommunication Engineering (optional studies), 11 - 37 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Optional studies, until the degeree is full (120 ECTS cr)

521401S: Electronics Design II, 6 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Nissinen
Opintokohteen kielet: English
Leikkaavuudet:

521443S	Electronics Design II	5.0 op

ECTS Credits:

6 ECTS

Language of instruction:

In Finnish (In English if needed).

Timing:

Autumn, period 1

Learning outcomes:

1. should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies
2. should be able to analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits
3. should be able to estimate and minimize the effects of noise in electrical circuits
4. should be able to explain the terminology used with DA and AD conversion and converters
5. should be able to analyze and outline the main architectural principles and also to evaluate the characteristics of DA and AD converters

Contents:

Modeling of BJT and MOS transistors, CMOS and BJT building blocks especially as IC-realizations, noise and analysis of noise, internal structure of operational amplifiers, critical parameters, comparators, S/H-circuits, structures and properties of A/D and D/A converters.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching: Lectures 30h, exercises 20h. Self study: a small design work 20h. Learning without guidance either privately or in a group 60h.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Principles of electronics design, Electronics design I

Recommended optional programme components:

-

Recommended or required reading:

Lecture handout,T. C. Carusone, D. A. Johns & K.W. Martin: Analog integrated circuit design , Wiley cop. 2012. 2nd ed., chapters 1, 3, 6, 9, 10, 15, 16 and 17, parts of 4 ja 11; P.E. Allen & D.R. Holberg: CMOS Analog Circuit Design, Oxford University Press 2002, chapters 1,3,4,5, 6, 8 and 10.

Assessment methods and criteria:

The course unit is passed by a final exam and a passed design work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521406S: Digital Techniques 3, 7 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

7 ECTS

Language of instruction:

In Finnish. Exams can be arranged in English on demand.

Timing:

Spring, peridos 3-4

Learning outcomes:

1. knows the phases of the design process of hardware parts of digital system implemented in FPGA or ASIC technologies, and understands their purpose, and the problems and aims associated with different design tasks

2. is able to use the tools needed in industrial design projects.

Contents:

1. Digital systems design process. 2. Assertion-based verification, 3. Universal verification methodology (UVM) 4. ASIC design and verification (technology choice, logic synthesis, physical synthesis, timing analysis, power analysis, design for testability). 5. Use of SystemC language in the modeling of digital circuits. 6. Architecture-level synthesis of digital circuits.

Mode of delivery:

Classroom

Learning activities and teaching methods:

Lectures 20h/ exercises 20h (group work)/ independent work 120h.

Target group:

Primarily electrical and computer science and engineering students. Also other student of University of Oulu can take the course.

Prerequisites and co-requisites:

Digital techniques 1 and Digital techniques 2

Recommended optional programme components:

-

Recommended or required reading:

Lecture textbook (in finnish) and literature announced during course.

Assessment methods and criteria:

Final exam and a design excercise, or weekly assignments consisting of theoretical and design exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5, The grade is the average of the exam and the design exercise.

Person responsible:

Jukka Lahti

Working life cooperation:

-

Other information:

-

555285A: Project management, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Industrial Engineering and Management

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

555288A	Project Management	5.0 op
ay555285A	Project management (OPEN UNI)	5.0 op
555282A	Project Management	4.0 op
555280P	Basic Course of Project Management	2.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

Finnish. Check the course in English 555288A Project Management.

Timing:

Period 2.

Learning outcomes:

Upon completion of the course, the student will be able to:

- describe explain the essential concepts and methods related to project management
- apply project management methods to create a schedule for a project and calculate critical path
- understand essential concepts related to project cost management and able to apply earned value method and three point estimate to manage project costs
- recognises the essential tasks of project risk management

Contents:

Defining project management, project goals and objectives, project phases and project life-cycle management, project planning, organising and scope management, schedule management, cost management, earned value calculation and project risk management, project stakeholder management, project communications management, the role of project manager, new modes of project delivery

Mode of delivery:

The tuition will be implemented as web-based teaching.

Learning activities and teaching methods:

Web-based lectures 16h, self-study 118h

Target group:

Industrial Engineering and Management students and other students taking Industrial Engineering and Management as minor.

Prerequisites and co-requisites:

No prerequisites exist.

Recommended optional programme components:

This course is part of the 25 ECTS module of Industrial engineering and management that also includes555225P Basics of industrial engineering and management, 555242A Product development, 555264P Managing well-being and quality of working life, and 555286A Process and quality management.

Recommended or required reading:

Lecture material, exercise book, Artto, Martinsuo & Kujala 2006. Projektiliiketoiminta. WSOY

Assessment methods and criteria:

Weekly assignments and final online exam

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Assistant professor Kirsi Aaltonen

Working life cooperation:

Videos from the industry’s projects

Other information:

Substitutes courses 555280P Basic Course of Project Management + 555282A Project Management.

555391S: Advanced Course in Project Management, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Industrial Engineering and Management

Arvostelu: 1 - 5, pass, fail

Opettajat: Kirsi Aaltonen

Opintokohteen kielet: English

Leikkaavuudet:

555381S Project Leadership 5.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

English.

Timing:

Periods 1-2.

Learning outcomes:

Upon completion of the course, the student will be able to:

- explain and describe the most important project management areas and tools
- identify and evaluate the most applicable managerial approaches for different types of projects
- identify development needs and opportunities in project-based organisations
- to develop project management processes in an organisation

Contents:

different type of projects and industry specific approaches to project management, agile project management, managing large international projects, project governance, project risk and uncertainty management, project time and schedule management, management of innovative projects.

Mode of delivery:

The tuition will be implemented as blended teaching (web-based teaching and face-to-face teaching).

Learning activities and teaching methods:

Lectures, web-based-lectures and workshops 26h, group exercises and cases 66h, self-study 42h.

Target group:

Industrial Engineering and Management students.

Prerequisites and co-requisites:

555285A Basic course in project management.

Recommended optional programme components:

-

Recommended or required reading:

Lecture materials and reading materials (articles, book chapters) related to each lecture.

Assessment methods and criteria:

This course utilises continuous assessment. The grading is based on case assignments solved in groups and discussed during the lecture, and group assignment that is presented and discussed in the workshops. Since the implementation of the cases and group work vary, the assessment methods and criteria will be defined at the beginning of the course.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Assistant professor Kirsi Aaltonen

Working life cooperation:

The course includes guest lectures from industry.

Other information:

Substitutes course 555381S Project Leadership.

H453222: Modules of the option RF Engineering, 70 - 90 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Other Entity
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory

A451226: Module of the option, RF Engineering, 36 - 71 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Module of the Option
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Obligatory studies: basic and advanced module, tot. 36 ECTS cr

521401S: Electronics Design II, 6 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Nissinen
Opintokohteen kielet: English
Leikkaavuudet:

521443S	Electronics Design II	5.0 op

ECTS Credits:

6 ECTS

Language of instruction:

In Finnish (In English if needed).

Timing:

Autumn, period 1

Learning outcomes:

1. should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies
2. should be able to analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits
3. should be able to estimate and minimize the effects of noise in electrical circuits

4. should be able to explain the terminology used with DA and AD conversion and converters
5. should be able to analyze and outline the main architectural principles and also to evaluate the characteristics of DA and AD converters

Contents:

Modeling of BJT and MOS transistors, CMOS and BJT building blocks especially as IC-realizations, noise and analysis of noise, internal structure of operational amplifiers, critical parameters, comparators, S/H-circuits, structures and properties of A/D and D/A converters.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching: Lectures 30h, exercises 20h. Self study: a small design work 20h. Learning without guidance either privately or in a group 60h.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Principles of electronics design, Electronics design I

Recommended optional programme components:

-

Recommended or required reading:

Lecture handout,T. C. Carusone, D. A. Johns & K.W. Martin: Analog integrated circuit design , Wiley cop. 2012. 2nd ed., chapters 1, 3, 6, 9, 10, 15, 16 and 17, parts of 4 ja 11; P.E. Allen & D.R. Holberg: CMOS Analog Circuit Design, Oxford University Press 2002, chapters 1,3,4,5, 6, 8 and 10.

Assessment methods and criteria:

The course unit is passed by a final exam and a passed design work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521348S: Statistical Signal Processing 1, 5 op

Voimassaolo: 01.08.2016 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Janne Lehtomäki, Juntti, Markku Johannes

Opintokohteen kielet: Finnish

Leikkaavuudet:

521484A	Statistical Signal Processing	5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the key tools of linear algebra and quadratic optimization and can apply them in solving signal processing problems.
2. understands how to handle complex valued random variables and processes.
3. understands the key concepts in estimation theory such as the classical and Bayesian philosophies.
4. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
5. can derive an estimator for a given criterion and basic data models.
6. can use the methodology of estimation theory to analyze the performance of estimators and compare to performance benchmarks such as the Cramer-Rao lower bound.
7. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.

Contents:

Review of probability, complex valued random variables and stochastic processes; linear algebra, eigenvalue decomposition, SVD (Singular value decomposition), use of Matlab; estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, least squares estimation, Bayesian estimation, linear Bayesian estimation; statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching and e-learning tool usage

Learning activities and teaching methods:

Face-to-face-teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521330A. The recommended prerequisite is the completion of Telecommunication Engineering.

Recommended optional programme components:

521323S Wireless communications I and 031051S Numerical Matrix Analysis are recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory."vol 1 Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory, vol. 2." Prentice Hall 1999.
3. Peter Selinger, “Matrix Theory and Linear Algebra”, Creative Commons.
4. Paolo Prandoni & Martin Vetterli, Martin, “Signal Processing for Communications”, CRC Press 2008.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.7 and that of project report 0.3.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Janne Lehtomäki and Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle https://moodle.oulu.fi/course/view.php?id=4203.

521395S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti, Timo Kokkonen

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S-02	Wireless Communications I, Exercise	0.0 op
521323S	Wireless Communications 2	5.0 op
521323S-02	Wireless Communications I, Exercise	0.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 2	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op
521323S-01	Wireless Communications I, Exam	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

Student
1. can analyze the performance of multilevel digital modulation methods in AWGN channel
2. can explain the effect of fading channel on the performance of the modulation method and can analyze the performance
3. recognizes and understand suitable diversity methods for fading channel and related combining methods
4. can understand and explain coding methods for wireless channels
5. recognizes different wideband systems
6. understands the cellular system principle

Contents:

Radio channel models, digital modulation and detection methods, carrier and symbol synchronization, performance of digital modulation in AWGN and fading channel, diversity techniques, coding for wireless channel, multicarrier modulation, spread spectrum, cellular systems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program.

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering

Recommended optional programme components:

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Recommended or required reading:

Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.

Assessment methods and criteria:

The course is passed with minor exams (only during lecture period) or with final exam; and the accepted design work report. In the final grade of the course, the weight for the examination(s) is 0.6 and that for the design work report 0.4.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Iinatti / Timo Kokkonen

Working life cooperation:

Visiting lecturers from industry.

Other information:

-

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S-01	Radio Engineering	0.0 op
521326S-02	Radio Engineering	0.0 op
521335S	Radio Engineering	6.0 op
521335S-01	Radio engineering, partial credit	0.0 op
521335S-02	Exercise work, Radio engineering 1	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.
A student can also explain factors, which are limiting the bandwidth of impedance matching networks. Smith chart (admittance/impedance chart).
3. will be able to design a low noise RF amplifier. The amplifier is designed that the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

4. knows single sideband and double sideband noise in mixers. A student will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.
5. will be able to design passive microwave components like a Wilkinson power divider, a directional coupler and hybrids.
6. can explain basic priciples of RF-oscillators. A student can design a cross-coupled oscillator and voltage controlled oscillator.
7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.
8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.

Contents:

Noise, non-linearity, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers design, Wilkinson power dividers, directional couplers, hybrids, automatic gain control (AGC), cross-coupled oscillator, voltage controlled oscillators, power amplifier design.

Mode of delivery:

The lectures and the exercises are organized as remote sessions.

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).

Target group:

1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521324S: Statistical Signal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521373S Statistical Signal Processing 2 6.0 op

521373S-01 Statistical Signal Processing 2, exam 0.0 op

521373S-02 Statistical Signal Processing 2, exercise work 0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course at the 1st spring semester of the master studies.

Learning outcomes:

Upon completion the student will

1. understand the key design problems and constraints of the typical estimation problems in statistical signal processing.
2. have the skills to apply estimation, detection and other statistical signal processing methods to solve practical problems in signal processing applications.
3. can use linear algebra, basics of optimization and statistical signal processing to derive algorithms with statistical models.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including adaptive algorithms.
5. understands the basic requirements for the convergence of an iterative and adaptive algorithm.
6. can model the operation of a transceiver using Matlab and other simulators to assess the performance of transceiver algorithms.
7. can solve simple composite hypothesis testing problems with unknown parameters

Contents:

Linear Bayesian estimators and filters, sequential Bayesian and least squares algorithms, Wiener and Kalman filtering, iterative algorithms, adaptive filtering and algorithms, statistical decision theory for signals with unknown parameters, application examples: equalization in communications engineering, array processing and beamforming, spectral analysis and estimation, delay estimation and positioning.

Mode of delivery:

Online teching and e-learning tool usage

Learning activities and teaching methods:

Online teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521348S Statistical Signal Processing I. The recommended prerequisite is the completion of 521330A Telecommunications Engineering, 521323S Wireless Communications I, 031025A Introduction to Optimization and 031051S Numerical Matrix Analysis.

Recommended optional programme components:

521317S Wireless communications II is recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory," vol. 1. Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory," vol. 2. Prentice Hall 1998.
3. Simon Haykin, “Adaptive Filter Theory”, 3rd ed. or newer, Prentice Hall 1996.

4. Gene H. Golub & Charlers F. Van Loan, “Matrix computations”, 3rd ed. or newer, Johns Hopkins University Press 1996.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.6 and that of project report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle: https://moodle.oulu.fi/course/view.php?id=6010

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish. English, if there are at least 3 international students in class.

Timing:

The course is held in the 4^{th} period. It is recommended to complete the course during Master level studies.

Learning outcomes:

1. After completing the course the student has knowledge of the behavior of passive components at RF frequencies, knows the fabrication methods of components and is also able to apply the knowledge to practical applications.

2. The student also knows the operating principles of transfer lines, antennas and filters and of their design.

3. The student can apply the fundamentals of RF and microwave techniques to measurements, is able to make the measurements of RF components, has knowledge of the operating principles of RF region measurement equipment and is able to compare the usability of d

4. The student knows how to perform typical measurements of RF region magnitudes (power, frequency, impedance and noise).

Contents:

Fundamentals of RF and microwave techniques, components in microwave circuits, measurement instruments, measuring of power, frequency, impedance and noise, time-domain and active circuit measurements.

Mode of delivery:

Face-to-face teaching, independent design exercises and laboratory exercises.

Learning activities and teaching methods:

Lectures 24 h, design execises 20 h, laboatory exercises 20 h, independent work 68,5 h.

Target group:

Masters students on electrical engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronic Components and Materials, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handout, Lecture notes. A. Lehto, A. Räisänen: Mikroaaltomittaustekniikka (in Finnish), I. Bahl: Luped Elements for RF and Microwave circuits, R. Ludvig, P.Bretchko: RF circuit Desing: Theory ans Applications, Prentice Hall 2000 and literature announced at the beginning of the lectures.

Assessment methods and criteria:

Final exam, design exercises and laboratory exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Merja Teirikangas

Working life cooperation:

No.

Other information:

-

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English/Finnish.

Timing:

Period 1

Learning outcomes:

1. is able to choose the optimum method of the choices presented in the course in the field of power supply, thermal design, grounding, and routing of the high speed signals.
2. is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components.
3. can calculate reliability of an electrical device or system.
4. The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.

Contents:

Power supplies, thermal design, grounding, transmission of fast signals by using transmission lines, electrical disturbances, crosstalk, non-idealities of electrical components.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 30 h of lectures and 20 h of exercises.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course.

Prerequisites and co-requisites:

Both Principles of Electronics Design and Analogue Electronics I must have been accepted.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Lecture notes. Ward & Angus: Electronic Product Design, Hall&Hall&McCall: High speed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques. Eric Bogatin: Signal and Power Integrity – Simplified, 2. ed.

Assessment methods and criteria:

The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No.

Other information:

-

A451297: Advanced Module, Radio engineering, 36 - 42 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Radio engineering - advanced module

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish (English as a book examination)

Timing:

Autumn, period 2

Learning outcomes:

1. On completion of the study module students should be able to detail the advantages of differential signal processing in IC realizations and
2. to analyze and design differential amplifiers and other electronic blocks for implementation in an IC environment.
3. They should be able to explain how an SC (switched capacitor) technology functions and to apply such a technology to sampling and filtering.
4. They should also be able to describe the principles for realizing continuous filters in IC technologies, to explain the principles of the delta–sigma technology
5. and to apply it for realizing integrated DA and AD converters.
6. They should be able to account for the functioning, use and architecture of a phase-locked loop,
7. to explain the functioning of an MOS transistor in the area of weak inversion and to indicate how use can be made of this functional area in circuit design.

Contents:

Advanced operational amplifier topologies, especially differential ones, bandgap and PTAT bias circuits and references, problems related to the design of multi-stage amplifiers (output stages, LP /LV implementations), signal sampling and error sources related to it, SC-techniques (especially in filters), implementation principles of continuous time IC filters, DS techniques in general and particularly in AD/DA converters, operations with frequency/phase domain signals, design of IC layout.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h and Exercises 20 h; Self-study or in a group of two persons: laboratory exercise 40 h (CAD tools used in IC design and familiarization into the complete analogue IC design flow) and learning without guidance either privately or in a group 69 h.
The course is organized remotely and Zoom links for lectures and exercises can be found from Moodle under the topics lectures and exercises.

Target group:

Electrical Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

Electronics Design II, Filters, Introduction to Microfabrication Techniques (recommended).

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

Lecture notes: D. A. Johns & K. Martin: Analog integrated circuit design, Wiley & Sons 1997 chapter 6, chapter 8 partially, 9, 10, 14, 15 and 2. Also P. E. Allen & D. R. Holberg: CMOS Analog Circuit Design, Oxford university press 2002, chapters 2, 7, and 9, proper parts of other chapters of the book.

Assessment methods and criteria:

Passed final exam and exercise work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: English

Leikkaavuudet:

521375S	Design of Tranceivers	5.0 op
521375S-01	Design of tranceivers, partial credit	0.0 op
521375S-02	Design of tranceivers, partial credit	0.0 op

ECTS Credits:

6 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

3. can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them.

4. will be able to define parameters used in the transceiver system level design and can design a transceiver at the system level so that the requirements for the system are fulfilled.

5. knows nonlinear distortion and can design the automatic gain control in the system level.

6. will be able to explain factors, which are important for the selection of D/A- and A/D-converters and can derive various methods to create the in phase and the quadratute components of a received signal.

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.

Contents:

Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A /D-converter in a receiver, frequency synthesis, design and implementation examples.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (54 h).

Target group:

1st year M.Sc. and WCE-RF students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521075S: Microelectronics Packaging Technologies, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Sami Myllymäki

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

3rd period

Learning outcomes:

1. Upon completing the course student can explain how electronics packaging technology has since invention of transistors to current date and can estimate how this development is going to continue in future.
2. The student can describe can explain what is meant by microjoining techniques and what are the pros and cons of these.
3. The student can tell what different kind of materials, and why, are used in IC packaging technology.
4. The student can explain what is meant with system level packaging and how the strong miniaturization on IC requires new system level packaging techniques to be developed.
5. He can explain why active and passive components are being, more and more, embedded to be a part of the circuit board.
6. In addition, he can explain why and how radio electronics will be migrate towards circuit board and components on it.

Contents:

Radio technology applications are emphasized. Trends of packaging and component technologies. Area array packaging techniques. BGA-components. Micro joining and bonding. Multi-chip-modules: MCM-L, MCM-D and MCM-C modules. Fine line techniques. System level packaging (SOC, SOP).

Multilayer substrates and integration of passive components. 3-D packaging. radio electronics modules. MEMS components. Electronics applications to nanotechnology.

Mode of delivery:

Face to face teaching

Learning activities and teaching methods:

Lecturing 24 h, practical work 12 h.

Target group:

Primarily major students of electrical engineering.

Prerequisites and co-requisites:

Recommended Introduction to Microfabrication Techniques.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Rao R. Tummala(edit): Fundamentals of microsystems packaging, New York, McGraw-Hill, 2001. R. R. Tummala and M. Swaminathan, Introduction to System-on-Package (SOP), McGraw-Hill, 2008.

Assessment methods and criteria:

The course is completed with the final exam and finished course work.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Sami Myllymäki

Working life cooperation:

No

Other information:

-

521388S: Antennas, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg

Opintokohteen kielet: English

Leikkaavuudet:

521380S	Antennas	4.0 op
521380S-01	Antennas, partial credit	0.0 op
521380S-02	Antennas, partial credit	0.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring, period 4

Learning outcomes:

After completing the course, student

1. knows antenna terminology and understands the role of antennas as a part of different radio systems.

2. is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays.

3. will be able to design wire antennas, micro strip antennas and antenna arrays for different radio systems.

4. will be able to design and analyze various antenna types and arrays using 3D electromagnetic simulation software.

Contents:

Introduction to different antenna types. Fundamental parameters of antennas. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas. Loop antennas. Microstrip antennas. Antenna arrays. Antennas for wireless devices. Antenna - human body interaction. Base station antennas. 3D electromagnetic simulation.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures and exercises 40 h / Compulsory antenna design work with an electromagnetic simulation 25 h / Self-study 70 h

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering 521384A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Recommended literature: C.A. Balanis: Antenna Theory, Analysis and Design (3rd or 4th Ed). John Wiley & Sons, 2005 or 2016. Chapters 1-6 and 14.

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. In the final grade of the course, the weight for the examination is 0.5 and that for the design work 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg

Working life cooperation:

No

Other information:

-

521402S: Telecommunications Circuit Design, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rahkonen, Timo Erkki

Opintokohteen kielet: Finnish

ECTS Credits:

6 ects / 42 contact hours + design excercise

Language of instruction:

English/Finnish

Timing:

Autumn, 1st period of the last year of studies

Learning outcomes:

After completing the course the student
- knows the most usual schematic structures and dimensioning principles of typical telecommunication circuit blocks
- can sketch the spectral effects of non-linear and time-varying circuit blocks
- can evaluate the performance of the available IC process node

Contents:

The course gives the background needed in the design of RFICs and other analog telecommunication circuit blocks.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 hours of lectures, 14 of excercises, and a relatively large design task.

Target group:

Last year MSc students with strong analog design background

Prerequisites and co-requisites:

Strong background in analog transistor level design is required.

Recommended optional programme components:

Needs electronics design 2-3 background

Recommended or required reading:

Handouts

Assessment methods and criteria:

Graded based on the final exam. The design excercise needs to be passed.

Grading:

Numerical scale 0-5. 0 is fail, 5 the best.

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

The topics are strongly related to the skills needed in the industry

Other information:

The course is the last advanced course in analog design, and requires the basic knowledge of transistor level analog design and IC design.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S Advanced practical training 5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

-

Obligatory, Radio engineering - advanced module, Choose 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise

521322S: Telecommunication Engineering Project, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Saarnisaari, Harri Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

521387S	Telecommunication Engineering Project	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English/Finnish

Timing:

Fall or Spring, periods 1-4

Learning outcomes:

After completing the course student can
1. depending on the work subject, either solve, design, construct, measure, simulate, test or analyze limited telecommunication and radio system and sub-system problems.
2. apply the technical knowledge acquired from advanced sources into practical engineering tasks.
3. document technical and scientific results.

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work.
If you would like to take the course, you can contact the course person responsible.

Learning activities and teaching methods:

The design exercise is done in a group of one or two students depending of work's difficulty. The design exercise can be simulation or implementation work. The work can be defined by the Department of Communications Engineering or by industry. In the later case a proposal must be submitted to the teacher before beginning of the work. Also, student must meet the schedule and deadlines given by a supervisor before starting the work. In preparing the work report document the writing instructions of DCE department's diploma thesis must be followed.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Depending on the subject: advanced courses dealing with telecommunication systems, digital communications, digital signal processing or/and radio engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Varies depending on the topic.

Assessment methods and criteria:

Written work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Harri Saarnisaari

Working life cooperation:

No

Other information:

-

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.
3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

Optional studies: please select courses so that the minimum extent is 120 ECTS.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Kyösti, Markus Berg

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

Autumn, period 2.

Learning outcomes:

After completing the course, student
1. will be able to define what the radio channel is and is able to distinguish it into modellable parts.

2. knows different radio wave propagation mechanisms.

3. can apply physical and empirical radio channel models.

4. is able to analyse which are the dominating propagation mechanisms in different environments.

5. will know how to measure the properties of different radio channels.

Contents:

The radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radio wave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Statistical description of fading radio channel. Principles of the radio channel modelling. Noise calculations. Radio wave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modelling for outdoor mobile systems. Radio wave propagation inside or into buildings. Radio channels of mobile satellite links. Slow fading. Multipath propagation and its effects on narrowband and wideband radio channels. MIMO radio channels. Measurement methods of radio channels. Atmospheric attenuation on terahertz frequency bands.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h / Exercises 8 h / compulsory laboratory work 25 h / Self-study 74 h.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Andreas Molisch. "Wireless Communications", 2012. Wireless Communications. Wiley-IEEE Press.
Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007.

Assessment methods and criteria:

The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Pekka Kyösti

Working life cooperation:

No

Other information:

-

521328A: Simulations and Tools for Telecommunications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Johanna Vartiainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521369A	Simulations and Tools for Telecommunications	3.0 op
521369A-01	Simulations and Tools for Telecommunications, exam	0.0 op
521369A-02	Simulations and Tools for Telecomm. exercise	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, period 2

Learning outcomes:

1. A student recognizes problems and limitations related to simulations.

2. She/he can select a suitable simulation method and knows how to validate the model.

3. Student knows how to generate signals, random numbers and noise.

4. She/he knows how to model fading channels.

5. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results.

6. She/he can explain principles of network level simulations.

7. A student knows basics of one or two fundamental simulation programs

Contents:

Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs/availability).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h (including program introductions), and the compulsory assignment with a simulation program (40 h).

Target group:

3rd year bachelor's degree students and M.Sc. students

Prerequisites and co-requisites:

Telecommunication Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition. Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Johanna Vartiainen

Working life cooperation:

No

Other information:

In 2020, the whole course including compulsory exercise and exam is organized in Moodle https://moodle.oulu.fi/enrol/index.php?id=3757 (opens no later than one week before the start of the course)

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. Students understand how the modern communications networks have evolved and how the architecture has changed through the recent paradigm shift towards software-centric communications.
2. Students are able to describe the basic system architecture elements of mobile networks, and understands the significance of emerging technologies such as Network Function Virtualization (NFV), Software Defined Networking (SDN), and core network functionalities such as Evolved Packet Core (EPC).
3. Students can describe the main principles of mobility management, network management and orchestration, and network security, and can apply and solve related engineering problems.
4. Students know the basic properties of routing algorithms, and can use graph theory to solve network routing problems.
5. Students are able to simulate different types of networks in simulation environments and solve basic network programming problems. Upon completing the required coursework, students understand the basic functionalities in TCP/IP protocol stack.

Contents:

Communications architecture in mobile, wireless local area and personal area networks. Introduction to cloud and edge computing, network function virtualization and software defined networking. Basic principles of mobility management, network security, network management and orchestration. The goal is to present the basics of the modern communications architectures, and their technical implementation.

Mode of delivery:

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available in Moodle.
https://moodle.oulu.fi/course/view.php?id=1454

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work (15 h). Design work can be done alternatively either as NS-2 simulation or TCP/IP programming exercise. Design work instructions are provided in digital learning environment (Moodle).

Target group:

1st year M.Sc. and WCE students

Prerequisites and co-requisites:

-

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015; A comprehensive Guide to 5G Security, M Liyanage, I Ahmad, A Abro, A Gurtov, M Ylianttila – 2018; In addition, selected supportive online reading materials from recent standards and publications are provided in digital learning environment (Optima / Moodle).

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Mika Ylianttila

Working life cooperation:

No

Other information:

-

521349S: Wireless Communications II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Antti-Heikki Tölli
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. The student is familiarised with the channel capacity as the fundamental performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna scenarios.
2. The student understands the basic principles for multiuser communications in fading channels, apprehends the notion of capacity region for multi-access and broadcast channels, and is familiarised with different practical multiple access, random access and scheduling methods.
3. The student is acquainted with core principles of adaptive transmission, which requires accurate channel estimates at the receiver and a reliable information exchange mechanisms between the receiver and transmitter. Practical variable-rate variable-power MQAM modulation techniques for fading channels are introduced.
4. The student understands the principles of transmitter and receiver design in the presence of channel distortion. The student is familiarised with various (adaptive) equalization solutions to combat intersymbol interference.
5. Finally, the student is acquainted with the capacity optimal multi-antenna transmission and reception scheme, as well as, with basic multiantenna space-time coding schemes in a single-user multiple-input multiple-output (MIMO) communications scenario.

Contents:

Capacity of wireless channels, multiuser communications, adaptive modulation and coding, equalization, point-to-point MIMO communications and space-time coding.

Mode of delivery:

Fully remotely,
https://moodle.oulu.fi/course/view.php?id=2086

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program (20 h).

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme).

Prerequisites and co-requisites:

In addition to courses “521395S Wireless Communications I”, 521348S “Statistical Signal Processing I”, 031025A “Introduction to optimization” and 031051S “Numerical matrix analysis”, a working knowledge in digital communications, random processes, linear algebra, matrix manipulation and detection theory is required.

Recommended optional programme components:

Prior knowledge of 521390S Information Theory and 521392S Convex Optimisation is very useful but not mandatory. The course 521324S Statistical Signal Processing II is recommended to be taken in parallel.

Recommended or required reading:

D. N. C. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005, Chapters 3-7.
Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005, Chapters 4, 9-11.
14. Upamanyu Madhow: Fundamentals of Digital Communication, Cambridge University Press, 2008, Chapter 5 (Equalization).
Supporting material: Cover & Thomas, "Elements of Information Theory", John Wiley & Sons; Boyd & Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is a weighted sum of exam (70%), homework (20%), and work report (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Antti Tölli

Working life cooperation:

No

Other information:

Course replaces the old course 521317S Wireless Communications II (8cr).

521289S: Machine Learning, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Seppänen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521497S-01	Pattern Recognition and Neural Networks, Exam	0.0 op
521497S-02	Pattern Recognition and Neural Networks; Exercise Work	0.0 op
521497S	Pattern Recognition and Neural Networks	5.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

English.

Timing:

The course unit is held in the spring semester, during period III. It is recommended to complete the course at the end of studies.

Learning outcomes:

After completing the course, student

1. can design simple optimal classifiers from the basic theory and assess their performance.
2. can explain the Bayesian decision theory and apply it to derive minimum error classifiers and minimum cost classifiers.
3. can apply regression techniques to practical machine learning problems.

Contents:

Introduction. Bayesian decision theory. Parametric and non-parametric classification. Feature extraction. Classifier design and optimization. Example classifiers. Statistical regression methods.

Mode of delivery:

Online teaching, guided laboratory work and independent assignment. The laboratory works are done on an online system (Mathworks Grader). Student can do the lab works remotely or in the lab using the same online system.
The course is implemented as remote education via the Moodle work space https://moodle.oulu.fi/course/view.php?id=5729
This work space opens to students before the course begins. The student must register to the course in WebOodi in order to participate the course.

Learning activities and teaching methods:

Lectures 16 h, Laboratory work 16 h, and Self-study the rest (Independent task assignment).

Target group:

Students who are interested in machine learning and pattern recognition theory and methods.

Prerequisites and co-requisites:

The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Programming skills, especially basics of the Matlab.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Will be informed when the course starts.

Assessment methods and criteria:

Laboratory work is supervised by assistants who also verify that the task assignments are completed properly. The Matworks Grader online system also verifies the completed tasks. The independent task assignment is graded which establishes the grade for the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail. The final grade is established by the independent task assignment.

Person responsible:

Tapio Seppänen

Working life cooperation:

No

521279S: Signal Processing Systems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Sangi

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period II. For master students of Computer Science and Engineering specializing in Computer Engineering, it is recommended to complete the course at the first autumn semester.

Learning outcomes:

Learning outcomes of the course are:

1. The student understands common real number formats used in digital signal processing.

2. The student can implement a digital filter using fixed-point computations. He can optimize word lengths so that the required performance goals are fulfilled.
3. The student knows the CORDIC algorithm and can utilize it in the implementation of function and transform (e.g. DCT) computations.
4. The student knows the principles, which allow computationally efficient implementation of decimation and interpolation operations. Related to this, he can implement narrow-band digital filters.
5. The student can explain how a modulated filter bank works and knows its polyphase decomposition based implementation.
6. The student can implement convolution for long data sequences and filters. He also knows, how the same principles are used in the implementation of correlation.
7. The student can explain the general operational principles of adaptive filters and knows some of their applications. He knows operation of some common adaptive algorithms. He can study behaviour of adaptive filters with simulation.

Some exercise tasks of the course are done in the Matlab environment utilizing also its Simulink tool. The student learns how it can be used in the modelling of signal processing systems.

Contents:

Fixed-point and floating-point arithmetics, fixed-point filter implementation, CORDIC, DCT, FFT, polyphase decomposition, multirate signal processing, modulated filter banks, sectioning, adaptive filters and algorithms, Matlab and Simulink tools in DSP modelling.

Mode of delivery:

The tuition will be implemented as face-to-face teaching and web-based teaching. Moodle is used as the learning environment.
Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available from October 16 in Moodle.

Learning activities and teaching methods:

Lectures 28 h / Group work 42 h / Self-study 65 h. The group work consists of six weekly design tasks.

Target group:

The course is primarily targeted to the students of Computer Science and Engineering specializing to Computer Engineering.

Prerequisites and co-requisites:

A recommended prerequisite is the completion of "521337A Digital Filters".

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course provides lecture notes for reading. In addition, the following books provide useful information:
E.C. Ifeachor, B.W. Jervis. Digital Signal Processing - A Practical Approach. Second Edition. Prentice-Hall, 2002.
W.T. Padgett, D.V. Anderson. Fixed-Point Signal Processing. Morgan&Claypool Publishers, 2009.

Assessment methods and criteria:

The course uses continuous assessment, which is based on evaluation of the weekly group works and exams arranged during lectures.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pekka Sangi

Working life cooperation:

The course does not contain working life cooperation. There may be guest lectures.

Other information:

The web page of the course arranged at Autumn 2020 will be https://moodle.oulu.fi/course/view.php?id=3212

521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-4

Learning outcomes:

After completing the course the student understand and is able to analyze basic principles of the topic which has been presented in the course. The final outcomes will be defined based on the contents.
Objective: Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

Varies yearly based on actual topics in telecommunications and radio engineering.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and/or exercises and/or design exercise and/or seminars depending on the topic of the year. The start and implementation of the course will be informed separately. The course can be given several times with different contents during the academic year and it can be included into the degree several times.

Target group:

1 st and 2 nd year M.Sc. and WCE students.

Prerequisites and co-requisites:

Will be defined based on the contents.

Recommended optional programme components:

-

Recommended or required reading:

Will be defined in the beginning of the course.

Assessment methods and criteria:

Depends on the working methods.

Grading:

The course unit utilizes a numerical grading scale 1-5.
Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

-

521325S: Communication Signal Processing, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521360S	Communication Signal Processing II	4.0 op
521360S-01	Synchronization for Digital Receivers, exam	0.0 op
521360S-02	Synchronisation for Digital Receivers, exercise work	0.0 op

ECTS Credits:

5 ECTS cr / 130 hours of work

Language of instruction:

English

Timing:

The course is held bi-annually in the spring semester, during period 4. It is recommended to complete the course at the 1st or 2nd spring semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the functional structure of communications transceiver and understands the requirements for various wireless systems for the transceiver.
2. knows the architectural and functional design of (all-)digital transceiver with synchronization, channel estimation, encoding/decoding, multiantenna processing and connection establishment.
3. understands the requirements of the current wireless communications standards and related multiplexing and multiple access on transceiver design.
4. can derive digital domain algorithms for separate functionalities and match them to operate together via agreed interfaces.
5. can model the operation of the algorithms and the whole transceiver using Matlab and C other to assess their performance by computer simulations.

Contents:

Wireless transceiver functional split, digital parts and architecture, multirate filtering and filter banks, transceiver digital front-end architecture and design, synchronization and channel estimation, equalization and soft detection, algorithm-architecture co-simulation, multiantenna transceivers.

Mode of delivery:

Remote teaching and e-learning tool usage.

Learning activities and teaching methods:

Remote teaching (lectures, exercises and seminar presentations) 30 h, Simulation and design exercises and presentation preparation in groups 80 h, independent work & passed assignment 20 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 521348S Statistical signal processing I, 521324S Statistical Signal Processing II, 521323S Wireless communications I, 521317S Wireless communications II.

Recommended optional programme components:

-

Recommended or required reading:

Parts from books:

1. P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, “Signal Processing and Optimization for Transceiver Systems”, Cambridge University Press, 2010.
2. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
3. H. Meyr, M. Moeneclaey & S. A. Fechtel, “Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing”. John Wiley, 1998.
4. F. Ling, “Synchronization in Digital Communication Systems”, Cambridge University Press, 2017.
5. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory," vol. 2. Prentice Hall 1998.
6. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the design and simulation projects, giving a seminar presentation on those, and a final exam. In the final grade of the course, the weight for the examination is 0.5 and that of project report 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

The project focuses on timely design problems in wireless industry. Industrial visiting lectures are organized. The project can be done as true industrial design project.

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2021.

H451227: Module of the Option, Photonics and Measurement Technology, 60 - 80 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Other Entity
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Module of the option, compulsory studies, 30 ECTS cr

A451223: Module of the Option, Photonics and Measurement Techniques, 30 - 41 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Module of the Option
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory courses, 30 ECTS cr

521088S: Optoelectronics, 5 op

Voimassaolo: 01.01.2014 -
Opiskelumuoto: Advanced Studies
Laji: Course

Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Määttä
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn, period 1

Learning outcomes:

1. is able to explain the principles of operation of optical fibres and wavequides

2. is able to explain the principles of operation of semiconductor light sources and photo detectors, and knows the factors affecting their performance

3. is able to outline the circuit-level structures for optical transmitter circuits and photo detector preamplifiers

4. is able to compare their performance in terms of the main performance parameters

Contents:

Wave/particle dualism of optical radiation, optical waveguides and their properties, sources of radiation (LED- and laser structures), photo detectors (PIN- and AP-diodes,SPAD), light source modulation, preamplifiers and their bandwidth/stability/noise analysis.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h and exercises 20 h, may include a seminar.

Target group:

This course is targeted mainly for the students of electrical engineering degree program, but available for other students as well.

Prerequisites and co-requisites:

Principles of semiconductor devices.

Recommended optional programme components:

This course is independent, no other components are recommended simultaneously.

Recommended or required reading:

Lecture notes, S. Kasap: Optoelectronics and Photonics, Principles and Practices, Prentice Hall 2013, 2nd Ed.

Assessment methods and criteria:

Final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Kari Määttä

Working life cooperation:

Does not apply.

Other information:

-

521096S: Measurement Systems, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Christian Schuss
Opintokohteen kielet: Finnish
Leikkaavuudet:

521110S	Measuring and Testing Systems	6.0 op
521110S-01	Measuring and Testing Systems, exam	0.0 op
521110S-02	Measuring and Testing Systems, exercise work	0.0 op

ECTS Credits:

5 ECTS credits / 128h

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Guided course is on period 2. The course can be completed independently in during spring semester. Ask responsible person for instructions.

Learning outcomes:

1. is able to design a multisensor measurement systems which store the measurement data.
2. is able to assembly a multisensor measurement systems which store the measurement data.
3. is able to program with LabView.

Contents:

Basics of measurement and testing systems, especially wired and wireless data transmission. Data acquisition cards. Basics of LabView programming.

Mode of delivery:

The course can be completed independently during spring semester. Ask instructions from responsible person.

Learning activities and teaching methods:

The course includes 28h lectures and guided exercises. 100 h self-studies.

Target group:

Master level students regardless of master's programme.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

This course compensates earlier courses with same core content but different course code or credit named Measuring and Testing Systems.

Recommended or required reading:

Course material is in English and Finnish and can be found in Moodle.

Assessment methods and criteria:

Final exam and passed laboratory works.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

No.

521124S: Electronic Sensors, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Alexey Popov, Aliaksandr Bykau
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English.

Timing:

Period 2.

Learning outcomes:

After the course the student is capable to explain the operating principles of different sensors and can select a right sensor for each measuring target. He/she is able to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition the student is able to plan and design sensor signal conditioning circuits.

Contents:

Methods for measuring displacement, velocity, acceleration, torque, liquid level, pressure, flow, humidity, sound and temperature. Ultrasound, optical and nuclear measurement techniques and applications, material analyses such as pH measurement and gas concentration, pulp and paper measurements and smart sensors.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 26h, exercises 12h and self-study 100h.
The information about the course 521124S - Anturit ja mittausmenetelmät/Electronic Sensors has been added to the Moodle page:
https://moodle.oulu.fi/course/view.php?id=5357

Course description: "The course is aimed at students willing to be capable of explaining the operating principles of different sensors and selecting the right sensor for each measuring target. We will focus on how to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition, we will go into questions on how to plan and design sensor signal conditioning circuits."

The lectures and seminars will be organized remotely via Zoom environment. The corresponding link will be published on the page of the course in Moodle prior to the lecture.

Target group:

4 year students.

Prerequisites and co-requisites:

No.

Recommended optional programme components:

No.

Recommended or required reading:

H. N. Norton: Handbook of Transducers, Prentice Hall P T R, 1989 or 2002; lecture and exercise notes.

Assessment methods and criteria:

The course is passed by a final exam and passed exercises.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Aliaksandr Bykau ja Alexey Popov

Working life cooperation:

No.

521089S: Printed Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

Leikkaavuudet:

521217S	Printed Electronics	4.0 op
521095S	Advanced Course of Printed Electronics	3.0 op

ECTS Credits:

5

Language of instruction:

Finnish. English if more than two international students in the course.

Timing:

Period 3.

Learning outcomes:

1. Knows the most typical materials and printing methods suitable for their processing
2. Can explain the principles of materials and printing methods
3. Can utilize the material and manufacturing process knowledge to design fabrication processes for electrical components
4. Can analyse how the selected materials and printing methods influence on the performance of electrical components

Contents:

Materials (conductive and semi-conductive polymers, photoactive polymers, dielectrics, particle based inks) and processing methods (screen printing, gravure printing, flexo printing, inkjet) utilized in printed electronics, surface wetting and film formation, printed electrical components (passive components, solar cells, light emitting diodes, transistors) and their fabrication. Possibilities and challenges of printing based processing methods and how to take them into account in the printed electronics fabrication.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Combined lectures and exercises 30 h and self-study 100 h

Target group:

Primarily for the students of electrical engineering

Prerequisites and co-requisites:

None.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

D.R. Gamota, P. Brazis, K. Kalyanasundaram and J. Zhang, "Printed organic and molecular electronics", handout

Assessment methods and criteria:

Course is completed by final examination.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Tapio Fabritius

Working life cooperation:

Not included.

521097S: Wireless Measurements, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Christian Schuss

Opintokohteen kielet: English

Leikkaavuudet:

521114S	Wireless Measurements	4.0 op
521114S-01	Wireless Measurements, exam	0.0 op
521114S-02	Wireless Measurements, exercise work	0.0 op

ECTS Credits:

5 ECTS credits / 128h

Language of instruction:

In English

Timing:

Period 3.

Learning outcomes:

1. can tell and justifying argument the benefits and challenges of using wireless measurement solutions
2. can apply the most important standards when designing wireless measurement solutions
3. can apply wireless technologies in industrial, traffic, environmental, home and healthcare measurements

Contents:

Basics of wireless measurement technologies and standards, wireless sensors and sensor networks, wireless building and smart home applications, wireless measurement applications in traffic, wireless environmental measurements and wireless human health monitoring.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 22h. Seminars 6-12h depending on the number of students participating the course. The students prepare seminar presentations about contemporary topics selected by themselves or proposed by the teacher and give 10 minutes presentation to other students in the seminars.

Target group:

Master level students regardless of master's programme.

Prerequisites and co-requisites:

No prerequirements, but basics of measurements systems are recomended.

Recommended optional programme components:

The course replaces previous courses with same name, but different credits and code.

Recommended or required reading:

Lecture notes and seminar reports is Optima.

Assessment methods and criteria:

The course is passed with a written final exam (70 %) and a contemporary seminar (30 %).
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is on numerical scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

No.

521176A: Laboratory Works of Electronic Measurement Techniques, 5 op

Voimassaolo: 01.08.2020 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Christian Schuss

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

English. Some of supervisors can Finnish or Russian

Timing:

Period 4.

Learning outcomes:

The student The student
1. can design and conduct measurements to define amplifier and filter properties,
2. can design and conduct measurements with spectrum analyser and FFT oscilloscope,
3. can design and conduct measurements to define light and photosensor properties.
4. can apply techniques to increase precision and can detect and reject interference,
5. can use a fiber lidar.

Contents:

An overview to electronic measurements by concentrating to few topics: temperature, light and moisture sensors, measurements of filter and amplifier properties, frequency domain measurements, lidar measurements, reject of interference and noise.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lecture hall teaching (Start and end lecture) 4h, laboratory work 30 h and independent work 100 h.

Target group:

Course is recommended as a voluntary course to all engineering students. All students of the University of Oulu can attend the course.

Recommended optional programme components:

This course can replace Electronic measurement techniques.

Recommended or required reading:

Course material is in Moodle.

Assessment methods and criteria:

The course is passed when all laboratory works are passed.

Grading:

Pass or fail

Person responsible:

Christian Schuss

Working life cooperation:

No.

A451298: Advanced Module, Photonics and Measurement Techniques, 18 - 45 op

Voimassaolo: 01.08.2020 -
Opiskelumuoto: Module of the Option
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

select at least three courses in addition to Advanced Practical Training.

521092A: Electronic Measurement Techniques, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Christian Schuss
Opintokohteen kielet: Finnish
Leikkaavuudet:

521171A	Electronic Measurement Techniques	6.5 op
521171A-01	Electronic measurement techniques, exam	0.0 op
521171A-02	Electronic measurement techniques, exercise work	0.0 op
521430A	Electronic Measurement Techniques	6.0 op

ECTS Credits:

5 ECTS credits / 132 h

Language of instruction:

In Finnish or in English if two or more foreign students participate.

Timing:

Period 4 academic year 20-21 and 21-22. Period I from academic year 22-23 forward.

Learning outcomes:

1. remembers the electrical measurement technique terminology associated to measurement systems, sensors and buses.
2. can name most important analog signal conditioning structures
3. can plan and implement basic measurements with electrical thermometers
4. can plan and implement basic measurements with optical meters

5. can name common sources of noise and interference and means to control them
6. can name methods to realize electrical quantities

Contents:

Broad view to electronic measurements.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 28h and self-study 100h.

Target group:

Course is compulsory for electrical engineering students. Course is open for all students in University of Oulu.

Recommended optional programme components:

The course replaces previous courses with same name, but different credits and code.

Recommended or required reading:

Course material is in English and Finnish and can be found in Moodle.

Assessment methods and criteria:

The course is passed with a final exam.

Grading:

Numerical grading scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

None.

Other information:

-

521242A: Introduction to Biomedical Engineering, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Myllylä

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Period 1

Learning outcomes:

After completing the course, the student has a basic knowledge of the biomedical engineering discipline and the applications of engineering science to biomedical problems.

Contents:

Biomedical engineering is a multidisciplinary field of study that ranges from theory to applications at the interface between engineering, medicine and biology. This course will introduce the subdisciplines within biomedical engineering, including such as systems physiology, bioinstrumentation, bioimaging, biophotonics and biomedical signal analysis. General issues of the subdisciplines will be presented together with selected examples and clinical applications. A number of lectures will be given by professionals working in health tech companies, University of Oulu and Oulu University Hospital, presenting different fields of the biomedical engineering. In addition, course offerings of biomedical engineering at the University of Oulu are introduced.

Mode of delivery:

Face-to-face teaching. Under some circumstances distance learning using online material is possible (please, ask the teacher).

Learning activities and teaching methods:

The course includes online material, lectures and a group project. Lectures 28h and laboratory exercises 4 h and self-study 100h

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Participation in lectures or using the online material and writing a work report.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

1 - 5, pass, fail

Person responsible:

Teemu Myllylä

Working life cooperation:

Guest lecturers

Other information:

-

521240S: Biophotonics and Biomedical Optics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Alexey Popov, Aliaksandr Bykau

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English

Timing:

Period 2

Learning outcomes:

On successful completion of the course, students will be able to categorize the basic principles of modern optical and laser-based diagnostic modalities and instruments used in advanced biomedical research and clinical medicine. They will be able to demonstrate detailed understanding and evaluate the key biophotonics techniques underlying day-to-day clinical diagnostic and therapies and industrial applications in pharmacy, health care and cosmetic products. They can operate with the selected techniques of their choice.

Contents:

The course includes in-depth coverage of state-of-the-art optical imaging and spectroscopy systems for advanced biomedical research and clinical diagnosis, fundamental properties of light such as coherence, polarization, angular momentum, details of light interaction with tissue, and modern imaging system. Coherent Optical Tomography (OCT), Laser Doppler Flowmetry, Laser Speckle Imaging (LSI), Photo-Acoustic Tomography (PAT), Tissue polarimetry; Optical and Near-Infra-Red Spectroscopy (NIRS), Confocal and Fluorescence Microscopies; Tissue Optics: Light/matter interactions, index of refraction, reflection, optical clearing, absorption, Mie scattering, Rayleigh scattering, Monte Carlo modelling.

Mode of delivery:

Online teaching.
The information about the remote teaching of the course: 521240S Biophotonics and Biomedical Optics
has been added to the course workspace in moodle https://moodle.oulu.fi/course/view.php?id=2436&section=0
Shortly, the lectures and seminars will be organized remotely via the zoom environment.
The corresponding link will be published on the moodle page prior to the lecture.
The exam/test will performed online through the moodle or google forms at the estimated day.

Learning activities and teaching methods:

Lectures/exercises 38 h and self-study 100 h.
The information about the remote teaching of the course: 521240S Biophotonics and Biomedical Optics
has been added to the course workspace in moodle https://moodle.oulu.fi/course/view.php?id=2436&section=0
Shortly, the lectures and seminars will be organized remotely via the zoom environment.
The corresponding link will be published on the moodle page prior to the lecture.
The exam/test will performed online through the moodle or google forms at the estimated day.

Target group:

Students interested in biomedical measurements.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

A new course

Recommended or required reading:

V.V Tuchin: Handbook of Optical Biomedical Diagnostics, SPIE Press, 2002; V.V Tuchin: Handbook of Coherent Domain Optical Methods, Springer, 2nd edition, 2013. D.A Boas, C. Pitris, N. Ramanujam, Handbook of Biomedical Optics, CRC Press, 2011.

Assessment methods and criteria:

The course is passed by the final exam and with the assignments.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1 - 5

Person responsible:

Aliaksandr Bykau and Alexey Popov

Working life cooperation:

No.

521093S: Biomedical Instrumentation, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Myllylä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521107S	Biomedical Instrumentation	6.0 op

ECTS Credits:

5

Language of instruction:

English.

Timing:

Period 4.

Learning outcomes:

After the course the student is capable to explain principles, applications and design of medical instruments most commonly used in hospitals. He/she can describe the electrical safety aspects of medical instruments and can present the physiological signals commonly measured on humans. In addition the student is able to explain medical instrumentation development process and the factors affecting it. He/she also recognizes typical measurands and measuring spans and is able to plan and design a biosignal amplifier.

Contents:

Diagnostic instruments (common theories for medical devices, measurement quantities, sensors, amplifiers and registering instruments). Introduction to medical imaging and monitoring methods and instruments and physical therapy devices. Electrical safety aspects.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures/exercises 30 h and self-study 100 h.

Target group:

Students interested in biomedical measurements.

Prerequisites and co-requisites:

None

Recommended optional programme components:

Course replaces earlier courses Biomedical measurements and Biomedical instrumentation.

Recommended or required reading:

R. S. Khandpur: Biomedical Instrumentation, Technology and Applications, McGraw-Hill, 2005 and J. G. Webster: Medical Instrumentation, Application and Design, 4th edition, John Wiley & Sons, 2010.

Assessment methods and criteria:

The course is passed by the final exam or optionally with the assignments/test agreed at the first lecture.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1 - 5.

Person responsible:

Teemu Myllylä

Working life cooperation:

No.

521079S: Introduction to Nanotechnology, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Krisztian Kordas

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English

Timing:

4th period

Learning outcomes:

1. The students will acquire the basic principles of nanoscience and technology.

2. The course will also help understanding and rational thinking concerning strategies towards practical synthesis and safe utilization of nanomaterials.

Contents:

Nanotechnology definitions and the nanomaterials around us. Health concerns. Synthesis methods; morphological, structural, electrical, optical and spectroscopic characterization of nanomaterials. Properties on the nanoscale. Integration and device development with nanomaterials. Current and future applications.

Mode of delivery:

Lectures

Learning activities and teaching methods:

Though the course is primarily based on lectures, the communication channel is open in both directions enabling continuous comments, questions and feedback from the students. Critical explanations and think alouds are also applied to motivate thinking and active learning.

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Lecutre notes and parts of following books Springer Handbook of Nanotechnology, (Ed.) B. Bhushan. Springer Handbook of Nanomaterials, (Ed.) R. Vajtai. Nano-Age: How Nanotechnology Changes Our Future, M. Pagliaro. Applied Nanotechnology: The Conversion of Research Results to Products, J. Ramsden. Introduction to Nanotechnology, C.P. Poole, Jr.,F.J. Owens.

Assessment methods and criteria:

Examination.

Grading:

Numerical grading 1-5.

Person responsible:

Krisztian Kordas

Working life cooperation:

-

Other information:

-

521098S: Testing Techniques of Electronics and Printed Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Period 4.

Learning outcomes:

1. After completing the course the student is able to analyze different kinds of testing strategies, and is able to enhance the testability of electronics through the use of design for testability.
2. The student can also compare different testing techniques of analogue and digital electronics, which have been implemented using either embedded testing methods or external automatic testing equipment.
3. Additionally, the student is able to analyze tests made using an automatic test instrument, compare different test interfaces and data busses, and recognizes principles of design of a high-quality printed test circuit board.
4. The Student understands the specific features of printed electronics having an influence on electronics testing and reliability.

Contents:

Overview of different testing methods, constructions of testers, test fixtures, test signal generation and measurement, mixed-signal test buses, DC- and parametric measurements, dynamic tests, AD /DA converter tests, DSP-based tests, data analysis, embedded testing, design for testability, Boundary scan, test applications.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 26h/Exercises 14h and self-studying 100 h.

Target group:

Course is compulsory for the Electrical engineering students in the advanced module of Testing techniques and printed electronics.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronics Design I, Electronic Measurement Techniques.

Recommended optional programme components:

This course compensates 521098S Testing Techniques of Electronics if the student hasn’t got credits from it.

Recommended or required reading:

M. Burns, G. W. Roberts: An Introduction to Mixed-Signal IC Test and Measurement, Lecture slides. Additional material will be announced at the beginning of the course.

Assessment methods and criteria:

Exam and passed lab exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Tapio Fabritius

Working life cooperation:

No.

521115S: EMC Design, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannu Sorvoja

Opintokohteen kielet: Finnish

Leikkaavuudet:

521172S	EMC Design	4.0 op
521172S-02	EMC Design, Exercise work	0.0 op
521172S-01	EMC Design, Exam	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish. English, if there are more than 2 foreign students.

Timing:

Period 4.

Learning outcomes:

1. is able to name common EMC standards

2. is able to use EMC testing equipment and methods

3. can explain the noise coupling mechanisms

4. is able to use good design practices related to analogue and digital electronics design

5. is able to use good design practices related to analogue and digital electronics grounding

6. is able to use good design practices related to analogue and digital electronics filtering

7. is able to use good design practices related to analogue and digital electronics shielding

Contents:

EMC standards for emission and susceptibility, interference coupling, circuit design and grounding, connections, filtering, shielding, EMC testing laboratories, EMC tests and their background.

Mode of delivery:

face-to-face teaching

Learning activities and teaching methods:

The course includes 30 h lectures and 100 h self-studies.

Target group:

Primarily students studying electrical engineering. In addition, other students studying in the University of Oulu can carry out the course.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronics Design I, Digital Techniques I, Electronic Measurement Techniques, Measuring and Testing Systems, RF Components and Measurements.

Recommended optional programme components:

The course replaces previous courses with same name, but different credits and code.

Recommended or required reading:

Tim Williams: EMC for Product Designers, 5th edition, Oxford: Newnes, 2017.
Lecture slides.

Assessment methods and criteria:

Final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Hannu Sorvoja

Working life cooperation:

Company visits if possible.

Other information:

-

521108S: Optical Measurement Technology Exercise, 5 - 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Anssi Mäkynen

Opintokohteen kielet: Finnish

ECTS Credits:

5 – 10 ECTS credits / 140 - 280 hours of work.

Language of instruction:

Finnish or English.

Timing:

Periods 1 - 4.

Learning outcomes:

The student
1. is able to justify the chosen implementation principle.
2. is able to assess the suitability of the implementation method for different measurement needs.
3. is able to produce solutions for small-scale optical measurement engineering design tasks.
The detailed objectives of the course will vary depending on the assignment.

Contents:

The content and scope of the course will be confirmed on a case-by-case basis.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Includes 140 to 280 hours of independently conducted work depending on the scope of exercise.

Target group:

All students of the University of Oulu can attend the course. Prime target is 4th year students in Electrical Engineering degree program.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

The course is carried out by completing the assignment.

Grading:

Numerical grading scale 1-5.

Person responsible:

Anssi Mäkynen

Working life cooperation:

No.

Other information:

-

521175S: Printed electronics design and construction exercise, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 – 10 ECTS credits / 140 - 280 hours of work

Language of instruction:

English

Timing:

Period 3 - 5.

Learning outcomes:

During this course, students will learn about the practical aspects of various printing methods. In addition, students will gain hands-on experience on how to control the printing process according to their needs and application requirements. To increase the applicability of this course, students will be involved in the development of printed batteries.
This course consists of three cross-linked modules: theoretical, practical and analytical. After completing this course, students will be able to:
Theoretical

- Identify the main parameters governing the printing processes in various printing methods,
- Apply basic formulas and equations to predict ink-substrate interactions,
- Design basic models of printed batteries and their components by utilizing the most commonly used modeling software.

Practical

- Understand and apply basic principles governing the printing process,
- Create appropriate ink formulations and tune the printing process,
- Design and fabricate various thin-film structures by using screen and ink-jet printing methods.

Analytical

- Conduct characterization of inks and printed layers,
- Perform basic characterization of printed batteries,
- Present a concluding report of achieved results in a form understandable for a general audience.

Before starting this course, to increase the interaction, the students will be asked to provide one additional learning outcome based on their interests that will be appropriately formulated at the first session and included in the intended learning outcome.

Contents:

The content and scope of the course will be confirmed on a case-by-case basis. Primarily 5 ECTS cr.

Mode of delivery:

Independent work and face-to-face teaching

Learning activities and teaching methods:

Includes 140 to 280 hours of independently conducted work depending on the scope of exercise.

Target group:

All students of the University of Oulu can attend the course. Prime target 4th year students in Electrical Engineering degree program.

Prerequisites and co-requisites:

Printed electronics course 521089S (or equal) is needed to be admitted to this course.

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

The course is carried out by completing the assignment.

Grading:

Numerical grading scale 1-5.

Person responsible:

Rafal Sliz

Working life cooperation:

No.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

-

Optional Studies (42 ECTS cr): Photonics and measurement techniques. You must take the optional studies to make total 120 ECTS cr

521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op

Opiskelumuoto: Advanced Studies

Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-4

Learning outcomes:

After completing the course the student understand and is able to analyze basic principles of the topic which has been presented in the course. The final outcomes will be defined based on the contents.
Objective: Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

Varies yearly based on actual topics in telecommunications and radio engineering.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and/or exercises and/or design exercise and/or seminars depending on the topic of the year. The start and implementation of the course will be informed separately. The course can be given several times with different contents during the academic year and it can be included into the degree several times.

Target group:

1 st and 2 nd year M.Sc. and WCE students.

Prerequisites and co-requisites:

Will be defined based on the contents.

Recommended optional programme components:

-

Recommended or required reading:

Will be defined in the beginning of the course.

Assessment methods and criteria:

Depends on the working methods.

Grading:

The course unit utilizes a numerical grading scale 1-5.
Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

-

521395S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti, Timo Kokkonen

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01 Wireless Communications I, Exam 0.0 op

521395S-02 Wireless Communications I, Exercise 0.0 op

521323S Wireless Communications 2 5.0 op

521323S-02 Wireless Communications I, Exercise 0.0 op

521320S Wireless Communications 2 8.0 op

521320S-01 Intermediate exam or final exam, Wireless Communications 2 0.0 op

521320S-02 Exercisework, Wireless Communications 2 0.0 op

521323S-01 Wireless Communications I, Exam 0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

Student
1. can analyze the performance of multilevel digital modulation methods in AWGN channel
2. can explain the effect of fading channel on the performance of the modulation method and can analyze the performance
3. recognizes and understand suitable diversity methods for fading channel and related combining methods
4. can understand and explain coding methods for wireless channels
5. recognizes different wideband systems
6. understands the cellular system principle

Contents:

Radio channel models, digital modulation and detection methods, carrier and symbol synchronization, performance of digital modulation in AWGN and fading channel, diversity techniques, coding for wireless channel, multicarrier modulation, spread spectrum, cellular systems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program.

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering

Recommended optional programme components:

-

Recommended or required reading:

Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.

Assessment methods and criteria:

The course is passed with minor exams (only during lecture period) or with final exam; and the accepted design work report. In the final grade of the course, the weight for the examination(s) is 0.6 and that for the design work report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Iinatti / Timo Kokkonen

Working life cooperation:

Visiting lecturers from industry.

Other information:

-

521362S: Electonics and Communications Engineering Seminar, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Isohookana

Opintokohteen kielet: Finnish

Leikkaavuudet:

521350S	Seminar in Telecommunication and Radio Engineering	1.0 op

ECTS Credits:
0/1
Language of instruction:
English
Timing:
Autumn and spring, periods 1-4.
Learning outcomes:
1. Student can prepare a presentation of predetermined length of her/his thesis.
2. Student has experience on presenting her/his topic.
3. Student has experience on evaluating other students' presentations.
4. Student has a general view of other completed diploma thesis.

Contents:
The content is determined by the diploma work topics and other current research topics.
Mode of delivery:
Seminar presentations.
Learning activities and teaching methods:
Seminar sessions when necessary during the whole year. Please be in contact University Lecturer Matti Isohookana. (matti.isohookana(at)oulu.fi)
Target group:
2nd year M.Sc. and WCE students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
Instructions for preparing a diploma work in the degree program.
Assessment methods and criteria:
Course is mandatory for all ECE and WCE students who have started their Master’s studies in study year 2017 or later. Course is mandatory also for ECE and WCE students with Telecommunication or Radio Engineering study option who have started their studies in the study year 2015 or later. All students have to give a seminar presentation (30 minutes with questions and discussion). If a student will participate into three other seminars (s)he will get one credit unit which can be included to the optional studies.
Presentations are given in English. Seminars are given during the whole year when necessary.
Read more about assessment criteria at the University of Oulu webpage.

Grading:
The course unit utilizes grading passed.
Person responsible:
Matti Isohookana
Working life cooperation:
-
Other information:
Objective: Students get practice in preparing and giving an oral presentation. At the same time they learn about current research and development projects going on in the university and in the industry.
Link to Moodle: https://moodle.oulu.fi/course/view.php?id=4214

521976S: Master's Thesis in Electronics and Communications Engineering, 30 op

Voimassaolo: 01.01.2020 -

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
30
Grading:
1-5

521011S: Maturity Test for Master's Degree, Electronics and Communications Engineering, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
0; The maturity test is integrated in the MSc Thesis credits (30 ECTS).
Language of instruction:
Finnish/Swedish/other
Timing:
1-4
Learning outcomes:
After the maturity test, the student has demonstrated that his/her language skills meet the requirements of the work life.
Contents:
The aim of the maturity test is to confirm the student's familiarity of the thesis area as well as his/her command of the domestic language of his/her school education.
Mode of delivery:
The maturity test is written in a controlled event, on a topic provided by the thesis supervisor.
Learning activities and teaching methods:
Written essay, approximately 3 pages.
Target group:
-
Prerequisites and co-requisites:
The maturity test can be written when the thesis is complete or being finished.
Recommended optional programme components:
-
Recommended or required reading:
MSc thesis

Assessment methods and criteria:
The maturity test is evaluated and approved by the thesis supervisor
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass/fail.
Person responsible:
Thesis supervisor.
Working life cooperation:
-
Other information:
-

A451225: Module of the Option, Wireless Communications Engineering, 40 - 65 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Module of the Option
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

obligatory studies of the RAN stydy option

031051S: Numerical Matrix Analysis, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Applied Mathematics and Computational Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Marko Huhtanen
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish or English.
The course can be completed in English by intermediate exams or by a final exam.

Timing:

Fall semester, period 1

Learning outcomes:

After completing the course the student knows the most efficient and numerically stable methods to solve the basic problems in linear algebra. He/she knows the basic matrix factorizations and their approximations. The student has the capability to solve very large and sparse problems with the iterative solutions methods and understands the significance of preconditioning.

Contents:

Theory of matrix decompositions, SVD-decomposition, LU-decomposition, QR-decomposition, Schur-decomposition, FFT, eigenvalue- and generalized eigenvalue problems, matrix functions, GMRES, MINRES, Preconditioning.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 14 h / Self-study 93 h.

Target group:

-

Prerequisites and co-requisites:

Completion of courses Calculus I and II, a course on Differential Equations and a Course on Linear Algebra and Numerical analysis

Recommended optional programme components:

-

Recommended or required reading:

Material posted on the web-page of the course.

Assessment methods and criteria:

Intermediate exams or a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Marko Huhtanen

Working life cooperation:

-

Other information:

-

521348S: Statistical Signal Processing 1, 5 op

Voimassaolo: 01.08.2016 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Janne Lehtomäki, Juntti, Markku Johannes

Opintokohteen kielet: Finnish

Leikkaavuudet:

521484A	Statistical Signal Processing	5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the key tools of linear algebra and quadratic optimization and can apply them in solving signal processing problems.
2. understands how to handle complex valued random variables and processes.
3. understands the key concepts in estimation theory such as the classical and Bayesian philosophies.
4. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
5. can derive an estimator for a given criterion and basic data models.
6. can use the methodology of estimation theory to analyze the performance of estimators and compare to performance benchmarks such as the Cramer-Rao lower bound.

7. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.

Contents:

Review of probability, complex valued random variables and stochastic processes; linear algebra, eigenvalue decomposition, SVD (Singular value decomposition), use of Matlab; estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, least squares estimation, Bayesian estimation, linear Bayesian estimation; statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching and e-learning tool usage

Learning activities and teaching methods:

Face-to-face-teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521330A. The recommended prerequisite is the completion of Telecommunication Engineering.

Recommended optional programme components:

521323S Wireless communications I and 031051S Numerical Matrix Analysis are recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory."vol 1 Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory, vol. 2." Prentice Hall 1999.
3. Peter Selinger, “Matrix Theory and Linear Algebra”, Creative Commons.
4. Paolo Prandoni & Martin Vetterli, Martin, “Signal Processing for Communications”, CRC Press 2008.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.7 and that of project report 0.3.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Janne Lehtomäki and Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle https://moodle.oulu.fi/course/view.php?id=4203.

521395S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti, Timo Kokkonen

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S-02	Wireless Communications I, Exercise	0.0 op
521323S	Wireless Communications 2	5.0 op
521323S-02	Wireless Communications I, Exercise	0.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 2	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op
521323S-01	Wireless Communications I, Exam	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

Student
1. can analyze the performance of multilevel digital modulation methods in AWGN channel
2. can explain the effect of fading channel on the performance of the modulation method and can analyze the performance
3. recognizes and understand suitable diversity methods for fading channel and related combining methods
4. can understand and explain coding methods for wireless channels
5. recognizes different wideband systems
6. understands the cellular system principle

Contents:

Radio channel models, digital modulation and detection methods, carrier and symbol synchronization, performance of digital modulation in AWGN and fading channel, diversity techniques, coding for wireless channel, multicarrier modulation, spread spectrum, cellular systems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program.

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering

Recommended optional programme components:

-

Recommended or required reading:

Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.

Assessment methods and criteria:

The course is passed with minor exams (only during lecture period) or with final exam; and the accepted design work report. In the final grade of the course, the weight for the examination(s) is 0.6 and that for the design work report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Iinatti / Timo Kokkonen

Working life cooperation:

Visiting lecturers from industry.

Other information:

-

031025A: Introduction to Optimization, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held in the autumn, during period 1.

Learning outcomes:

After completing the course the student is able to solve optimization convex optimization problems with the basic optimization algorithms. The student is also able to form the necessary and sufficient conditions for the optimality.

Contents:

Linear optimization, Simplex-algorithm, nonlinear optimization, KKT-conditions, duality, conjugate gradient method, penalty and barrier function methods.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 14 h / Self-study 93 h.
The course, Introduction to Optimization, will be lectured remotely through the ZOOM video conferencing tool. The more detailed instructions and access to ZOOM lectures can be found in the Moodle work space of the course. The link is here: https://moodle.oulu.fi/course/view.php?id=5350.

Target group:

Students in Wireless Communication Engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses Calculus I and II, Matrix algebra

Recommended optional programme components:

-

Recommended or required reading:

P. Ciarlet; Introduction to numerical linear algebra and optimization, M. Bazaraa, H. Sherali, C.M. Shetty; Nonlinear programming

Assessment methods and criteria:

The course can be completed by a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail

Person responsible:

Keijo Ruotsalainen

Working life cooperation:

-

Other information:

The course, Introduction to Optimization, will be lectured remotely through the ZOOM video conferencing tool. The more detailed instructions and access to ZOOM lectures can be found in the Moodle work space of the course. The link is here: https://moodle.oulu.fi/course/view.php?id=5350.

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. Students understand how the modern communications networks have evolved and how the architecture has changed through the recent paradigm shift towards software-centric communications.
2. Students are able to describe the basic system architecture elements of mobile networks, and understands the significance of emerging technologies such as Network Function Virtualization (NFV), Software Defined Networking (SDN), and core network functionalities such as Evolved Packet Core (EPC).
3. Students can describe the main principles of mobility management, network management and orchestration, and network security, and can apply and solve related engineering problems.
4. Students know the basic properties of routing algorithms, and can use graph theory to solve network routing problems.
5. Students are able to simulate different types of networks in simulation environments and solve basic network programming problems. Upon completing the required coursework, students understand the basic functionalities in TCP/IP protocol stack.

Contents:

Communications architecture in mobile, wireless local area and personal area networks. Introduction to cloud and edge computing, network function virtualization and software defined networking. Basic principles of mobility management, network security, network management and orchestration. The goal is to present the basics of the modern communications architectures, and their technical implementation.

Mode of delivery:

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available in Moodle.
https://moodle.oulu.fi/course/view.php?id=1454

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work (15 h). Design work can be done alternatively either as NS-2 simulation or TCP/IP programming exercise. Design work instructions are provided in digital learning environment (Moodle).

Target group:

1st year M.Sc. and WCE students

Prerequisites and co-requisites:

-

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015; A comprehensive Guide to 5G Security, M Liyanage, I Ahmad, A Abro, A Gurtov, M Ylianttila – 2018; In addition, selected supportive online reading materials from recent standards and publications are provided in digital learning environment (Optima / Moodle).

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Mika Ylianttila

Working life cooperation:

No

Other information:

-

521324S: Statistical Signal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521373S	Statistical Signal Processing 2	6.0 op
521373S-01	Statistical Signal Processing 2, exam	0.0 op
521373S-02	Statistical Signal Processing 2, exercise work	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course at the 1st spring semester of the master studies.

Learning outcomes:

Upon completion the student will

1. understand the key design problems and constraints of the typical estimation problems in statistical signal processing.
2. have the skills to apply estimation, detection and other statistical signal processing methods to solve practical problems in signal processing applications.
3. can use linear algebra, basics of optimization and statistical signal processing to derive algorithms with statistical models.

4. can use numerical analysis to approximate optimal algorithms with iterative solutions including adaptive algorithms.
5. understands the basic requirements for the convergence of an iterative and adaptive algorithm.
6. can model the operation of a transceiver using Matlab and other simulators to assess the performance of transceiver algorithms.
7. can solve simple composite hypothesis testing problems with unknown parameters

Contents:

Linear Bayesian estimators and filters, sequential Bayesian and least squares algorithms, Wiener and Kalman filtering, iterative algorithms, adaptive filtering and algorithms, statistical decision theory for signals with unknown parameters, application examples: equalization in communications engineering, array processing and beamforming, spectral analysis and estimation, delay estimation and positioning.

Mode of delivery:

Online teching and e-learning tool usage

Learning activities and teaching methods:

Online teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521348S Statistical Signal Processing I. The recommended prerequisite is the completion of 521330A Telecommunications Engineering, 521323S Wireless Communications I, 031025A Introduction to Optimization and 031051S Numerical Matrix Analysis.

Recommended optional programme components:

521317S Wireless communications II is recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory," vol. 1. Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory," vol. 2. Prentice Hall 1998.
3. Simon Haykin, “Adaptive Filter Theory”, 3rd ed. or newer, Prentice Hall 1996.
4. Gene H. Golub & Charlers F. Van Loan, “Matrix computations”, 3rd ed. or newer, Johns Hopkins University Press 1996.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.6 and that of project report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle: https://moodle.oulu.fi/course/view.php?id=6010

521349S: Wireless Communications II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Antti-Heikki Tölli
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. The student is familiarised with the channel capacity as the fundamental performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna scenarios.
2. The student understands the basic principles for multiuser communications in fading channels, apprehends the notion of capacity region for multi-access and broadcast channels, and is familiarised with different practical multiple access, random access and scheduling methods.
3. The student is acquainted with core principles of adaptive transmission, which requires accurate channel estimates at the receiver and a reliable information exchange mechanisms between the receiver and transmitter. Practical variable-rate variable-power MQAM modulation techniques for fading channels are introduced.
4. The student understands the principles of transmitter and receiver design in the presence of channel distortion. The student is familiarised with various (adaptive) equalization solutions to combat intersymbol interference.
5. Finally, the student is acquainted with the capacity optimal multi-antenna transmission and reception scheme, as well as, with basic multiantenna space-time coding schemes in a single-user multiple-input multiple-output (MIMO) communications scenario.

Contents:

Capacity of wireless channels, multiuser communications, adaptive modulation and coding, equalization, point-to-point MIMO communications and space-time coding.

Mode of delivery:

Fully remotely,
https://moodle.oulu.fi/course/view.php?id=2086

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program (20 h).

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme).

Prerequisites and co-requisites:

In addition to courses “521395S Wireless Communications I”, 521348S “Statistical Signal Processing I”, 031025A “Introduction to optimization” and 031051S “Numerical matrix analysis”, a working knowledge in digital communications, random processes, linear algebra, matrix manipulation and detection theory is required.

Recommended optional programme components:

Prior knowledge of 521390S Information Theory and 521392S Convex Optimisation is very useful but not mandatory. The course 521324S Statistical Signal Processing II is recommended to be taken in parallel.

Recommended or required reading:

D. N. C. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005, Chapters 3-7.
Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005, Chapters 4, 9-11.
14. Upamanyu Madhow: Fundamentals of Digital Communication, Cambridge University Press, 2008, Chapter 5 (Equalization).
Supporting material: Cover & Thomas, "Elements of Information Theory", John Wiley & Sons; Boyd & Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is a weighted sum of exam (70%), homework (20%), and work report (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Antti Tölli

Working life cooperation:

No

Other information:

Course replaces the old course 521317S Wireless Communications II (8cr).

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S-01	Radio Engineering	0.0 op
521326S-02	Radio Engineering	0.0 op
521335S	Radio Engineering	6.0 op
521335S-01	Radio engineering, partial credit	0.0 op
521335S-02	Exercise work, Radio engineering 1	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.
A student can also explain factors, which are limiting the bandwidth of impedance matching networks. Smith chart (admittance/impedance chart).
3. will be able to design a low noise RF amplifier. The amplifier is designed that the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.
4. knows single sideband and double sideband noise in mixers. A student will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.
5. will be able to design passive microwave components like a Wilkinson power divider, a directional coupler and hybrids.
6. can explain basic priciples of RF-oscillators. A student can design a cross-coupled oscillator and voltage controlled oscillator.
7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.
8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.

Contents:

Noise, non-linearity, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers design, Wilkinson power dividers, directional couplers, hybrids, automatic gain control (AGC), cross-coupled oscillator, voltage controlled oscillators, power amplifier design.

Mode of delivery:

The lectures and the exercises are organized as remote sessions.

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).

Target group:

1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

A451226: Module of the option, RF Engineering, 36 - 71 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Module of the Option

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Obligatory studies: basic and advanced module, tot. 36 ECTS cr

521401S: Electronics Design II, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: English

Leikkaavuudet:

521443S Electronics Design II 5.0 op

ECTS Credits:

6 ECTS

Language of instruction:

In Finnish (In English if needed).

Timing:

Autumn, period 1

Learning outcomes:

1. should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies
2. should be able to analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits
3. should be able to estimate and minimize the effects of noise in electrical circuits
4. should be able to explain the terminology used with DA and AD conversion and converters
5. should be able to analyze and outline the main architectural principles and also to evaluate the characteristics of DA and AD converters

Contents:

Modeling of BJT and MOS transistors, CMOS and BJT building blocks especially as IC-realizations, noise and analysis of noise, internal structure of operational amplifiers, critical parameters, comparators, S/H-circuits, structures and properties of A/D and D/A converters.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching: Lectures 30h, exercises 20h. Self study: a small design work 20h. Learning without guidance either privately or in a group 60h.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Principles of electronics design, Electronics design I

Recommended optional programme components:

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Recommended or required reading:

Lecture handout,T. C. Carusone, D. A. Johns & K.W. Martin: Analog integrated circuit design , Wiley cop. 2012. 2nd ed., chapters 1, 3, 6, 9, 10, 15, 16 and 17, parts of 4 ja 11; P.E. Allen & D.R. Holberg: CMOS Analog Circuit Design, Oxford University Press 2002, chapters 1,3,4,5, 6, 8 and 10.

Assessment methods and criteria:

The course unit is passed by a final exam and a passed design work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521348S: Statistical Signal Processing 1, 5 op

Voimassaolo: 01.08.2016 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Janne Lehtomäki, Juntti, Markku Johannes

Opintokohteen kielet: Finnish

Leikkaavuudet:

521484A	Statistical Signal Processing	5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the key tools of linear algebra and quadratic optimization and can apply them in solving signal processing problems.
2. understands how to handle complex valued random variables and processes.
3. understands the key concepts in estimation theory such as the classical and Bayesian philosophies.
4. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
5. can derive an estimator for a given criterion and basic data models.
6. can use the methodology of estimation theory to analyze the performance of estimators and compare to performance benchmarks such as the Cramer-Rao lower bound.
7. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.

Contents:

Review of probability, complex valued random variables and stochastic processes; linear algebra, eigenvalue decomposition, SVD (Singular value decomposition), use of Matlab; estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, least squares estimation, Bayesian estimation, linear Bayesian estimation; statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching and e-learning tool usage

Learning activities and teaching methods:

Face-to-face-teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521330A. The recommended prerequisite is the completion of Telecommunication Engineering.

Recommended optional programme components:

521323S Wireless communications I and 031051S Numerical Matrix Analysis are recommended to be taken in parallel.

Recommended or required reading:

Parts from books:
1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory."vol 1 Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory, vol. 2." Prentice Hall

1999.
3. Peter Selinger, “Matrix Theory and Linear Algebra”, Creative Commons.
4. Paolo Prandoni & Martin Vetterli, Martin, “Signal Processing for Communications”, CRC Press 2008.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.7 and that of project report 0.3.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Janne Lehtomäki and Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle https://moodle.oulu.fi/course/view.php?id=4203.

521395S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti, Timo Kokkonen

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S-02	Wireless Communications I, Exercise	0.0 op
521323S	Wireless Communications 2	5.0 op
521323S-02	Wireless Communications I, Exercise	0.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 2	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op
521323S-01	Wireless Communications I, Exam	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

Student
1. can analyze the performance of multilevel digital modulation methods in AWGN channel
2. can explain the effect of fading channel on the performance of the modulation method and can analyze the performance
3. recognizes and understand suitable diversity methods for fading channel and related combining methods
4. can understand and explain coding methods for wireless channels
5. recognizes different wideband systems
6. understands the cellular system principle

Contents:

Radio channel models, digital modulation and detection methods, carrier and symbol synchronization, performance of digital modulation in AWGN and fading channel, diversity techniques, coding for wireless channel, multicarrier modulation, spread spectrum, cellular systems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program.

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering

Recommended optional programme components:

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Recommended or required reading:

Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.

Assessment methods and criteria:

The course is passed with minor exams (only during lecture period) or with final exam; and the accepted design work report. In the final grade of the course, the weight for the examination(s) is 0.6 and that for the design work report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Iinatti / Timo Kokkonen

Working life cooperation:

Visiting lecturers from industry.

Other information:

-

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S-01	Radio Engineering	0.0 op
521326S-02	Radio Engineering	0.0 op
521335S	Radio Engineering	6.0 op
521335S-01	Radio engineering, partial credit	0.0 op
521335S-02	Exercise work, Radio engineering 1	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.
A student can also explain factors, which are limiting the bandwidth of impedance matching networks. Smith chart (admittance/impedance chart).
3. will be able to design a low noise RF amplifier. The amplifier is designed that the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.
4. knows single sideband and double sideband noise in mixers. A student will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.
5. will be able to design passive microwave components like a Wilkinson power divider, a directional coupler and hybrids.
6. can explain basic priciples of RF-oscillators. A student can design a cross-coupled oscillator and voltage controlled oscillator.
7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.
8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.

Contents:

Noise, non-linearity, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers design, Wilkinson power dividers, directional couplers, hybrids, automatic gain control (AGC), cross-coupled oscillator, voltage controlled oscillators, power amplifier design.

Mode of delivery:

The lectures and the exercises are organized as remote sessions.

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).

Target group:

1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

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Recommended or required reading:

Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521324S: Statistical Signal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521373S	Statistical Signal Processing 2	6.0 op
521373S-01	Statistical Signal Processing 2, exam	0.0 op
521373S-02	Statistical Signal Processing 2, exercise work	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course at the 1st spring semester of the master studies.

Learning outcomes:

Upon completion the student will

1. understand the key design problems and constraints of the typical estimation problems in statistical signal processing.
2. have the skills to apply estimation, detection and other statistical signal processing methods to solve practical problems in signal processing applications.
3. can use linear algebra, basics of optimization and statistical signal processing to derive algorithms with statistical models.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including adaptive algorithms.
5. understands the basic requirements for the convergence of an iterative and adaptive algorithm.
6. can model the operation of a transceiver using Matlab and other simulators to assess the performance of transceiver algorithms.
7. can solve simple composite hypothesis testing problems with unknown parameters

Contents:

Linear Bayesian estimators and filters, sequential Bayesian and least squares algorithms, Wiener and Kalman filtering, iterative algorithms, adaptive filtering and algorithms, statistical decision theory for signals with unknown parameters, application examples: equalization in communications engineering, array processing and beamforming, spectral analysis and estimation, delay estimation and positioning.

Mode of delivery:

Online teching and e-learning tool usage

Learning activities and teaching methods:

Online teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal Analysis, 031021P Probability and Mathematical Statistics, 031078P Matrix Algebra, 521348S Statistical Signal Processing I. The recommended prerequisite is the completion of 521330A Telecommunications Engineering, 521323S Wireless Communications I, 031025A Introduction to Optimization and 031051S Numerical Matrix Analysis.

Recommended optional programme components:

521317S Wireless communications II is recommended to be taken in parallel.

Recommended or required reading:

Parts from books:

1. Steven M Kay, "Fundamentals of statistical signal processing: estimation theory," vol. 1. Prentice Hall 1993.
2. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory," vol. 2. Prentice Hall 1998.
3. Simon Haykin, “Adaptive Filter Theory”, 3rd ed. or newer, Prentice Hall 1996.
4. Gene H. Golub & Charlers F. Van Loan, “Matrix computations”, 3rd ed. or newer, Johns Hopkins University Press 1996.
5. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the simulation project tasks, and a mid-term exam during the course. The mid-term exams can be retaken by a final exam later. In the final grade of the course, the weight for the examination is 0.6 and that of project report 0.4.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

No

Other information:

Lecture materials etc. can be found on Moodle: https://moodle.oulu.fi/course/view.php?id=6010

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish. English, if there are at least 3 international students in class.

Timing:

The course is held in the 4th period. It is recommended to complete the course during Master level studies.

Learning outcomes:

1. After completing the course the student has knowledge of the behavior of passive components at RF frequencies, knows the fabrication methods of components and is also able to apply the knowledge to practical applications.

2. The student also knows the operating principles of transfer lines, antennas and filters and of their design.

3. The student can apply the fundamentals of RF and microwave techniques to measurements, is able to make the measurements of RF components, has knowledge of the operating principles of RF region measurement equipment and is able to compare the usability of d

4. The student knows how to perform typical measurements of RF region magnitudes (power, frequency, impedance and noise).

Contents:

Fundamentals of RF and microwave techniques, components in microwave circuits, measurement instruments, measuring of power, frequency, impedance and noise, time-domain and active circuit measurements.

Mode of delivery:

Face-to-face teaching, independent design exercises and laboratory exercises.

Learning activities and teaching methods:

Lectures 24 h, design execises 20 h, laboatory exercises 20 h, independent work 68,5 h.

Target group:

Masters students on electrical engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronic Components and Materials, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handout, Lecture notes. A. Lehto, A. Räisänen: Mikroaaltomittaustekniikka (in Finnish), I. Bahl: Luped Elements for RF and Microwave circuits, R. Ludvig, P.Bretchko: RF circuit Desing: Theory ans Applications, Prentice Hall 2000 and literature announced at the beginning of the lectures.

Assessment methods and criteria:

Final exam, design exercises and laboratory exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Merja Teirikangas

Working life cooperation:

No.

Other information:

-

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English/Finnish.

Timing:

Period 1

Learning outcomes:

1. is able to choose the optimum method of the choices presented in the course in the field of power supply, thermal design, grounding, and routing of the high speed signals.
2. is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components.
3. can calculate reliability of an electrical device or system.
4. The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.

Contents:

Power supplies, thermal design, grounding, transmission of fast signals by using transmission lines, electrical disturbances, crosstalk, non-idealities of electrical components.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 30 h of lectures and 20 h of exercises.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course.

Prerequisites and co-requisites:

Both Principles of Electronics Design and Analogue Electronics I must have been accepted.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Lecture notes. Ward & Angus: Electronic Product Design, Hall&Hall&McCall: High speed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques. Eric Bogatin: Signal and Power Integrity – Simplified, 2. ed.

Assessment methods and criteria:

The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No.

Other information:

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A453273: Advanced module, Telecommunication Engineering, 10 - 47 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Advanced module mandatory courses, choose min. 30 ECTS cr in addition to Advanced Practical Training 3 ECTS cr. These are alternative: 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Kyösti, Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

Autumn, period 2.

Learning outcomes:

After completing the course, student
1. will be able to define what the radio channel is and is able to distinguish it into modellable parts.

2. knows different radio wave propagation mechanisms.

3. can apply physical and empirical radio channel models.

4. is able to analyse which are the dominating propagation mechanisms in different environments.

5. will know how to measure the properties of different radio channels.

Contents:

The radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radio wave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Statistical description of fading radio channel. Principles of the radio channel modelling. Noise calculations. Radio wave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modelling for outdoor mobile systems. Radio wave propagation inside or into buildings. Radio channels of mobile satellite links. Slow fading. Multipath propagation and its effects on narrowband and wideband radio channels. MIMO radio channels. Measurement methods of radio channels. Atmospheric attenuation on terahertz frequency bands.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h / Exercises 8 h / compulsory laboratory work 25 h / Self-study 74 h.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Andreas Molisch. "Wireless Communications", 2012. Wireless Communications. Wiley-IEEE Press.
Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007.

Assessment methods and criteria:

The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Pekka Kyösti

Working life cooperation:

No

Other information:

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521328A: Simulations and Tools for Telecommunications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Johanna Vartiainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521369A	Simulations and Tools for Telecommunications	3.0 op
521369A-01	Simulations and Tools for Telecommunications, exam	0.0 op
521369A-02	Simulations and Tools for Telecomm. exercise	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, period 2

Learning outcomes:

1. A student recognizes problems and limitations related to simulations.

2. She/he can select a suitable simulation method and knows how to validate the model.

3. Student knows how to generate signals, random numbers and noise.

4. She/he knows how to model fading channels.

5. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results.

6. She/he can explain principles of network level simulations.

7. A student knows basics of one or two fundamental simulation programs

Contents:

Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs/availability).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h (including program introductions), and the compulsory assignment with a simulation program (40 h).

Target group:

3rd year bachelor’s degree students and M.Sc. students

Prerequisites and co-requisites:

Telecommunication Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition. Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Johanna Vartiainen

Working life cooperation:

No

Other information:

In 2020, the whole course including compulsory exercise and exam is organized in Moodle
https://moodle.oulu.fi/enrol/index.php?id=3757 (opens no later than one week before the start of the course)

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: English

Leikkaavuudet:

521375S	Design of Tranceivers	5.0 op
521375S-01	Design of tranceivers, partial credit	0.0 op
521375S-02	Design of tranceivers, partial credit	0.0 op

ECTS Credits:

6 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

3. can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them.

4. will be able to define parameters used in the transceiver system level design and can design a transceiver at the system level so that the requirements for the system are fulfilled.

5. knows nonlinear distortion and can design the automatic gain control in the system level.

6. will be able to explain factors, which are important for the selection of D/A- and A/D-converters and can

derive various methods to create the in phase and the quadratute components of a received signal.

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.

Contents:

Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A/D-converter in a receiver, frequency synthesis, design and implementation examples.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (54 h).

Target group:

1st year M.Sc. and WCE-RF students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521377S: Communications Networks II, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:

7 ECTS cr

Language of instruction:

English

Timing:

Spring, periods 3-4

Learning outcomes:

1. Upon completing the required coursework, the students understand basic principles of programmable networking. The students understand the challenges in existing architectures and how Software Defined Networking (SDN) can solve those challenges.
2. Students understand the idea of SDN network control and data planes, and what it means in practice. The students learn how the network control-data plane separation is possible with SDN. The students have knowledge of how different control plane architectures can be developed or used for different networked environments.
3. Students understand the novel features in the 5G architecture, such as Multi-Access Edge Computing (MEC) and Network Function Virtualization (NFV) and the benefits of MEC and NFV for mobile networks. Students understand the importance of edge computing and virtualization techniques in achieving the low-latency and reliability requirements of 5G standard. Students know the planned use cases of multi-access edge computing in 5G systems and can describe some of the system architecture components.
4. Students understand the significance of network security, network load-balancing and network slicing in modern and emerging communications networks and how they need to be taken into consideration when using SDN and NFV.
5. Students understand the dynamics of simple programmable networks, the importance of queuing systems in the current model of programmable networks such as OpenFlow-based SDNs. The student is also able to design a queuing system for SDN-based network control plane to provide services in a balanced way to the underlying data plane the control plane is responsible for.
6. Students understand the basic principles of queueing theory, such as Birth and Death Process, the M/M/1, M/M/c, M/M/c/K and queuing networks models. Students understand concept of Markov model and its application in communication network analysis. Students can apply queueing theory to model SDN or virtualized networks.
7. Students learn skills to design and implement simple SDNs and analyze performance in network emulation and simulation environments.

Contents:

Introduction to the concepts of Software Defined Networking (SDN): the OpenFlow based SDN architecture, SDN control plane and data plane (OpenFlow switches), Software Defined Monitoring, SDN and Network Function Virtualization (NFV) integration in cellular systems. Introduction to Multi-Access Edge computing (MEC), and the use cases of MEC in 5G, and MEC-IoT integration. Introduction to queueing theory and queueing systems and application of queueing theory to model software defined mobile network or virtualized networks (Jackson network). Furthermore, the course discusses the significance of network security, network load-balancing and network slicing in modern and emerging communications networks. Course provides hands-on experience on virtual networks using SDN with Mininet network emulator.

Mode of delivery:

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available in Moodle.
https://moodle.oulu.fi/course/view.php?id=1457

Learning activities and teaching methods:

Lectures 30 h, exercises 15 h and the compulsory design work with a simulation program (30 h). Description of Mininet exercises and Simulink simulation design work are provided in digital learning environment (Moodle).

Target group:

1 st year M.Sc. and WCE students.

Prerequisites and co-requisites:

Communications Networks I

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture” M Liyanage, A Gurtov, M Ylianttila – 2015.; A comprehensive Guide to 5G Security, M Liyanage, I Ahmad, A Abro, A Gurtov, M Ylianttila – 2018; In addition, selected supportive online reading materials from recent standards and publications are provided in digital learning environment (Optima / Moodle).

Assessment methods and criteria:

The course is passed with a final examination and the accepted emulation/simulation work report. The final grade is based on examination.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Mika Ylianttila

Working life cooperation:

No

Other information:

-

521388S: Antennas, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English
Leikkaavuudet:

521380S	Antennas	4.0 op
521380S-01	Antennas, partial credit	0.0 op
521380S-02	Antennas, partial credit	0.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring, period 4

Learning outcomes:

After completing the course, student
1. knows antenna terminology and understands the role of antennas as a part of different radio systems.

2. is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays.

3. will be able to design wire antennas, micro strip antennas and antenna arrays for different radio systems.

4. will be able to design and analyze various antenna types and arrays using 3D electromagnetic simulation software.

Contents:

Introduction to different antenna types. Fundamental parameters of antennas. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas. Loop antennas. Microstrip antennas. Antenna arrays. Antennas for wireless devices. Antenna - human body interaction. Base station antennas. 3D electromagnetic simulation.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures and exercises 40 h / Compulsory antenna design work with an electromagnetic simulation 25 h / Self-study 70 h

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering 521384A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Recommended literature: C.A. Balanis: Antenna Theory, Analysis and Design (3rd or 4th Ed). John Wiley & Sons, 2005 or 2016. Chapters 1-6 and 14.

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. In the final grade of the course, the weight for the examination is 0.5 and that for the design work 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg

Working life cooperation:

No

Other information:

-

521279S: Signal Processing Systems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Sangi

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course is held in the autumn semester, during period II. For master students of Computer Science and Engineering specializing in Computer Engineering, it is recommended to complete the course at the first autumn semester.

Learning outcomes:

Learning outcomes of the course are:

1. The student understands common real number formats used in digital signal processing.
2. The student can implement a digital filter using fixed-point computations. He can optimize word lengths so that the required performance goals are fulfilled.
3. The student knows the CORDIC algorithm and can utilize it in the implementation of function and transform (e.g. DCT) computations.
4. The student knows the principles, which allow computationally efficient implementation of decimation and interpolation operations. Related to this, he can implement narrow-band digital filters.
5. The student can explain how a modulated filter bank works and knows its polyphase decomposition based implementation.
6. The student can implement convolution for long data sequences and filters. He also knows, how the same principles are used in the implementation of correlation.

7. The student can explain the general operational principles of adaptive filters and knows some of their applications. He knows operation of some common adaptive algorithms. He can study behaviour of adaptive filters with simulation.

Some exercise tasks of the course are done in the Matlab environment utilizing also its Simulink tool. The student learns how it can be used in the modelling of signal processing systems.

Contents:

Fixed-point and floating-point arithmetics, fixed-point filter implementation, CORDIC, DCT, FFT, polyphase decomposition, multirate signal processing, modulated filter banks, sectioning, adaptive filters and algorithms, Matlab and Simulink tools in DSP modelling.

Mode of delivery:

The tuition will be implemented as face-to-face teaching and web-based teaching. Moodle is used as the learning environment.
Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available from October 16 in Moodle.

Learning activities and teaching methods:

Lectures 28 h / Group work 42 h / Self-study 65 h. The group work consists of six weekly design tasks.

Target group:

The course is primarily targeted to the students of Computer Science and Engineering specializing to Computer Engineering.

Prerequisites and co-requisites:

A recommended prerequisite is the completion of "521337A Digital Filters".

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course provides lecture notes for reading. In addition, the following books provide useful information:
E.C. Ifeachor, B.W. Jervis. Digital Signal Processing - A Practical Approach. Second Edition. Prentice-Hall, 2002.
W.T. Padgett, D.V. Anderson. Fixed-Point Signal Processing. Morgan&Claypool Publishers, 2009.

Assessment methods and criteria:

The course uses continuous assessment, which is based on evaluation of the weekly group works and exams arranged during lectures.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pekka Sangi

Working life cooperation:

The course does not contain working life cooperation. There may be guest lectures.

Other information:

The web page of the course arranged at Autumn 2020 will be https://moodle.oulu.fi/course/view.php?id=3212

521322S: Telecommunication Engineering Project, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Saarnisaari, Harri Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

521387S	Telecommunication Engineering Project	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English/Finnish

Timing:

Fall or Spring, periods 1-4

Learning outcomes:

After completing the course student can
1. depending on the work subject, either solve, design, construct, measure, simulate, test or analyze limited telecommunication and radio system and sub-system problems.
2. apply the technical knowledge acquired from advanced sources into practical engineering tasks.
3. document technical and scientific results.

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work.
If you would like to take the course, you can contact the course person responsible.

Learning activities and teaching methods:

The design exercise is done in a group of one or two students depending of work's difficulty. The design exercise can be simulation or implementation work. The work can be defined by the Department of Communications Engineering or by industry. In the later case a proposal must be submitted to the teacher before beginning of the work. Also, student must meet the schedule and deadlines given by a supervisor before starting the work. In preparing the work report document the writing instructions of DCE department's diploma thesis must be followed.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Depending on the subject: advanced courses dealing with telecommunication systems, digital communications, digital signal processing or/and radio engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Varies depending on the topic.

Assessment methods and criteria:

Written work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Harri Saarnisaari

Working life cooperation:

No

Other information:

-

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.
3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-4

Learning outcomes:

After completing the course the student understand and is able to analyze basic principles of the topic which has been presented in the course. The final outcomes will be defined based on the contents.
Objective: Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

Varies yearly based on actual topics in telecommunications and radio engineering.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and/or exercises and/or design exercise and/or seminars depending on the topic of the year. The start and implementation of the course will be informed separately. The course can be given several times with different contents during the academic year and it can be included into the degree several times.

Target group:

1 st and 2 nd year M.Sc. and WCE students.

Prerequisites and co-requisites:

Will be defined based on the contents.

Recommended optional programme components:

-

Recommended or required reading:

Will be defined in the beginning of the course.

Assessment methods and criteria:

Depends on the working methods.

Grading:

The course unit utilizes a numerical grading scale 1-5.
Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

-

521389S: Wireless Body Area Networks, 5 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Hämäläinen
Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3-4

Learning outcomes:

Upon completing of the course, the student will be able to
1. distinguish the basic short range communications technologies used in the wireless body area network context,
2. understand the most relevant standards,
3. differentiate and compare the key points behind these standardized technologies and what are their advantages and disadvantages.
4. understand the major characteristics and applications utilizing WBAN and
5. understand the impact of wireless channels on the WBAN system and how channel affects to the WBAN system performance.

Contents:

Introduction, existing short range radio technologies, application, WBAN architecture, sensors & actuators & wearables, WBAN protocols, signal propagation within a human, WBAN antennas, WBAN transceivers, conclusion.

Mode of delivery:

Face-to-face teaching, compulsory seminar presentation

Learning activities and teaching methods:

Lectures 28 h + compulsory seminar presentation

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in EE degree programme). Special target group is students focusing on medical information and communications technologies.

Prerequisites and co-requisites:

-

Recommended optional programme components:

This course is an independent entity.

Recommended or required reading:

There is no recommended textbook for this course. Course material consists of lecture notes and selected publications.

Assessment methods and criteria:

Passing the course requires an accepted final exam and given seminar presentation.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Matti Hämäläinen

Working life cooperation:

No

Other information:

Course will be given every second year in even years. Will be held next time in Spring 2022.

521325S: Communication Signal Processing, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521360S	Communication Signal Processing II	4.0 op
521360S-01	Synchronization for Digital Receivers, exam	0.0 op
521360S-02	Synchronisation for Digital Receivers, exercise work	0.0 op

ECTS Credits:

5 ECTS cr / 130 hours of work

Language of instruction:

English

Timing:

The course is held bi-annually in the spring semester, during period 4. It is recommended to complete the course at the 1st or 2nd spring semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the functional structure of communications transceiver and understands the requirements for various wireless systems for the transceiver.
2. knows the architectural and functional design of (all-)digital transceiver with synchronization, channel estimation, encoding/decoding, multiantenna processing and connection establishment.
3. understands the requirements of the current wireless communications standards and related multiplexing and multiple access on transceiver design.
4. can derive digital domain algorithms for separate functionalities and match them to operate together via agreed interfaces.
5. can model the operation of the algorithms and the whole transceiver using Matlab and C other to assess their performance by computer simulations.

Contents:

Wireless transceiver functional split, digital parts and architecture, multirate filtering and filter banks, transceiver digital front-end architecture and design, synchronization and channel estimation, equalization and soft detection, algorithm-architecture co-simulation, multiantenna transceivers.

Mode of delivery:

Remote teaching and e-learning tool usage.

Learning activities and teaching methods:

Remote teaching (lectures, exercises and seminar presentations) 30 h, Simulation and design exercises and presentation preparation in groups 80 h, independent work & passed assignment 20 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 521348S Statistical signal processing I, 521324S Statistical Signal Processing II, 521323S Wireless communications I, 521317S Wireless communications II.

Recommended optional programme components:

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Recommended or required reading:

Parts from books:
1. P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, “Signal Processing and Optimization for Transceiver Systems”, Cambridge University Press, 2010.
2. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
3. H. Meyr, M. Moeneclaey & S. A. Fechtel, “Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing”. John Wiley, 1998.
4. F. Ling, “Synchronization in Digital Communication Systems”, Cambridge University Press, 2017.
5. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory," vol. 2. Prentice Hall 1998.
6. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the design and simulation projects, giving a seminar presentation on those, and a final exam. In the final grade of the course, the weight for the examination is 0.5 and that of project report 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

The project focuses on timely design problems in wireless industry. Industrial visiting lectures are organized. The project can be done as true industrial design project.

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2021.

521390S: Information Theory, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Hirley Alves, Markus Leinonen

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1, will be lectured on even years (2020, 2022, ...)

Learning outcomes:

Upon completing the required coursework, the student is able to use the basic methodology of information theory to calculate the capacity bounds of communication and data compression systems. He can estimate the feasibility of given design tasks before the execution of the detailed design. What is more, she can independently search for information and knowledge related to communication engineering, system design and signal processing.

Contents:

Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, rate distortion theory, quantization methods, introduction to network information theory, introduction to network coding, modern topics in information theory, compressed sensing, and information theory tools for machine learning.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises 50 h, homework, seminar and compulsory lab assignments 30 h, independent work 50 h.

Target group:

2nd year M.Sc. electrical and communications engineering, WCE as well as computer science and engineering students

Prerequisites and co-requisites:

Signal Analysis, Telecommunication Engineering, Probability and Mathematical Statistics.

Recommended optional programme components:

Wireless Communications I and II, Statistical Signal Processing I and II.

Recommended or required reading:

Parts from books
Thomas M. Cover & Joy A. Thomas: Elements of Information Theory, 2nd ed. John Wiley & Sons, 2006 ISBN-13 978-0-471-24195-9, ISBN-10 0-471-24195-4,
Raymond W. Yeung, Information Theory and Network Coding, Springer; 2008 edition, ISBN-13: 978-0387792330
Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with two mid-term exams or with a final exam, and the accepted lab exercise report. The final grade is a weighted sum of exam (70%), homework and seminars (20%), and lab exercise (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Hirley Alves/Markus Leinonen

Working life cooperation:

No

Other information:

Objective: To learn the information theory as a discipline and its most important applications in information technology in general and in communications engineering.

521391S: Channel Coding and Modulation, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rajatheva Rajatheva

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1, next time in year 2021

Learning outcomes:

1. Student is fully conversant with commonly used error control coding techniques – block, convolutional, TCM, Lattice, Turbo, LDPC, Polar: code construction and decoding algorithms.
2. Student is able to evaluate the performance of a given code by analytical or computational-simulation methods.
3. Student is able to read and understand peer reviewed publications in Coding.

Contents:

Introduction: Groups, Rings, Fields, Construction of higher level Galois Fields, Factoring
Linear, Cyclic and Convolutional codes – Viterbi and Sequential decoding
Golay code, Reed Muller, Non binary BCH, Reed Solomon (RS) Codes and Decoding with Berlekamp Massey (BM) Algorithm
Lattice Codes: Introduction to Coded Modulation, Ungerboeck and Forney Constructions, Packing, Covering, Vornoi Constellations
Turbo Codes: BCJR Algorithm, Extrinsic Information, EXIT Chart
Soft-input Soft-output (SISO) Decoding, Serial and Parallel concatenated codes, Application in 3G and 4G systems
LDPC Codes: Low density parity check matrices, encoding, Decoding in a graph, QC-LDPC, Application in WiFi and enhanced mobile broadband (eMBB) in 5G
Polar Codes: Successive Cancellation decoding, List decoding, Short frame codes, Control channel in 5G
Applications and Developments: Satisfying latency and reliability in 5G through coding, Application of coding in Distributed Computing, Storage, Application of learning methods in coding

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises 50 h and compulsory homework and lab assignments 35 h.

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Probability and Statistics

Recommended optional programme components:

-

Recommended or required reading:

Parts from books
Error Control Codes, Shu Lin and Costello, Pearson, 2005, 2nd Edition
Theory and Practice of Error Control Codes, Richard Blahut, Addison-Wesley, ISBN-13: 978-0201101027.
Fundamentals of Convolutional Coding, 2nd Edition, Rolf Johannesson, Kamil Sh. Zigangirov
ISBN: 978-0-470-27683-9, 688 pages, June 2015, Wiley-IEEE Press
Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with two mid-term exams or with final exam.
The final grade is a weighted sum of exams (50%), homeworks (45%), and lab exercise (5%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Nandana Rajatheva

Working life cooperation:

No

Other information:

Objective: Comprehensive course on coding techniques, including non binary constructions based on higher level Galois Fields, codes based on graphs and new applications The course will start on Galois field constructions based on integer rings and continue with detailed Berlekamp-Massey Algorithm, Lattice Codes based on David Forney papers, Turbo, LDPC and Polar Codes as applied in 4G and 5G.

521392S: Convex Optimization, 7 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Italo Atzeni, Antti-Heikki Tölli

Opintokohteen kielet: Finnish

ECTS Credits:

7 ECTS cr (521392S Convex Optimization) or
10 ECTS cr (522010J Convex Optimization)

Language of instruction:

English

Timing:

Autumn 2020 (periods 1 and 2).

Learning outcomes:

- The students will be able to recognize, formulate, reformulate, and solve various engineering problems as convex optimization problems, both analytically and algorithmically.
- The students will be able to identify convex sets, convex functions, and different types of convex optimization problems.
- The students will learn the necessary and sufficient conditions for optimality, as well as the essential concepts of duality.
- The students will be able to write basic MATLAB solvers based on CVX and disciplined convex programming.
- The students will learn high-level algorithmic optimization aspects and will be able to write basic MATLAB solvers.

Contents:

- Convex sets
- Convex functions
- Convex optimization problems: linear problems, quadratic problems, second-order cone programming, geometric programming, semidefinite programming
- Duality
- CVX and disciplined convex programming
- Optimization algorithms: unconstrained minimization (Newton´s methods), equality-constrained minimization, inequality-constrained optimization (interior-point methods)
- Applications: regression and fitting, beamforming, primal and dual decomposition, linear programming/geometric programming applications, sparse and low-rank optimization

Mode of delivery:

Face-to-face teaching (F2F) teaching

Learning activities and teaching methods:

F2F lectures, self-lectures, homework, and final project.

Target group:

Primarily ITEE Master’s and PhD students, but other students from the University of Oulu are also welcome. The course should benefit anyone who uses or will use scientific computing or optimization in engineering or related fields (e.g., communications, signal processing, machine learning and control).

Prerequisites and co-requisites:

- Required: solid knowledge of linear algebra (e.g., 031051S “Numerical matrix analysis”) and random processes, good knowledge of MATLAB programming.
- Desirable: exposure to numerical computing/optimization (e.g., 031025A “Introduction to optimization”) and digital communications.

Recommended or required reading:

- S. Boyd and L. Vandenberghe, “Convex Optimization”. Cambridge, U.K., Cambridge Univ. Press, 2004.
- The course reader, homework with solutions, and other material by Prof. S. Boyd are available on his web page: http://web.stanford.edu/class/ee364a/
- The video lectures by Prof. S. Boyd are available on YouTube: https://www.youtube.com/watch?v=McLq1hEq3UY&list=PL3940DD956CDF0622
- IEEE journal papers related to convex optimization and its applications.

Assessment methods and criteria:

521392S: written exams 50%, homework 25%, and final project 25%; 522010J: written exams 40%, homework 20%, and final project 40%. A passing grade is required for each of the assessment items (exam, homework, and final project).

- Written exam. The written exam consists of either two mid-term exams or one final exam (no notes and no book allowed).
- Homework. All the homework assignments must be completed. The students are allowed, and even encouraged, to work in small groups, but each student is required to write and submit his/her own homework.
- Final project. The topic of the final project must be agreed upon between the teachers and the students by 31/01/2021 (it is each student's responsibility to contact the teachers before this date). The final project must be completed by 31/05/2021.
    - PhD and Master's students that are already involved in research are required to propose a topic related with their current research work.
    - Other Master's students will be assigned a topic by the teachers.

Grading:

(1-5).

Person responsible:

- Teachers: Italo Atzeni and Antti Tölli
- Teaching assistants: Bikshapathi Gouda and Hamidreza Bakshad Mahmoodi

Working life cooperation:

No

Other information:

The course content, F2F lectures, self-lectures, homework, and written exams are the same for 521392S (7 ECTS credits) and 522010J (10 ECTS credits). A larger and more involved project work is required for 522010J with respect to 521392S.

- The first period focuses on the basic theoretical aspects and consists of self-lectures and F2F lectures (one per week).
    - Self-lectures. The students are required to watch a video lecture by Prof. S. Boyd, aided by the corresponding material.
    - F2F lectures. It consists of a recap of the self-lecture with questions from the students, as well as practical examples and exercises.
- The second period focuses on high-level algorithmic aspects and relevant applications, and consists of F2F lectures (two per week).

521393S: Statistical Communication Theory, 7 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail
Opettajat: Rajatheva Rajatheva
Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

English

Timing:

Fall, period 1-2, every other year, next time in 2020

Learning outcomes:

1. Student is conversant with commonly used estimation and detection techniques: receiver design and algorithms.
2. Student is able to evaluate the performance of a wireless receiver by analytical or simulation methods.
3. Student is able to read and understand peer reviewed publications in relevant topics.
4. Student is familiar with the novel applications in physical layer and new directions including 5G and beyond
5. Student can observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise – Vienna simulator.

Contents:

Detection of Signals – general Gaussian, ROC curves – performance, Estimation, Representation of Random Processes: Homogeneous Integral Equations and Eigenfunctions, Signals with unwanted parameters, Multiple channels, Mobility in Detection, Correlation functions: Bello functions – derivations, Waveforms for mm-wave and higher frequencies, Application of learning methods in Physical layer

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises 70 h and compulsory home assignments and lab 50 h

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Signals and Systems, Probability, Random Variables and Processes, Linear Algebra

Recommended optional programme components:

Wireless Communications I, Statistical Signal Processing I

Recommended or required reading:

Parts from books
Detection, Estimation, and Modulation Theory, Part I, 2nd Edition by Harry L. Van Trees, Kristine L. Bell, and Zhi Tian, Wiley, 2013.
Principles of Mobile Communications, G. Stuber, Springer, 2012. Wireless Communications, A. Molisch, John Wiley & Sons, 2nd Edition, 2011. Lecture notes and other literature.
Principles of Communication Engineering,John M. Wozencraft, Irwin Mark Jacobs, McGraw Hill.
Lecture notes and other literature.

Assessment methods and criteria:

The course is passed two mid-term exams or with final exam.
The final grade is a weighted sum of exam (50%), home assignments (45%), and lab exercise (5%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Nandana Rajatheva

Working life cooperation:

No

Other information:

Objective is to develop a theoretical understanding of statistical communication theory.

521394S: Multiantenna Communications, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti-Heikki Tölli

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

1. Upon completing the coursework, the student will have a deep understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless systems.
2. The student understands and can derive the channel capacity for various multiple-input multiple-output (MIMO) communication scenarios, can explain the effect of having the channel state information at the transmitter, and is acquainted with physical modelling of MIMO channels.
3. The student have knowledge of generalized MIMO transmitter and receiver structures for scenarios with and without channel state information. Both linear and non-linear transceiver structures are covered. The Massive MIMO foundations are reviewed including a brief introduction to the its analysis via random matrix theory.
4. After learning the basics in a single-user MIMO communications, the student is acquainted with the basic principles for multiuser multiantenna communications in fading channels and can derive the capacity region for MIMO multi-access and broadcast channels.
5. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication and interference management schemes in realistic multi-cell scenarios, and how these technologies are deployed in current and future wireless systems and standards. In addition, hybrid beamforming and low precision quantization schemes are covered especially intended for mmWave and TeraHz communication scenarios.

Contents:

Point-to-point MIMO communications, multiuser multiple antenna communications in uplink and downlink, opportunistic communications, massive MIMO, beamforming for mmWave, scheduling and interference management, coordinated multi-cell transmission.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program (20 h).

Target group:

Target group 2nd year WCE students and M.Sc. students (i.e., 5th year in ECE degree programme).

Prerequisites and co-requisites:

“521317S Wireless Communications II”, 521348S “Statistical Signal Processing I”, 031025A “Introduction to optimization” and 031051S “Numerical matrix analysis”, a working knowledge in digital communications, random processes, linear algebra, matrix manipulation and detection theory is required.

Recommended optional programme components:

Recommended optional programme components Prior knowledge of 521390S Information Theory, 521324S Statistical Signal Processing II and 521392S Convex Optimisation is very useful but not mandatory.

Recommended or required reading:

D. N. C. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005, Chapters 7-10, as well as, a few recent journal publications related to multiuser MIMO, massive MIMO, cooperative transmission reception, interference management and mmWave beamforming. Supporting material: Cover & Thomas, "Elements of Information Theory", John Wiley & Sons; Boyd & Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is a weighted sum of exam (70%), homeworks (20%), and work report (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Antti Tölli

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in Fall 2021.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

-

A451297: Advanced Module, Radio engineering, 36 - 42 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Radio engineering - advanced module

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Nissinen
Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish (English as a book examination)

Timing:

Autumn, period 2

Learning outcomes:

1. On completion of the study module students should be able to detail the advantages of differential signal processing in IC realizations and
2. to analyze and design differential amplifiers and other electronic blocks for implementation in an IC environment.
3. They should be able to explain how an SC (switched capacitor) technology functions and to apply such a technology to sampling and filtering.
4. They should also be able to describe the principles for realizing continuous filters in IC technologies, to explain the principles of the delta–sigma technology
5. and to apply it for realizing integrated DA and AD converters.
6. They should be able to account for the functioning, use and architecture of a phase-locked loop,
7. to explain the functioning of an MOS transistor in the area of weak inversion and to indicate how use can be made of this functional area in circuit design.

Contents:

Advanced operational amplifier topologies, especially differential ones, bandgap and PTAT bias circuits and references, problems related to the design of multi-stage amplifiers (output stages, LP/LV implementations), signal sampling and error sources related to it, SC-techniques (especially in filters), implementation principles of continuous time IC filters, DS techniques in general and particularly in AD/DA converters, operations with frequency/phase domain signals, design of IC layout.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h and Exercises 20 h; Self-study or in a group of two persons: laboratory exercise 40 h (CAD tools used in IC design and familiarization into the complete analogue IC design flow) and learning without guidance either privately or in a group 69 h.
The course is organized remotely and Zoom links for lectures and exercises can be found from Moodle under the topics lectures and exercises.

Target group:

Electrical Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

Electronics Design II, Filters, Introduction to Microfabrication Techniques (recommended).

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

Lecture notes: D. A. Johns & K. Martin: Analog integrated circuit design, Wiley & Sons 1997 chapter 6, chapter 8 partially, 9, 10, 14, 15 and 2. Also P. E. Allen & D. R. Holberg: CMOS Analog Circuit Design, Oxford university press 2002, chapters 2, 7, and 9, proper parts of other chapters of the book.

Assessment methods and criteria:

Passed final exam and exercise work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: English

Leikkaavuudet:

521375S	Design of Tranceivers	5.0 op
521375S-01	Design of tranceivers, partial credit	0.0 op
521375S-02	Design of tranceivers, partial credit	0.0 op

ECTS Credits:

6 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

3. can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them.

4. will be able to define parameters used in the transceiver system level design and can design a transceiver at the system level so that the requirements for the system are fulfilled.

5. knows nonlinear distortion and can design the automatic gain control in the system level.

6. will be able to explain factors, which are important for the selection of D/A- and A/D-converters and can derive various methods to create the in phase and the quadratute components of a received signal.

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.

Contents:

Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A/D-converter in a receiver, frequency synthesis, design and implementation examples.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (54 h).

Target group:

1st year M.Sc. and WCE-RF students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

521075S: Microelectronics Packaging Technologies, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Sami Myllymäki

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

3rd period

Learning outcomes:

1. Upon completing the course student can explain how electronics packaging technology has since invention of transistors to current date and can estimate how this development is going to continue in future.
2. The student can describe can explain what is meant by microjoining techniques and what are the pros and cons of these.
3. The student can tell what different kind of materials, and why, are used in IC packaging technology.
4. The student can explain what is meant with system level packaging and how the strong miniaturization on IC requires new system level packaging techniques to be developed.
5. He can explain why active and passive components are being, more and more, embedded to be a part of the circuit board.
6. In addition, he can explain why and how radio electronics will be migrate towards circuit board and components on it.

Contents:

Radio technology applications are emphasized. Trends of packaging and component technologies. Area array packaging techniques. BGA-components. Micro joining and bonding. Multi-chip-modules: MCM-L, MCM-D and MCM-C modules. Fine line techniques. System level packaging (SOC, SOP). Multilayer substrates and integration of passive components. 3-D packaging. radio electronics modules. MEMS components. Electronics applications to nanotechnology.

Mode of delivery:

Face to face teaching

Learning activities and teaching methods:

Lecturing 24 h, practical work 12 h.

Target group:

Primarily major students of electrical engineering.

Prerequisites and co-requisites:

Recommended Introduction to Microfabrication Techniques.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Rao R. Tummala(edit): Fundamentals of microsystems packaging, New York, McGraw-Hill, 2001. R.R. Tummala and M. Swaminathan, Introduction to System-on-Package (SOP), McGraw-Hill, 2008.

Assessment methods and criteria:

The course is completed with the final exam and finished course work.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Sami Myllymäki

Working life cooperation:

No

Other information:

-

521388S: Antennas, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg

Opintokohteen kielet: English

Leikkaavuudet:

521380S	Antennas	4.0 op
521380S-01	Antennas, partial credit	0.0 op
521380S-02	Antennas, partial credit	0.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring, period 4

Learning outcomes:

After completing the course, student
1. knows antenna terminology and understands the role of antennas as a part of different radio systems.

2. is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays.

3. will be able to design wire antennas, micro strip antennas and antenna arrays for different radio systems.

4. will be able to design and analyze various antenna types and arrays using 3D electromagnetic simulation software.

Contents:

Introduction to different antenna types. Fundamental parameters of antennas. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas. Loop antennas. Microstrip antennas. Antenna arrays. Antennas for wireless devices. Antenna - human body interaction. Base station antennas. 3D electromagnetic simulation.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures and exercises 40 h / Compulsory antenna design work with an electromagnetic simulation 25 h / Self-study 70 h

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering 521384A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Recommended literature: C.A. Balanis: Antenna Theory, Analysis and Design (3rd or 4th Ed). John Wiley & Sons, 2005 or 2016. Chapters 1-6 and 14.

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. In the final grade of the course, the weight for the examination is 0.5 and that for the design work 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg

Working life cooperation:

No

Other information:

-

521402S: Telecommunications Circuit Design, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rahkonen, Timo Erkki

Opintokohteen kielet: Finnish

ECTS Credits:

6 ects / 42 contact hours + design excercise

Language of instruction:

English/Finnish

Timing:

Autumn, 1st period of the last year of studies

Learning outcomes:

After completing the course the student

- knows the most usual schematic structures and dimensioning principles of typical telecommunication circuit blocks
- can sketch the spectral effects of non-linear and time-varying circuit blocks
- can evaluate the performance of the available IC process node

Contents:

The course gives the background needed in the design of RFICs and other analog telecommunication circuit blocks.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 hours of lectures, 14 of excercises, and a relatively large design task.

Target group:

Last year MSc students with strong analog design background

Prerequisites and co-requisites:

Strong background in analog transistor level design is required.

Recommended optional programme components:

Needs electronics design 2-3 background

Recommended or required reading:

Handouts

Assessment methods and criteria:

Graded based on the final exam. The design excercise needs to be passed.

Grading:

Numerical scale 0-5. 0 is fail, 5 the best.

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

The topics are strongly related to the skills needed in the industry

Other information:

The course is the last advanced course in analog design, and requires the basic knowledge of transistor level analog design and IC design.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.

Contents:

Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

The students acquire their training job themselves.

Target group:

MSc students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

Jari Hannu

Working life cooperation:

Yes.

Other information:

-

Obligatory, Radio engineering - advanced module, Choose 521322S Telecommunication engineering project or 521300S Electronics design and construction exercise

521322S: Telecommunication Engineering Project, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Saarnisaari, Harri Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

521387S	Telecommunication Engineering Project	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English/Finnish

Timing:

Fall or Spring, periods 1-4

Learning outcomes:

After completing the course student can
1. depending on the work subject, either solve, design, construct, measure, simulate, test or analyze limited telecommunication and radio system and sub-system problems.
2. apply the technical knowledge acquired from advanced sources into practical engineering tasks.
3. document technical and scientific results.

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work.
If you would like to take the course, you can contact the course person responsible.

Learning activities and teaching methods:

The design exercise is done in a group of one or two students depending of work's difficulty. The design exercise can be simulation or implementation work. The work can be defined by the Department of Communications Engineering or by industry. In the later case a proposal must be submitted to the teacher before beginning of the work. Also, student must meet the schedule and deadlines given by a supervisor before starting the work. In preparing the work report document the writing instructions of DCE department's diploma thesis must be followed.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Depending on the subject: advanced courses dealing with telecommunication systems, digital communications, digital signal processing or/and radio engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Varies depending on the topic.

Assessment methods and criteria:

Written work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Harri Saarnisaari

Working life cooperation:

No

Other information:

-

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.
3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

A453246: Supplementary module/Electives, Wireless Communications Engineering, 10 - 41 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Supplementary Module
Laji: Study module
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Radio engineering (WCE-RF): Optional courses

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Pekka Kyösti, Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

Autumn, period 2.

Learning outcomes:

After completing the course, student
1. will be able to define what the radio channel is and is able to distinguish it into modellable parts.

2. knows different radio wave propagation mechanisms.

3. can apply physical and empirical radio channel models.

4. is able to analyse which are the dominating propagation mechanisms in different environments.

5. will know how to measure the properties of different radio channels.

Contents:

The radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radio wave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Statistical description of fading radio channel. Principles of the radio channel modelling. Noise calculations. Radio wave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modelling for outdoor mobile systems. Radio wave propagation inside or into buildings. Radio channels of mobile satellite links. Slow fading. Multipath propagation and its effects on narrowband and wideband radio channels. MIMO radio channels. Measurement methods of radio channels. Atmospheric attenuation on terahertz frequency bands.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h / Exercises 8 h / compulsory laboratory work 25 h / Self-study 74 h.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Andreas Molisch. "Wireless Communications", 2012. Wireless Communications. Wiley-IEEE Press.
Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007.

Assessment methods and criteria:

The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Pekka Kyösti

Working life cooperation:

No

Other information:

-

521328A: Simulations and Tools for Telecommunications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Johanna Vartiainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521369A	Simulations and Tools for Telecommunications	3.0 op
521369A-01	Simulations and Tools for Telecommunications, exam	0.0 op
521369A-02	Simulations and Tools for Telecomm. exercise	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, period 2

Learning outcomes:

1. A student recognizes problems and limitations related to simulations.

2. She/he can select a suitable simulation method and knows how to validate the model.

3. Student knows how to generate signals, random numbers and noise.

4. She/he knows how to model fading channels.

5. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results.

6. She/he can explain principles of network level simulations.

7. A student knows basics of one or two fundamental simulation programs

Contents:

Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs/availability).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h (including program introductions), and the compulsory assignment with a simulation program (40 h).

Target group:

3rd year bachelor's degree students and M.Sc. students

Prerequisites and co-requisites:

Telecommunication Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition. Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Johanna Vartiainen

Working life cooperation:

No

Other information:

In 2020, the whole course including compulsory exercise and exam is organized in Moodle https://moodle.oulu.fi/enrol/index.php?id=3757 (opens no later than one week before the start of the course)

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

1. Students understand how the modern communications networks have evolved and how the architecture has changed through the recent paradigm shift towards software-centric communications.
2. Students are able to describe the basic system architecture elements of mobile networks, and understands the significance of emerging technologies such as Network Function Virtualization (NFV), Software Defined Networking (SDN), and core network functionalities such as Evolved Packet Core (EPC).
3. Students can describe the main principles of mobility management, network management and orchestration, and network security, and can apply and solve related engineering problems.
4. Students know the basic properties of routing algorithms, and can use graph theory to solve network routing problems.
5. Students are able to simulate different types of networks in simulation environments and solve basic network programming problems. Upon completing the required coursework, students understand the basic functionalities in TCP/IP protocol stack.

Contents:

Communications architecture in mobile, wireless local area and personal area networks. Introduction to cloud and edge computing, network function virtualization and software defined networking. Basic principles of mobility management, network security, network management and orchestration. The goal is to present the basics of the modern communications architectures, and their technical implementation.

Mode of delivery:

Due to Covid-19 pandemic, teaching in Autumn 2020 will be implemented remotely. Details of arrangement can be found from the course web page, which will be available in Moodle.
https://moodle.oulu.fi/course/view.php?id=1454

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work (15 h). Design work can be done alternatively either as NS-2 simulation or TCP/IP programming exercise. Design work instructions are provided in digital learning environment (Moodle).

Target group:

1st year M.Sc. and WCE students

Prerequisites and co-requisites:

-

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015; A comprehensive Guide to 5G Security, M Liyanage, I Ahmad, A Abro, A Gurtov, M Ylianttila – 2018; In addition, selected supportive online reading materials from recent standards and publications are provided in digital learning environment (Optima / Moodle).

Assessment methods and criteria:

The course is passed with a final examination and the accepted design work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Mika Ylianttila

Working life cooperation:

No

Other information:

-

521349S: Wireless Communications II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Antti-Heikki Tölli
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. The student is familiarised with the channel capacity as the fundamental performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna scenarios.
2. The student understands the basic principles for multiuser communications in fading channels, apprehends the notion of capacity region for multi-access and broadcast channels, and is familiarised with different practical multiple access, random access and scheduling methods.
3. The student is acquainted with core principles of adaptive transmission, which requires accurate channel estimates at the receiver and a reliable information exchange mechanisms between the receiver and transmitter. Practical variable-rate variable-power MQAM modulation techniques for fading channels are introduced.
4. The student understands the principles of transmitter and receiver design in the presence of channel distortion. The student is familiarised with various (adaptive) equalization solutions to combat intersymbol interference.
5. Finally, the student is acquainted with the capacity optimal multi-antenna transmission and reception scheme, as well as, with basic multiantenna space-time coding schemes in a single-user multiple-input multiple-output (MIMO) communications scenario.

Contents:

Capacity of wireless channels, multiuser communications, adaptive modulation and coding, equalization, point-to-point MIMO communications and space-time coding.

Mode of delivery:

Fully remotely,
https://moodle.oulu.fi/course/view.php?id=2086

Learning activities and teaching methods:

Lectures and exercise (total 40 hours) and the compulsory design work with a simulation program (20 h).

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in ECE degree programme).

Prerequisites and co-requisites:

In addition to courses “521395S Wireless Communications I”, 521348S “Statistical Signal Processing I”, 031025A “Introduction to optimization” and 031051S “Numerical matrix analysis”, a working knowledge in digital communications, random processes, linear algebra, matrix manipulation and detection theory is required.

Recommended optional programme components:

Prior knowledge of 521390S Information Theory and 521392S Convex Optimisation is very useful but not mandatory. The course 521324S Statistical Signal Processing II is recommended to be taken in parallel.

Recommended or required reading:

D. N. C. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005, Chapters 3-7.
Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005, Chapters 4, 9-11.
14. Upamanyu Madhow: Fundamentals of Digital Communication, Cambridge University Press, 2008, Chapter 5 (Equalization).
Supporting material: Cover & Thomas, "Elements of Information Theory", John Wiley & Sons; Boyd & Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is a weighted sum of exam (70%), homework (20%), and work report (10%).

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Antti Tölli

Working life cooperation:

No

Other information:

Course replaces the old course 521317S Wireless Communications II (8cr).

521325S: Communication Signal Processing, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521360S	Communication Signal Processing II	4.0 op
521360S-01	Synchronization for Digital Receivers, exam	0.0 op
521360S-02	Synchronisation for Digital Receivers, exercise work	0.0 op

ECTS Credits:

5 ECTS cr / 130 hours of work

Language of instruction:

English

Timing:

The course is held bi-annually in the spring semester, during period 4. It is recommended to complete the course at the 1st or 2nd spring semester of the master studies.

Learning outcomes:

Upon completion the student

1. knows the functional structure of communications transceiver and understands the requirements for various wireless systems for the transceiver.
2. knows the architectural and functional design of (all-)digital transceiver with synchronization, channel estimation, encoding/decoding, multiantenna processing and connection establishment.
3. understands the requirements of the current wireless communications standards and related multiplexing and multiple access on transceiver design.
4. can derive digital domain algorithms for separate functionalities and match them to operate together via agreed interfaces.
5. can model the operation of the algorithms and the whole transceiver using Matlab and C other to assess their performance by computer simulations.

Contents:

Wireless transceiver functional split, digital parts and architecture, multirate filtering and filter banks, transceiver digital front-end architecture and design, synchronization and channel estimation, equalization and soft detection, algorithm-architecture co-simulation, multiantenna transceivers.

Mode of delivery:

Remote teaching and e-learning tool usage.

Learning activities and teaching methods:

Remote teaching (lectures, exercises and seminar presentations) 30 h, Simulation and design exercises and presentation preparation in groups 80 h, independent work & passed assignment 20 h.

Target group:

Electrical, communications and computer science and engineering students.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 521348S Statistical signal processing I, 521324S Statistical Signal Processing II, 521323S Wireless communications I, 521317S Wireless communications II.

Recommended optional programme components:

-

Recommended or required reading:

Parts from books:
1. P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, “Signal Processing and Optimization for Transceiver Systems”, Cambridge University Press, 2010.
2. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
3. H. Meyr, M. Moeneclaey & S. A. Fechtel, “Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing”. John Wiley, 1998.
4. F. Ling, “Synchronization in Digital Communication Systems”, Cambridge University Press, 2017.
5. Steven M. Kay, "Fundamentals of statistical signal processing: Detection theory,” vol. 2. Prentice Hall 1998.
6. Other literature, lecture notes and material.

Assessment methods and criteria:

Completing the design and simulation projects, giving a seminar presentation on those, and a final exam. In the final grade of the course, the weight for the examination is 0.5 and that of project report 0.5.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:

Markku Juntti

Working life cooperation:

The project focuses on timely design problems in wireless industry. Industrial visiting lectures are organized. The project can be done as true industrial design project.

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2021.

WCE-RAN and WCE-RF

900017Y: Survival Finnish, 2 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900017Y Survival Finnish Course (OPEN UNI) 2.0 op

Proficiency level:

A1.1

Status:

The course is intended for the international students in every faculty at the University of Oulu.

Required proficiency level:

No previous Finnish studies.

ECTS Credits:

2 ECTS cr

Language of instruction:

Finnish and English.

Timing:

-

Learning outcomes:

By the end of the course the student can understand and use some very common everyday expressions and phrases, and s/he can locate informational content in simple texts and messages. The student also knows the basic characteristics of Finnish language and Finnish communication styles.

Contents:

This is an introductory course which aims to help students to cope with the most common everyday situations in Finnish. During the course, students learn some useful everyday phrases, some general features of the vocabulary and grammar, and the main principles of pronunciation.

The topics and communicative situations covered in the course are: general information about the Finnish language, some politeness phrases (how to greet people, thank and apologize), introducing oneself, giving and asking for basic personal information, numbers, some time expressions (how to tell and ask the time, days of the week, time of day), food, drink and asking about prices.

The structures studied are: personal pronouns and their possessive forms, forming affirmative, negative and interrogative sentences, the conjugation of some verbs, the basics of the partitive singular and some local cases for answering the ‘where'-question.

Mode of delivery:

Contact teaching, on-line learning and independent work. There will be organized also one on-line group in each semester.

Learning activities and teaching methods:

Lessons 2 times a week (26 h, including the final exam) and guided self study (24 h).

Target group:

International degree and post-graduate degree students, exchange students and the staff members of the University.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Will be provided during the course.

Assessment methods and criteria:

Regular and active participation in the weekly lessons (twice a week), homework assignments and written exam at the end of the course will be observed in assessment.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grading scale is on a pass/fail basis.

Person responsible:

Arja Haapakoski

Working life cooperation:

-

Other information:

Sign-up in WebOodi or in Tuudo.

900013Y: Beginners' Finnish Course 1, 3 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900013Y	Beginners' Finnish Course 1 (OPEN UNI)	2.0 op

Proficiency level:

A1 (target level A1.2)

Status:

The course is intended for the international students in every faculty of Oulu University.

Required proficiency level:

A1.1, Completion of the Survival Finnish course (900017Y) or the equivalent language skills.

ECTS Credits:

3 ECTS credits

Language of instruction:

As much Finnish as possible; English will be used as a help language.

Timing:

-

Learning outcomes:

By the end of the course the student can understand and use some familiar and common everyday expressions relating to her/himself and everyday situations. S/he can interact in a simple way provided the other person talks slowly and clearly and is willing to help. The student is able to read short simple texts and messages dealing with familiar topics. S/he also deepens her/his understanding of the Finnish language and communication styles.

Contents:

This is lower elementary course which aims to help students to learn communication skills in ordinary everyday situations. During the course, students broaden their vocabulary and knowledge of grammar and principles of pronunciation. They also practise to understand easy Finnish talk about everyday subjects, and reading and writing short and simple texts/messages.

The topics and communicative situations covered in the course are: talking about oneself, one's family, studies and daily routines, as well as asking about these things from other person; expressing opinions; food, drink and transactions in the grocery; accommodation and describing it; colours and adjectives.

The structures studied are: verb types, basics of the change of the consonants k, p and t in verbs and nouns, basics of the partitive and genitive cases, possessive structure, some declension types for nouns (word types) and the basics of the local cases.

Mode of delivery:

Contact teaching and guided self study

Learning activities and teaching methods:

Lessons 2 times a week (26 h, including the final exam) and guided self study (55 h)

Target group:

International degree and post-graduate degree students, exchange students and the staff members of the University.

Prerequisites and co-requisites:

Completion of the Survival Finnish Course

Recommended optional programme components:

-

Recommended or required reading:

Kuparinen, K. & Tapaninen, T. Oma suomi 1 (chapter 2 - 5)

Assessment methods and criteria:

Regular and active participation in the weekly lessons (twice a week), homework assignments and written exam at the end of the course will be observed in assessment.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grading scale is 1-5.

Person responsible:

Anne Koskela

Working life cooperation:

-

Other information:

Sign-up in WebOodi or Tuudo. The course will start right after the Survival Finnish course.

900053Y: Beginners' Finnish Course 2, 5 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900053Y	Beginners' Finnish Course 2 (OPEN UNI)	4.0 op

Proficiency level:

A1.3

Status:

International degree and post-graduate degree students, exchange students and the staff members of the University.
Students of the Oulu University of Applied Sciences (OAMK) students and OAMK's international and exchange students may also participate to this cross-institutional study. The quota principle is as follows: at least two OAMK students in a course and if there are more places, they are filled according to the queuing principle.
See more information for OAMK students https://www.oulu.fi/forstudents/crossinstitutionalstudy.

Required proficiency level:

A1.2, completion of the Beginners’ Finnish course 1 (900013Y) or the equivalent language skills.

ECTS Credits:

5 ECTS credits

Language of instruction:

As much Finnish as possible; English will be used as a help language.

Timing:

-

Learning outcomes:

By the end of the course the student can understand and use some very common everyday expressions and sentences. S/he can communicate in easy and routine tasks requiring a simple and direct exchange of information on familiar everyday matters. The student understands different kinds of short texts. S/he can for example locate important information in them. In addition, s/he has acquired more detailed knowledge of the language and culture.

Contents:

This is a post-elementary course. During the course students learn more about communication in ordinary everyday situations in Finnish. They also extend their vocabulary and knowledge of grammar. Students practise understanding simple Finnish talk and short texts.

The topics and communicative situations covered in the course are: talking about weather, carrying out transactions in clothing stores and at the doctor’s, asking about location, asking for help/favours, expressing how you are feeling, writing an invitation and email; talking about past, describing people and things; seasons, the names of the months, travelling, vehicles, body parts, adjectives, food, drink and parties.
The structures studied are: the local cases, more about the change of the consonants k, p and t, more declension types for nouns (word types), nominative plural (basic form plural), basics of the imperfect (past tense of verbs), basics of the object cases, some postposition structures, some sentence types (predicative and necessity sentences).

Mode of delivery:

Contact teaching and quided self study

Learning activities and teaching methods:

Lessons 2 times a week (52 h, including the tests) and guided self study (83 h)

Target group:

International degree and post-graduate degree students, exchange students and the staff members of the University.
Students of the Oulu University of Applied Sciences (OAMK) students and OAMK's international and exchange students may also participate to this cross-institutional study. The quota principle is as follows: at least two OAMK students in a course and if there are more places, they are filled according to the queuing principle.
See more information for OAMK students https://www.oulu.fi/forstudents/crossinstitutionalstudy.

Prerequisites and co-requisites:

Completion of the Beginners’ Finnish Course 1 or the equivalent language skills.

Recommended optional programme components:

-

Recommended or required reading:

Kuparinen, K. & Tapaninen, T. Oma suomi 1 (chapters 6 - 10)

Assessment methods and criteria:

Regular and active participation in the weekly lessons (twice a week), homework assignments and tests will be taken into consideration in the assessment.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grading scale is 1-5.

Person responsible:

Arja Haapakoski

Working life cooperation:

-

Other information:

Sign-up in WebOodi or Tuudo. Staff members in staff training portal.

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish. English, if there are at least 3 international students in class.

Timing:

The course is held in the 4th period. It is recommended to complete the course during Master level studies.

Learning outcomes:

1. After completing the course the student has knowledge of the behavior of passive components at RF frequencies, knows the fabrication methods of components and is also able to apply the knowledge to practical applications.

2. The student also knows the operating principles of transfer lines, antennas and filters and of their design.

3. The student can apply the fundamentals of RF and microwave techniques to measurements, is able to make the measurements of RF components, has knowledge of the operating principles of RF region measurement equipment and is able to compare the usability of d

4. The student knows how to perform typical measurements of RF region magnitudes (power, frequency, impedance and noise).

Contents:

Fundamentals of RF and microwave techniques, components in microwave circuits, measurement instruments, measuring of power, frequency, impedance and noise, time-domain and active circuit measurements.

Mode of delivery:

Face-to-face teaching, independent design exercises and laboratory exercises.

Learning activities and teaching methods:

Lectures 24 h, design execises 20 h, laboatory exercises 20 h, independent work 68,5 h.

Target group:

Masters students on electrical engineering

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronic Components and Materials, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handout, Lecture notes. A. Lehto, A. Räisänen: Mikroaaltomittaustekniikka (in Finnish), I. Bahl: Luped Elements for RF and Microwave circuits, R. Ludvig, P.Bretchko: RF circuit Desing: Theory ans Applications, Prentice Hall 2000 and literature announced at the beginning of the lectures.

Assessment methods and criteria:

Final exam, design exercises and laboratory exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Merja Teirikangas

Working life cooperation:

No.

Other information:

-

521097S: Wireless Measurements, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Christian Schuss
Opintokohteen kielet: English
Leikkaavuudet:

521114S	Wireless Measurements	4.0 op
521114S-01	Wireless Measurements, exam	0.0 op
521114S-02	Wireless Measurements, exercise work	0.0 op

ECTS Credits:

5 ECTS credits / 128h

Language of instruction:

In English

Timing:

Period 3.

Learning outcomes:

1. can tell and justifying argument the benefits and challenges of using wireless measurement solutions
2. can apply the most important standards when designing wireless measurement solutions
3. can apply wireless technologies in industrial, traffic, environmental, home and healthcare measurements

Contents:

Basics of wireless measurement technologies and standards, wireless sensors and sensor networks, wireless building and smart home applications, wireless measurement applications in traffic, wireless environmental measurements and wireless human health monitoring.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 22h. Seminars 6-12h depending on the number of students participating the course. The students prepare seminar presentations about contemporary topics selected by themselves or proposed by the teacher and give 10 minutes presentation to other students in the seminars.

Target group:

Master level students regardless of master's programme.

Prerequisites and co-requisites:

No prerequirements, but basics of measurements systems are recomended.

Recommended optional programme components:

The course replaces previous courses with same name, but different credits and code.

Recommended or required reading:

Lecture notes and seminar reports is Optima.

Assessment methods and criteria:

The course is passed with a written final exam (70 %) and a contemporary seminar (30 %).
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is on numerical scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

No.

521389S: Wireless Body Area Networks, 5 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Hämäläinen
Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3-4

Learning outcomes:

Upon completing of the course, the student will be able to
1. distinguish the basic short range communications technologies used in the wireless body area network context,
2. understand the most relevant standards,
3. differentiate and compare the key points behind these standardized technologies and what are their advantages and disadvantages.
4. understand the major characteristics and applications utilizing WBAN and
5. understand the impact of wireless channels on the WBAN system and how channel affects to the WBAN system performance.

Contents:

Introduction, existing short range radio technologies, application, WBAN architecture, sensors & actuators & wearables, WBAN protocols, signal propagation within a human, WBAN antennas, WBAN transceivers, conclusion.

Mode of delivery:

Face-to-face teaching, compulsory seminar presentation

Learning activities and teaching methods:

Lectures 28 h + compulsory seminar presentation

Target group:

1st year WCE students and M.Sc. students (i.e., 4th year in EE degree programme). Special target group is students focusing on medical information and communications technologies.

Prerequisites and co-requisites:

-

Recommended optional programme components:

This course is an independent entity.

Recommended or required reading:

There is no recommended textbook for this course. Course material consists of lecture notes and selected publications.

Assessment methods and criteria:

Passing the course requires an accepted final exam and given seminar presentation.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Matti Hämäläinen

Working life cooperation:

No

Other information:

Course will be given every second year in even years. Will be held next time in Spring 2022.

813621S: Research Methods, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Information Processing Science DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Netta Iivari
Opintokohteen kielet: English
Leikkaavuudet:

521146S	Research Methods in Computer Science	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

English

Timing:

The course is held in the spring semester, during periods 3 and 4. It is recommended to complete the course in the 1st spring semester of the Master's studies.

Learning outcomes:

After completing the course, the student will able to:
* explain the general principles of scientific research and the practices of scientific methodology,
* generate research problems in information processing sciences,
* identify and describe the main research approaches and methods in information processing sciences, and choose the appropriate approach and method for a research problem,
* evaluate the methodological quality of a research publication, as well as
* choose and apply the proper approach and method for his or her Master's thesis and find more information on the method from scientific literature.

Contents:

Introduction to general scientific principles, scientific research practices and quality of scientific publications, qualitative research approaches and selected research methods, quantitative research approaches and selected research methods, design science research and selected methods, requirements and examples of Master's theses, evaluation of research.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures / lecture videos 40 h, exercises 30 h and individual work 65 h. Learning diary is written about the lectures and exercises. Exercises include group work.

Target group:

MSc students

Prerequisites and co-requisites:

The required prerequisite is that the student has completed BSc degree as well as has basic knowledge on Software Engineering and Information Systems

Recommended or required reading:

Lecture slides and specified literature.

Assessment methods and criteria:

Accepted learning diary, active participation

Grading:

Pass or fail.

Person responsible:

Arto Lanamäki

521273S: Biosignal Processing I, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Zalan Rajna, Tapio Seppänen

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits.

Language of instruction:

English.

Timing:

The course unit is held in the autumn semester, during period 2. It is recommended to complete the course at the master's degree level.

Learning outcomes:

After completing the course, student:

1. knows about special characteristics of the biosignals and typical signal processing methods
2. can solve small-scale problems related to biosignal analysis
3. implement small-scale MATLAB software for signal processing algorithms.

Contents:

Biomedical signals. Digital filtering. Analysis in time-domain and frequency domain. Nonstationarity. Event detection. Signal characterization.

Mode of delivery:

Face-to-face teaching and guided laboratory work. The laboratory work can alternatively be performed on an online system (MathWorks Grader). Student can do the lab works remotely or in the lab using the same online system.

Learning activities and teaching methods:

Lectures 12h, Laboratory work 24h, Self-study for laboratory working and examination 99 h.

Target group:

Students interested in digital signal processing applications in biomedical engineering, at their master's level studies.

Prerequisites and co-requisites:

The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Programming skills, especially basics of the MATLAB. Basic knowledge of digital signal processing.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course is based on selected chapters of the book "Biomedical Signal Analysis", R.M Rangayyan, 2nd edition (2015). + Lecture slides + Task assignment specific material.

Assessment methods and criteria:

Face-to-face lectures. Students solve the programming problems in the laboratory work independently, supervised by assistants. The MathWorks Grader online system is used for programming tasks and it also verifies the completed tasks. Written examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Tapio Seppänen

Working life cooperation:

No.

521282S: Biosignal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Kortelainen

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 ECTS cr

Language of instruction:

Lectures and laboratory works are given in English. The examination can be taken in Finnish or English.

Timing:

Period 4

Learning outcomes:

After completing the course, student
1. knows the special characteristics of neural signals and the typical signal processing methods related to them
2. can solve advanced problems related to the neural signal analysis

Contents:

Introduction to neural signals, artifact removal, anesthesia and natural sleep, topographic analysis and source localization, epilepsy, evoked potentials.

Mode of delivery:

Online teaching / Moodle

Learning activities and teaching methods:

Lectures (8 h) and laboratory work (20 h), written exam.

Target group:

Engineering students, medical and wellness technology students, and other students interested in biomedical engineering. Students of the University of Oulu.

Prerequisites and co-requisites:

The basic engineering math courses, digital filtering, programming skills, Biosignal Processing I.

Recommended optional programme components:

-

Recommended or required reading:

The course is based on selected parts from books "EEG Signal Processing", S. Sanei and J. A. Chambers, "Bioelectrical Signal Processing in Cardiac and Neurological Applications", L. Sörnmo and P. Laguna, and "Neural Engineering", B. He (ed.) as well as lecture slides and task assignment specific material.

Assessment methods and criteria:

Laboratory work is supervised by the assistants who will also check that the task assignments are completed properly. The course ends with a written exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading of the accepted exam is in the range 1-5.

Person responsible:

Jukka Kortelainen

Working life cooperation:

-

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521467A: Digital Image Processing, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Heikkilä, Janne Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521467A	Digital Image Processing (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Lectures in Finnish and exercises in English. Course can be passed in Finnish and English.

Timing:

Spring, period 4.

Learning outcomes:

Upon completion of the course the student:
- understands the basic theory of digital image processing and knows its main applications,
- is able to apply spatial and frequency domain and wavelet based methods in image enhancement, restoration, compression and segmentation.

-

Contents:

1. Introduction
2. Fundamentals of digital image
3. Intensity transformations and spatial filtering
4. Image processing in frequency domain
5. Restoration
6. Color image processing
7. Wavelets and multi-scale processing
8. Compression
9. Morphological image processing
10. Segmentation

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 24 h, exercises 14 h and homework assignments 30 h. The rest is independent work.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521141P Elementary Programming or equivalent Python programming skills.

Recommended optional programme components:

None.

Recommended or required reading:

Gonzalez, R.C., Woods, R.E.: Digital Image Processing, Third Edition, Prentice-Hall, 2008, Chapters 1-10.
Lecture notes and exercise

Assessment methods and criteria:

The course is completed by passing the exam and homework assignments.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Janne Heikkilä

Working life cooperation:

None.

Other information:

Course is in Moodle: https://moodle.oulu.fi/course/view.php?id=6840

521145A: Human-Computer Interaction, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Simo Hosio

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish/English

Timing:

Autumn semester, Period II

Learning outcomes:

Upon completing this course, students will possess:

1. Knowledge of Human Computer Interaction (HCI) fundamentals
2. Knowledge and practical experience of user-centric computer interface and usability evaluation techniques, such as questionnaires and interviewing
3. Knowledge and experience of prototyping techniques (both paper-based as well as digital)
4. Knowledge of how HCI can be incorporated in the software development process

Contents:

Fundamental knowledge of humans, and how that relates to computer systems and interfaces. Learning design in 2-3 different ways, and conducting evaluations of the designs. Evaluation constitutes data collection and analysis, including qualitative and quantitative data.

Mode of delivery:

Online teaching (lectures), group work (labs).

Learning activities and teaching methods:

Lectures (12 h), exercises (16 h), and practical work (105 h). The course is passed with approved classroom/reading package reflections, and an approved group-based practical work (several assignments). The implementation is doable fully in English.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

While no specific courses are not required, elementary teamwork skills are required and the capability to provide documentation.

Recommended optional programme components:

All necessary material will be provided by the instructor.

Recommended or required reading:

No required reading.

Assessment methods and criteria:

The course completion relies on completed solo-work (reflections), and the numerical assessment is project-based. Students have to complete several individual exercises throughout the semester: ideating an application, designing various versions of its prototype, evaluating those prototypes, documenting the final application designs. Passing criteria: all stages of the project-based work must be completed, each receiving more than 50% of the available points.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Associate Professor Simo Hosio

Working life cooperation:

If relevant, guest lectures may be organized (optional).

Other information:

Using Moodle as the teaching platform: https://moodle.oulu.fi/course/view.php?id=5409

521045S: Mobile Computing, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aku Visuri

Opintokohteen kielet: English

Leikkaavuudet:

521046A	Mobile Computing	5.0 op
521147S	Mobile and Social Computing	5.0 op

Timing:

Person responsible:

Aku Visuri

Other information:

Course is in Moodle
https://moodle.oulu.fi/course/view.php?id=6195
New code and the course is 521046A Mobile Computing.
See course description 521046A Mobile Computing, 5 ECTS cr.

521043S: Internet of Things, 5 op

Voimassaolo: 01.08.2018 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Ella Peltonen
Opintokohteen kielet: English

Proficiency level:

Status:

ECTS Credits:

5 ECTS / 135 hours of work

Language of instruction:

English

Timing:

Autumn semester during period 2.

Learning outcomes:

Upon completion of the course, the student will be able to:
1. explain application areas of IoT and requirements from such application areas for IoT systems.
2. will be able to explain the state-of-the-art IoT solutions, and understand the basic technologies behind them.
3. learn the principles of the novel IoT technologies and know important directions IoT research towards.

Contents:

The basic technologies and novel applications of the Internet of Things, including networking technologies as well as Web of Things. IoT sensor technologies and sensing solutions for smart buildings including smart home, city, office, or campus environments, and wearables and other personal devices such as fabrication. Exercises will include hands-on programming and sensing data analytics tasks.

Mode of delivery:

The course will be given fully remotely. Please join the Moodle page (https://moodle.oulu.fi/course/view.php?id=5330, password is iot2020) and attend the introduction Zoom lectures in Tue 27.10. 10:15-12 (for general organisation) and Wed 28.10. 14:15-16 (for course project).

Learning activities and teaching methods:

20h lectures, 12h exercise sessions, independent studying 95 hours.

Target group:

M.Sc. students of Computer Science and Engineering, M. Sc. students of Ubicomp International master program. The course fits also for Statistics and Math MSc student interested in applying their knowledge into sensing and IoT data.

Prerequisites and co-requisites:

The Bachelor level knowledge of Computer science and engineering study programmes. Good programming skills in a chosen language.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture hand-out, complementary reading list, and exercise material will be provided.

Assessment methods and criteria:

Attending lectures and exercise sessions, and returning the weekly exercises online.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilises a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Ella Peltonen

Working life cooperation:

The course may include the invited guest lectures from industry and other top EU universities.

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521140S: Computer Graphics, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Guoying Zhao

Opintokohteen kielet: English

Leikkaavuudet:

521493S	Computer Graphics	7.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

In English

Timing:

Spring, period 4.

Learning outcomes:

Upon comletion of the course, the student

1. is able to specify and design 2D graphics algorithms including: line and circle drawing, polygon filling and clippin
2. is able to specify and design 3D computer graphics algorithms including transformations, viewing, hidden surface removal, shading, texture mapping and hierarchical modeling
3. is able to explain the relationship between the 2D and 3D versions of such algorithms
4. possesses the necessary basic skills to use these basic algorithms available in PyOpenGL

Contents:

The history and evolution of computer graphics; 2D graphics including: line and circle drawing, polygon filling, clipping, and 3D computer graphics algorithms including viewing transformations, shading, texture mapping and hierarchical modeling; graphics API (PyOpenGL) for implementation.

Mode of delivery:

Remote teaching

Learning activities and teaching methods:

Lectures 22 h / Programming lessons 12 hours / Self-study and programming assignments 101 h.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

Programming skills using Python; basic data structures; simple linear algebra.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

1) Textbook: Edward Angel, Dave Shreiner: Interactive Computer Graphics: A Top-Down Approach with WebGL, 7th Edition, Addison-Wesley 2015
2) Textbook: Edward Angel: Interactive Computer Graphics, 5th Edition, Addison-Wesley 2008
3) Reference: Peter Shirley, Michael Ashikhmin, Michael Gleicher, et al. : Fundamentals of Computer

Graphics, second edition, AK Peters, Ltd. 2005
4) Lecture notes (in English)
5) Online PyOpenGL tutorials (e.g. http://pyopengl.sourceforge.net/context/tutorials/index.html)

Assessment methods and criteria:

The assessment of the course is based on the exam (70%) and programming assignments (30%).
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5, zero stands for fail.

Person responsible:

Guoying Zhao, Tuomas Varanka, Muzammil Behzad.

Working life cooperation:

No

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521290S: Distributed Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Leppänen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521266S-01	Distributed Systems, Exam	0.0 op
521266S-02	Distributed Systems, Exercise Work	0.0 op
521266S	Distributed Systems	6.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

In English.

Timing:

Spring, period 3.

Learning outcomes:

After completing the course, the student
1. is able to explain the key principles of distributed systems
2. apply the principles in evaluating major design paradigms used in implementing distributed systems
3. solve distributed systems related problems
4. design and implement a small distributed system

Contents:

Introduction, architectures, processes, communication, naming, synchronization, consistency and replication, fault tolerance, security, case studies.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 22 h, exercises 16 h, project work 50 h, self-study 47 h.

Target group:

M.Sc. students (computer science and engineering) and other Students of the University of Oulu

Prerequisites and co-requisites:

None.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Required literature: Maarten van Steen and Andrew S. Tanenbaum, Distributed Systems – Principles and Paradigms, Third Edition, 2017.

Assessment methods and criteria:

The course uses continuous assessment so that there are 2 intermediate exams. Alternatively, the course can also be passed with a final exam. The course includes a mandatory project work.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical scale 1-5; zero stands for a fail.

Person responsible:

Teemu Leppänen

Working life cooperation:

None.

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521466S: Machine Vision, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Heikkilä, Janne Tapani

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Spring, period 3.

Learning outcomes:

Upon completion of the course the student
1. understands the fundamentals of image acquisition, representation and modeling
2. can utilize elementary methods of machine vision for image recognition problems
3. can use 2D transformations in model fitting and image registration
4. can explain the basics of 3D imaging and reconstruction

Contents:

1. Introduction, 2. Imaging and image representations, 3. Light and color, 4. Binary image analysis, 5. Texture, 6. Local features, 7. Recognition, 8. Motion, 9. 2D models and transformations, 10. Perceiving 3D from 2D images, 11. 3D transformations and reconstruction.

Mode of delivery:

Online lectures and exercises, homework assignments.

Learning activities and teaching methods:

Lectures (24 h), exercises (16 h) and programming assignments (32 h), self-studying (61 h)

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521467A Digital Image Processing or an equivalent course, basic Python programming skills.

Recommended optional programme components:

521289S Machine Learning. This course provides complementary knowledge on machine learning methods needed in machine vision.

Recommended or required reading:

Lecture slides and exercise material. The following books are recommended for further information: 1) Shapiro, L.G. & Stockman, G.C.: Computer Vision, Prentice Hall, 2001. 2) Szeliski, R.: Computer Vision: Algorithms and Applications, Springer, 2011. 3) Forsyth, D.A. & Ponce, J.: Computer Vision: A Modern Approach, Prentice Hall, 2002.

Assessment methods and criteria:

The course is passed with final exam and accepted homework assignments.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5. Zero stands for a fail.

Person responsible:

Janne Heikkilä

Working life cooperation:

No.

Other information:

Course is in Moodle: https://moodle.oulu.fi/course/view.php?id=4317

521156S: Towards Data Mining, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Satu Tamminen

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

Autumn, period I.

Learning outcomes:

After completing this course, student can recognize data types and perform required pre-processing steps before further analysis:

1. Student can design and implement a data collection process
2. Student can combine data from different sources
3. Student can normalize and transform data, and handle missing or incorrect values
4. Student can ensure generalizability of the results

Contents:

Course provides good ability to start Master’s Thesis or graduate studies. Topics at the course include data mining process in general level, data gathering and different data types, quality and reliability of the data, data preparation including the processing of missing values, outliers, and privacy issues, combination of signals from several sources, utilization of data bases in data mining process, and normalization and transformation of data and interdependence of the observations and their distributions. Additionally, topics concerning the generality of the results are covered, as well as, the principles of data division, for example, train-test-validate, cross-validation and leave-one-out methods.

Mode of delivery:

Lectures, independent work, group work

Learning activities and teaching methods:

16 h lectures, 16 h exercises, independent studying.

Target group:

The course is suitable for Master level students in Computer science and engineering study programmes, for minor subject studies or for doctoral students.

Prerequisites and co-requisites:

031021P Probability and Mathematical Statistics or similar

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture hand-out and exercise material will be provided. The course book will be announced in the beginning of the course. The material is mostly in English.

Assessment methods and criteria:

Weekly pre-lecture assignment + exercise submissions, and final exam. Half of the grade will be based on the submissions and half on the final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5; zero stands for a fail.

Person responsible:

Tamminen Satu

Working life cooperation:

-

Other information:

Moodle: https://moodle.oulu.fi/course/view.php?id=1679
Towards Data Mining 521156S:3

521260S: Programmable Web Project, 5 op

Voimassaolo: 01.08.2006 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ivan Sanchez Milara

Opintokohteen kielet: English

Leikkaavuudet:

ay521260S	Programmable Web Project (OPEN UNI)	5.0 op

Status:

The course is mandatory for International Master's Programme in Computer Science and Engineering and Master's Programme in Computer Science and Engineering. It is optional for other degree and master programmes.

ECTS Credits:

5 ECTS cr

Language of instruction:

In English.

Timing:

Spring, periods 3-4.

Learning outcomes:

Upon completion of this course, students:

- understand what a Web API is and learn different Web API architectures.
- understand the concept of hypermedia and how it is used to build Web APIs.
- are able to design and implement a Web API following REST architectural style principles using existing web frameworks.
- are able to write unit and functional tests to inspect their APIS.
- are able to document their Web APIs using adequate software tools.
- are able to implement simple software applications that make use of the APIs.

Contents:

RESTful Web APIs, Hypermedia and HATEOAS, RESTful Clients

Mode of delivery:

Online learning.

Learning activities and teaching methods:

Lectures 4 h, guided laboratory exercise 15 h, the rest as self-study and group work. Each group implements software and writes a report. Students present their work at least twice in online meetings with the course staff.

Target group:

M.Sc. level students of Computer Science and Engineering; other students of the university of Oulu are accepted if there is enough space in the classes.

Prerequisites and co-requisites:

Elementary programming (521141P) or equivalent Python programming skills. Applied computing project I is recommended.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Mainly course slides and links to different Web resources announced during the first lecture. Course books: * Leonard Richardson, Mike Amundsen & Sam Ruby. RESTful Web APIs. O'Reilly Media 2013. ISBN: 978-1-4493-5806-8. * Leonard Richardson & Sam Ruby,RESTful Web Services. O'Reilly Media 2007. ISBN: 978-0-596-52926-0.

Assessment methods and criteria:

Course will be assessed based on project work assignment (functional working software prototype, content of the report…) and the exercises results. More detailed information on assessment will be provided with the course material.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Ivan Sanchez Milara

Working life cooperation:

None.

Other information:

We will use Moodle to provide links to the working tools and information about distance learning: https://moodle.oulu.fi/course/view.php?id=6032

Course material can be found at Lovelace: https://lovelace.oulu.fi/.

521479S: Software Project, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail
Opettajat: Christian Wieser
Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

Finnish/English, material available in English.

Timing:

Autumn, periods 1-2.

Learning outcomes:

After completing the course, students have demonstrated their capabilities to design, develop and test real-life software. Further, they have shown their proficiency in professionally documenting their work during the assignment.

Contents:

Phases of software engineering process: requirement gathering, analysis, design, implementation, testing, (maintenance). Project-work, starting a project, project management, working with external parties, project documentation. Project related implementation techniques and tools, software documentation.

Mode of delivery:

Face-to-face and independent studies.

Learning activities and teaching methods:

Working methods: The course is done in groups of 3-4 students. The clients are typically various companies and societies. Project progress is supervised in formal reviews, where the project teams present their work as it reaches the milestones: the software requirement specification, the project plan, the software design specification, an operational prototype demonstration, the test documentation, and finally the functional software demonstration and release. In addition to formal reviews the project work is coordinated with steering group meetings. The work environment and development tools vary between projects. The number of students that can attend the course is limited. Lectures 10 h, design project in period 4-6 180 h.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521457A Software Engineering, 521453A Operating Systems, 521141P Elementary Programming, 521286A Computer Systems or 521142A Embedded Systems Programming and varying project related background reading.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Pressman, R.S.: Software Engineering A Practitioner's Approach, 4th edition, Mc Graw-Hill, 1997; Phillips, D.: The Software Project Manager's Handbook, IEEE Computer Society, 2000; Project documentation; project related manuals and handbooks.

Assessment methods and criteria:

Project work and documentation.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Christian Wieser

Working life cooperation:

-

Other information:

-

521283S: Big Data Processing and Applications, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Lauri Lovén
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

Period IV. It is recommended that the course is taken on the fourth year Spring.

Learning outcomes:

Upon completion of the course, the student :

1. is able to explain the big data phenomenon, its challenges and opportunities.
2. is able to explain the requirements and common principles for data intensive systems design and implementation, and evaluate the benefits, risks and restrictions of available solutions.
3. can explain the principles of big data management and processing technologies and utilize them on a basic level.

Contents:

General introduction into big data, namely: big data fundatmenals, data storage, batch and stream data processing, data analysis, privacy and security, big data use cases.

Mode of delivery:

Online teaching, exercises and seminars. Independent and group work.

Learning activities and teaching methods:

Lectures, exercises, seminars, independent and group work

Target group:

M.Sc. students (computer science and engineering) and other Students of the University of Oulu

Prerequisites and co-requisites:

The Bachelor level studies of Computer science and engineering study programmes or respective knowledge.

Recommended optional programme components:

Finishing 521290S Distributed Systems, 521497S Pattern recognition and neural networks, and 521286A Computer Systems is beneficial.

Recommended or required reading:

Lecture slides and exercise material will be provided. Each lecture will include the refernce list for recommended reading. Instructions to necessary installations will be given.

Assessment methods and criteria:

This course assesses students continuously by the completion of small project work, seminar presentations and short reports on a selected topic (group work). Answering two quizzes during the course is optional and provides additional points for final grade. To pass the course, it is enough to get 50 % of available points. No exam.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Lauri Lovén

Working life cooperation:

The course includes also invited lectures from industry.

Other information:

Course is in Moodle.

521158S: Natural Language Processing and Text Mining, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mourad Oussalah

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 120 hours of works

Language of instruction:

English

Timing:

Period 1. It is recommended to complete the course at the end of period 1

Learning outcomes:

Upon completing the course, the student is expected to i) comprehend, design and implement basic (online) text retrieval and query systems; ii) account for linguistic aspects and perform word sense disambiguation; iii) perform basic (statistical) inferences using corpus; iv) manipulate (statistical) language modelling toolkits, online lexical databases and various natural language processing tools.

Contents:

Foundation of text retrieval systems, Lexical ontologies, word sense disambiguation, Text categorization, Corpus-based inferences and Natural Language Processing tools

Mode of delivery:

Face- to-face teaching and laboratory sessions

Learning activities and teaching methods:

Lectures (24 h), tutorial/laboratory sessions (16h), seminar (6h) and practical work. The course is passed with an approved practical work and class test. The implementation is fully in English.

Target group:

students with (moderate to advanced) programming skills in Python

Prerequisites and co-requisites:

Programming skills (preferably) in Python

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

Introduction to Information Retrieval, by C. Manning, P. Raghavan, and H. Schütze. Cambridge University Press, 2008. (Free from http://nlp.stanford.edu/IR-book/) Foundations of statistical natural language processing, by Manning, Christopher D., Schütze, Hinrich. Cambridge, Mass.: MIT Press, 2000

Assessment methods and criteria:

One class test (30%) in the middle of the term + Project work (70%)
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Mourad Oussalah

Working life cooperation:

-

521289S: Machine Learning, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Seppänen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521497S-01	Pattern Recognition and Neural Networks, Exam	0.0 op
521497S-02	Pattern Recognition and Neural Networks; Exercise Work	0.0 op
521497S	Pattern Recognition and Neural Networks	5.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

English.

Timing:

The course unit is held in the spring semester, during period III. It is recommended to complete the course at the end of studies.

Learning outcomes:

After completing the course, student

1. can design simple optimal classifiers from the basic theory and assess their performance.
2. can explain the Bayesian decision theory and apply it to derive minimum error classifiers and minimum cost classifiers.
3. can apply regression techniques to practical machine learning problems.

Contents:

Introduction. Bayesian decision theory. Parametric and non-parametric classification. Feature extraction. Classifier design and optimization. Example classifiers. Statistical regression methods.

Mode of delivery:

Online teaching, guided laboratory work and independent assignment. The laboratory works are done on an online system (Mathworks Grader). Student can do the lab works remotely or in the lab using the same online system.
The course is implemented as remote education via the Moodle work space https://moodle.oulu.fi/course/view.php?id=5729
This work space opens to students before the course begins. The student must register to the course in WebOodi in order to participate the course.

Learning activities and teaching methods:

Lectures 16 h, Laboratory work 16 h, and Self-study the rest (Independent task assignment).

Target group:

Students who are interested in machine learning and pattern recognition theory and methods.

Prerequisites and co-requisites:

The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Programming skills, especially basics of the Matlab.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Will be informed when the course starts.

Assessment methods and criteria:

Laboratory work is supervised by assistants who also verify that the task assignments are completed properly. The Matworks Grader online system also verifies the completed tasks. The independent task assignment is graded which establishes the grade for the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail. The final grade is established by the independent task assignment.

Person responsible:

Tapio Seppänen

Working life cooperation:

No

521161S: Multi-Modal Data Fusion, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jaakko Suutala

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr / 135 hours of work

Language of instruction:

English

Timing:

Autumn / period 2.

Learning outcomes:

Upon completion of the course, the student will be able to
1. understand the problem of combining data of different natures and coming from different sources
2. explain basic principles of combining multi-sensor data
3. know the common types of data fusion techniques
4. understand and utilize Bayesian probabilistic reasoning framework in multi-modal data fusion
5. understand basic principles of machine learning applied to multi-modal data fusion
6. implement basic solutions towards the accomplishment of a given task requiring the integration and combination of data

Contents:

This course will provide a comprehensive introduction to the concepts and ideas of multi-sensor data fusion. We will be concentrated on defining general statistical framework for multi-modal data processing. Using this framework, we will show concepts of common representation and alignments, sequential Bayesian inference, and machine learning approaches to data fusion as well as specific models and algorithms in each category. Furthermore, the course will illustrate many real-life examples taken from a diverse range of applications to show how they can be benefitted from data fusion approaches.
The course will discuss the following topics:
1. Introduction
2. Sensors and architectures
3. Common representation
4. Alignments
5. Bayesian inference and probabilistic reasoning
6. Sequential Bayesian inference
7. Bayesian Decision Theory and ensemble learning

8. Advanced topics

Mode of delivery:

The course will be based on a combination of lectures (face-to-face teaching), exercises, and a final project.

Learning activities and teaching methods:

16 h lectures, 16 h exercises (including programming tasks), 35 h final programming project, home study.

Target group:

The course is suitable for Master level students in Computer science and engineering study programmes, for minor subject studies or for doctoral students.

Prerequisites and co-requisites:

The course will be self-contained as much as possible (i.e., no previous knowledge of multi-sensor data fusion is assumed). Basic knowledge on mathematics and statistics as well as related topics like signal processing, and machine learning will be a plus.
The required prerequisite is the completion of the following courses: 031078P Matrix Algebra, 031021P Probability and Mathematical Statistics, 521156S Towards Data Mining, and 521289S Machine Learning.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course will be based on the following textbook: H.B. Mitchell. Data Fusion: Concepts and Ideas. Springer (2012) and selected recent journal articles.

Assessment methods and criteria:

To pass the course, the student should return the exercises, complete a final programming project. Half of the grade will be based on exercises and half on the final project.

Grading:

The course will utilize a numerical grading scale 1-5. Zero stands for a fail.

Person responsible:

Jaakko Suutala and Markus Harju

Working life cooperation:

-

Other information:

Course uses Moodle platform.

521285S: Affective Computing, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Guoying Zhao

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits

Language of instruction:

In English

Timing:

Fall, periods 1

Learning outcomes:

After completing the course, student

1. is able to explain the emotion theory and modeling
2. is able to implement algorithms for emotion recognition from visual and audio signals, and the fusion of multi-modalities
3. has the ideas of wide applications of affective computing

Contents:

The history and evolution of affective computing; psychological study about emotion theory and modeling; emotion recognition from different modalities: facial expression, speech, fusion of multi-modalities; crowdsourcing study; synthesis of emotional behaviors; emotion applications.

Mode of delivery:

Online teaching in Moodle/Zoom.
Moodle: https://moodle.oulu.fi/course/view.php?id=325&section=0

Learning activities and teaching methods:

The course consists of lectures and exercises. The final grade is based on the points from exam while there are several mandatory exercises.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

A prior programming knowledge with Python, possibly the bachelor level mathematical studies and/or some lower level intermediate studies (e.g. computer engineering or artificial intelligence courses). The recommended optional studies include the advanced level studies e.g. the pattern recognition and neural networks and/or computer vision courses.

Recommended optional programme components:

-

Recommended or required reading:

All necessary material will be provided by the instructor.

Assessment methods and criteria:

The assessment of the course is based on the exam (100%) with mandatory exercises.
Read more about [assessment criteria] at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5, zero stands for fail.

Person responsible:

Guoying Zhao, Henglin Shi, Yante Li

Working life cooperation:

No

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521153S: Deep Learning, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Li Liu

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits/135 hours of work

Language of instruction:

English

Timing:

autumn, period 2

Learning outcomes:

Upon completion of this course, the students will be able to:

1. learn the theories, models, algorithms, implementation and recent progress of deep learning, and obtain empirical experience on training deep neural networks.
2. will learn about linear classifiers, multilayer neural networks, back propagation and stochastic gradient descent, convolutional neural networks, recurrent neural networks, generative adversarial networks, deep network compression, deep transfer learning techniques and deep reinforcement learning (tentative).
3. know about applications of deep learning to typical computer vision problems such as image classification, object detection and segmentation.
4. learn to implement, train and debug their own neural networks with PyTorch.

Contents:

Students should be comfortable taking derivatives and understanding matrix vector operations and notations.
Basic Probability and Statistics, Linear Algebra, basics of probabilities, Gaussian distributions, mean, standard deviation, etc.
have knowledge of Machine Learning course and digital image processing course

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

20h lectures, 12h exercise sessions, independent studying 95 hours.

Target group:

B.Sc. and M.Sc. students of Computer Science and Engineering. The course fits also for Statistics and Math M.Sc. students interested in learning deep learning techniques.

Prerequisites and co-requisites:

The Bachelor level knowledge of Computer science and engineering study programmes. Good programming skills in a chosen language.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture hand-out, complementary reading list, and exercise material will be provided.

Assessment methods and criteria:

Attending lectures and exercise sessions, and returning the weekly exercises and final project.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Li Liu

Working life cooperation:

The course may include the invited guest lectures from industry and other top universities.

521155S: Computer Security, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Tokola, Juha Röning

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr / 135 hours of work

Language of instruction:

English

Timing:

Autumn Semester, period 1.

Learning outcomes:

Upon completion of this course, students know and understand the basics and advanced concepts of the following key areas of the course and cybersecurity, know key terminology and can write about the topics clearly and with justifications:

- Finding software errors and vulnerabilities with fuzz-testing
- Vulnerabilities and testing of websites and communication protocols
- Principles of hardware level vulnerabilities and their testing and detection
- Principles of different software vulnerabilities, malware programs and shellcode and memory protection measures
- Cyber crime, cyber forensics and botnets
- Mobile and IoT security and manufacturing security, testing and protection measures

Additionally, students that have attained grades 2 or 3 have demonstrated technical capacity to perform practical work relevant to the course key areas. Students that have attained grades 4 or 5 have additionally demonstrated capacity for independent, ambitious work on the key areas working on advanced and challenging security research questions.

Contents:

The course covers the essential aspects of computer security and computer security research in theory and through practical examples.

Mode of delivery:

Contact teaching and independent work

Learning activities and teaching methods:

14 hours of lectures ja 28 hours of laboratory exercises, rest independent work alone or in groups.

Target group:

The course is intended for computer engineering masters students and additionally to any student interested in computer security that has the sufficient technical background to complete the course exercises.

Prerequisites and co-requisites:

As prior knowledge students should have a basic understanding of how computers, operating systems and the Internet work and basic skills in programming. Examples of suitable courses to cover these fundamentals are Operating Systems 521453A, Introduction to Programming 521141P and Computer Engineering 521267A.

Recommended optional programme components:

The course is an independent entity.

Recommended or required reading:

-

Assessment methods and criteria:

Grading of the course is made based on the course practical assignments.

Grading:

Numerical grade 0-5, where 0 stands for a fail.

Person responsible:

Juha Röning, Teemu Tokola

Working life cooperation:

-

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521495A: Artificial Intelligence, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jaakko Suutala, Pekka Sangi

Opintokohteen kielet: English

Leikkaavuudet:

ay521495A	Artificial Intellig (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course in held in the spring semester, during period III. For bachelor students of Computer Science and Engineering specializing to artificial intelligence, it is recommended to complete the course at the 3rd spring semester.

Learning outcomes:

After completing the course, students

1. know the basic search strategies that can be applied in problem solving and optimization.
2. understand how search-based decisions are made in game-like competitive applications.
3. know the basic principles of probabilistic reasoning in artificial intelligence systems.
4. know how rational decision making under uncertainty can be formulated using utility theory.
5. understand the fundamentals of machine learning and how some of the established methods can be applied to problems in AI.
6. are familiar with advanced AI applications of perception and robotics and how probabilistic inference and machine learning can be used in these settings.

In the course projects, students get some experience in programming and using search methods.

Contents:

intelligent agent types, uninformed search methods, informed (heuristic) search, local search, constraint satisfaction problems, adversarial search, uncertainty handling, probabilistic reasoning, utility, machine learning, decision networks, Markov decision process, reinforcement learning, applications

Mode of delivery:

The tuition is implemented as web-based teaching. Moodle environment is used in the course.
Due to Covid-19 pandemic, teaching in Spring 2021 will be implemented remotely. Course work space can be found from University of Oulu Moodle platform.
Moodle page in Spring 2021 will be https://moodle.oulu.fi/course/view.php?id=3211, where details of implementation will be provided. The page will be available from December 21, 2020.
Online lectures will be given with Zoom and link for them will be provided in Moodle.

Learning activities and teaching methods:

Lectures 28 h / Group work (programming projects) 42 h / Self-study 65 h

Target group:

The primary target group is the students of the Computer Science and Engineering specializing in Artificial Intelligence.

Prerequisites and co-requisites:

Completion of the course "521160P Introduction to Artificial Intelligence" (lectured in Finnish) is recommended, but is not a prerequisite. It is also recommended that a student has completed studies related to probability and statistics (e.g. course "031021P Probability and Mathematical Statistics") and Python programming (e.g. course "521141P Elementary Programming").

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course is based on the book Stuart Russell, Peter Norvig (2010, global edition 2016): Artificial Intelligence: A Modern Approach (3rd Edition), Chapters 1-6, 13-18, 20-21, partly 24-25.
The course utilizes materials of an introductory course on artificial intelligence taught at UC Berkeley (http://ai.berkeley.edu).

Assessment methods and criteria:

The assessment of the course is based on the final exam. Both the final exam and the course projects must be passed. Well-done course projects can increase the grade by one unit.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pekka Sangi, Jaakko Suutala

Working life cooperation:

The course does not contain working life cooperation.

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.
Moodle page in Spring 2021 will be https://moodle.oulu.fi/course/view.php?id=3211

521042S: Creative Design, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Georgi Georgiev

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits/ 135 hours of work

Language of instruction:

English

Timing:

Period 1

Learning outcomes:

Upon completion of this course, students are able to:
- Understand and apply in practice basic creative problem-solving and design thinking approaches.
- Systematically ideate and implement creative solutions to a problem, both independently and within a team.
- Apply creative design thinking and low-resolution prototyping, with emphasis on empathy, iterative strategies, and interactions.

Contents:

The course teaches students of (1) Creative problem-solving; (2) Design thinking and low-resolution prototyping; (3) Teamwork problem-solving; (4) Systematic ideation approaches.

Mode of delivery:

Face-to-face teaching, teamwork/individual work, and independent studying.

Learning activities and teaching methods:

Lectures 21h / Individual work 124h. There are TA hours each week where guidance is available.

Target group:

Primary target group is first year master's level students of computer science and engineering with the applied computing orientation.

Prerequisites and co-requisites:

There are no prerequisites or co-requisites.

Recommended optional programme components:

-

Recommended or required reading:

All necessary material will be provided by the instructor.

Assessment methods and criteria:

20% attendance of 7 lecture-exercises; 40% exercise completion and performance; 40% individual project outcome.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for fail.

Person responsible:

Georgi Georgiev

Working life cooperation:

-

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.

521288S: Multiprocessor Programming, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Praneeth Susarla

Opintokohteen kielet: Finnish

Leikkaavuudet:

521280S	DSP Laboratory Work	5.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

Spring semester, periods 3-4

Learning outcomes:

Upon completition of the course, the student:

1. has basic understanding of multiprocessor architectures and heterogeneous computing,
2. has basic understanding on how to design and implement algorithms for heterogeneous platforms,
3. understands the possible challenges and shortcomings related to the current heterogeneous systems,
4. is able to use the OpenCL framework for designing, implementing and optimizing signal processing algorithms for heterogeneous platforms

Contents:

Algorithm design, general purpose computing on graphics processing units, heterogeneous computing, OpenCL programming and optimization

Mode of delivery:

Opening lecture and independent exercise project, which is divided into smaller sub-entities. The exercise project is performed using both desktop and mobile platforms. After each sub-entity, a short seminar is held where the students discuss their results and possible ways to optimize the performance of their implementation.

Learning activities and teaching methods:

Opening lecture (2h), seminars (8h) and independent exercise project (125h).

Target group:

Computer Science and Engineering students + other Students of the University of Oulu. This is an advanced-level course intended for masters-level students and post-graduate students, especially to those who are specializing into signal processing.

Prerequisites and co-requisites:

Matrix Algebra 031078P, Elementary programming 521141P, Computer Systems 521286A, Digital Filters 521337A

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

-

Assessment methods and criteria:

Students complete the course exercises after the attending to the opening lecture in groups of two students. Assessment is based on the quality of the completed exercises and exercise reports. More detailed information on assessment will be announced at the beginning of the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5; zero stands for a fail.

Person responsible:

Praneeth Susarla

Working life cooperation:

No.

521281S: Application Specific Signal Processors, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mehdi Safarpour

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English.

Timing:

Autumn, period 1

Learning outcomes:

After completing the course, student

1. Can distinguish the main types of signal processors
2. Can design basic customized transport triggered architecture processors
3. Is capable of assembling a signal processor out of basic entities
4. Can match the processor performance and the application requirements

5. Applies the TTA codesign environment and Altera's FPGA tools to synthesize a system

Contents:

Examples of modern signal processing applications, main types of signal processors, parallel signal processing, transport triggered architectures, algorithm-architecture matching, TCE design environment and Altera FPGA tools.

Mode of delivery:

Lectures, exercises, independent work, group work.

Learning activities and teaching methods:

Lectures 12h (participation mandatory); Instructed labs 12h. Independent work 111h

Target group:

Computer Science and Engineering students + other Students of the University of Oulu. This is an advanced-level course intended for masters-level students and post-graduate students, especially to those who are specializing into signal processing.

Prerequisites and co-requisites:

521267A Computer Engineering or 521286A Computer Systems (8 ECTS cr) or 521287A Introduction to Computer Systems (5 ECTS cr) and 521337A digital filters, programming skills

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Handouts.

Assessment methods and criteria:

Participation in mandatory classes and approved lab exercises and project works.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5; zero stands for a fail.

Person responsible:

Mehdi Safarpour

Working life cooperation:

No.

521423S: Embedded System Project, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Tokola

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

Lecturing in Finnish, material available in English

Timing:

Spring, periods 3-4.

Learning outcomes:

1. After passing the course, the student is familiar with the design process of an embedded system, from specifying the application leading to the requirement specification for the device, and then to having produced a functional prototype of the defined system.
2. The student is more familiar with the roles of the client and the system developer during the requirement specification, and the role of the iterations as a part of the whole design process. From the specifications,

the student is familiar with the process of choosing the suitable hardware components, circuit design and implementation. In the end, the student is also able to know the factors arising from the SW/HW partitioning process of the actual implementation, and the concept of SW/HW dualism. The student can then better utilize the basic development tools used for embedded system design and recognize their possible advantages and disadvantages.
3. The student is more familiar with the testing and problem solving methodology related to the prototype implementation of an embedded system, to have the prototype working correctly according to the specifications.

Contents:

The embedded system design process, from initial specification to implementation of a first functional prototype and demonstrating its functionality in practice. The application can be suggested by the student group, or chosen from the topics suggested by the course organizers. During the work, the students familiarize themselves with modern design tools and methodologies related to embedded system design (according to the microcontroller the student group has chosen to utilize in their work). Most commonly used platforms on the course include STM, Atmel and Microchip based platforms.

Mode of delivery:

Online teaching. Lectures, tutoring and self-study.

Learning activities and teaching methods:

The course is run as a project work in groups of three with progress follow-up reporting meetings. Lectures 10 h, laboratory exercise in period 3-4 120 h.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

811122P Introduction to Programming
521412A Digital Techniques I
Also recommended; 521275A Embedded Software Project, 521432A Electronics Design I.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

-

Assessment methods and criteria:

Project work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning

Working life cooperation:

None.

521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-4

Learning outcomes:

After completing the course the student understand and is able to analyze basic principles of the topic which has been presented in the course. The final outcomes will be defined based on the contents. Objective: Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

Varies yearly based on actual topics in telecommunications and radio engineering.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and/or exercises and/or design exercise and/or seminars depending on the topic of the year. The start and implementation of the course will be informed separately. The course can be given several times with different contents during the academic year and it can be included into the degree several times.

Target group:

1 st and 2 nd year M.Sc. and WCE students.

Prerequisites and co-requisites:

Will be defined based on the contents.

Recommended optional programme components:

-

Recommended or required reading:

Will be defined in the beginning of the course.

Assessment methods and criteria:

Depends on the working methods.

Grading:

The course unit utilizes a numerical grading scale 1-5.
Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

-

521322S: Telecommunication Engineering Project, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Saarnisaari, Harri Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

521387S Telecommunication Engineering Project 4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English/Finnish

Timing:

Fall or Spring, periods 1-4

Learning outcomes:

After completing the course student can
1. depending on the work subject, either solve, design, construct, measure, simulate, test or analyze limited telecommunication and radio system and sub-system problems.
2. apply the technical knowledge acquired from advanced sources into practical engineering tasks.
3. document technical and scientific results.

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work.
If you would like to take the course, you can contact the course person responsible.

Learning activities and teaching methods:

The design exercise is done in a group of one or two students depending of work's difficulty. The design exercise can be simulation or implementation work. The work can be defined by the Department of Communications Engineering or by industry. In the later case a proposal must be submitted to the teacher before beginning of the work. Also, student must meet the schedule and deadlines given by a supervisor before starting the work. In preparing the work report document the writing instructions of DCE department's diploma thesis must be followed.

Target group:

1st or 2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Depending on the subject: advanced courses dealing with telecommunication systems, digital communications, digital signal processing or/and radio engineering.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Varies depending on the topic.

Assessment methods and criteria:

Written work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Markus Berg / Harri Saarnisaari

Working life cooperation:

No

Other information:

-

521300S: Electronics Design and Construction Exercise, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521441S	Electronics Design and Construction Exercise	6.5 op

ECTS Credits:

6

Language of instruction:

Finnish, English

Timing:

Periods 1-4

Learning outcomes:

1 is able to carry out all the stages needed to develop an electronic circuit or device starting from independent creation and design work to realization, testing and technical documentation.
2 is able to use independently without any help professional methods, software packages, measurement devices and tools.
3 Objective: To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.

Contents:

Design and construction of an electronic device or a part of a device according to the given specification. The task can be part of an industrial research or a product design project or part of the research project going on in Electronics or other laboratory. The subject of the work can be own suggestion of the student or a pre-selected course subject, which enables comprehensive training of skills needed for the design of a modern electronic device.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course

Prerequisites and co-requisites:

Student must have passed following courses: Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design and Filter Theory.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Not defined

Assessment methods and criteria:

The task can be carried out by a student or by a team of two students. The grade will be decided on the basis of the statement of the instructor, realization of the device and the report provided by the student.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

ECTS Credits:
3
Language of instruction:
Finnish/English
Timing:
1-4
Learning outcomes:
After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.
Contents:
Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.
Mode of delivery:
Independent work.

Learning activities and teaching methods:
The students acquire their training job themselves.
Target group:
MSc students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass/Fail
Person responsible:
Jari Hannu
Working life cooperation:
Yes.
Other information:
-

521362S: Electonics and Communications Engineering Seminar, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Isohookana

Opintokohteen kielet: Finnish

Leikkaavuudet:

521350S	Seminar in Telecommunication and Radio Engineering	1.0 op

ECTS Credits:
0/1
Language of instruction:
English
Timing:
Autumn and spring, periods 1-4.
Learning outcomes:
1. Student can prepare a presentation of predetermined length of her/his thesis.
2. Student has experience on presenting her/his topic.
3. Student has experience on evaluating other students' presentations.
4. Student has a general view of other completed diploma thesis.

Contents:
The content is determined by the diploma work topics and other current research topics.
Mode of delivery:
Seminar presentations.
Learning activities and teaching methods:
Seminar sessions when necessary during the whole year. Please be in contact University Lecturer Matti Isohookana. (matti.isohookana(at)oulu.fi)
Target group:
2nd year M.Sc. and WCE students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
Instructions for preparing a diploma work in the degree program.
Assessment methods and criteria:
Course is mandatory for all ECE and WCE students who have started their Master's studies in study year 2017 or later. Course is mandatory also for ECE and WCE students with Telecommunication or Radio Engineering study option who have started their studies in the study year 2015 or later. All students have to give a seminar presentation (30 minutes with questions and discussion). If a student will participate into three other seminars (s)he will get one credit unit which can be included to the optional studies.
Presentations are given in English. Seminars are given during the whole year when necessary.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes grading passed.
Person responsible:
Matti Isohookana
Working life cooperation:
-
Other information:
Objective: Students get practice in preparing and giving an oral presentation. At the same time they learn about current research and development projects going on in the university and in the industry.
Link to Moodle: https://moodle.oulu.fi/course/view.php?id=4214

521975S: Master's Thesis / Master's Degree Programme in Wireless Communications Engineering, 30 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521011S: Maturity Test for Master's Degree, Electronics and Communications Engineering, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
0; The maturity test is integrated in the MSc Thesis credits (30 ECTS).
Language of instruction:
Finnish/Swedish/other
Timing:
1-4
Learning outcomes:
After the maturity test, the student has demonstrated that his/her language skills meet the requirements of the work life.
Contents:
The aim of the maturity test is to confirm the student's familiarity of the thesis area as well as his/her command of the domestic language of his/her school education.
Mode of delivery:
The maturity test is written in a controlled event, on a topic provided by the thesis supervisor.
Learning activities and teaching methods:
Written essay, approximately 3 pages.
Target group:
-
Prerequisites and co-requisites:
The maturity test can be written when the thesis is complete or being finished.
Recommended optional programme components:
-
Recommended or required reading:
MSc thesis
Assessment methods and criteria:
The maturity test is evaluated and approved by the thesis supervisor
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass/fail.
Person responsible:
Thesis supervisor.
Working life cooperation:
-
Other information:
-

A451120: Basic and Intermediate Studies, Electrical Engineering, 150 - 170 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Basic and Intermediate Studies

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Choice of second domestic language, written and spoken. Basic and Intermediate Studies are 144 ECTS cr (includes 2 ECTS cr Swedish and 4 ECTS cr English)

901048Y: Second Official Language (Swedish), Written Skills, 1 op

Voimassaolo: 01.08.2014 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Vastuuyksikkö: Languages and Communication
Opintokohteen kielet: Swedish
Leikkaavuudet:

901060Y Second Official Language (Swedish), Written Skills 1.0 op
ay901048Y Second Official Language (Swedish), Written Skills (OPEN UNI) 1.0 op

Proficiency level:

This course is only for Finnish speaking students with CEFR-level A2 in Swedish language. University of Oulu, Languages and Communication unit don’t offer Beginners courses in Swedish.

901049Y: Second Official Language (Swedish), Oral Skills, 1 op

Voimassaolo: 01.08.2014 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Vastuuyksikkö: Languages and Communication
Opintokohteen kielet: Swedish
Leikkaavuudet:

901061Y Second Official Language (Swedish), Oral Skills 1.0 op
ay901049Y Second Official Language (Swedish), Oral Skills (OPEN UNI) 1.0 op

Proficiency level:

Please look course description from this course: 901048Y.

900081Y: Second Official Language (Finnish), Written Skills, 1 - 2 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Vastuuyksikkö: Languages and Communication
Opintokohteen kielet: Finnish

900082Y: Second Official Language (Finnish), Oral Skills, 1 - 3 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Vastuuyksikkö: Languages and Communication
Opintokohteen kielet: Finnish

Proficiency level:

The course is intended for the students who´s schooling language is Swedish. See 900081Y Second Official Language (Finnish), Written Skills.

Choose the minimum of 4 ects ofEnglish or German modules

902150Y: Professional English for Technology, 2 op

Voimassaolo: 01.08.2014 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

902011P-05	TE3/ Professional English for Technology	2.0 op

Proficiency level:

CEFR B2 - C1

Status:

This course is the first English course for students in the engineering programmes in the Faculty of Technology (TTK) and Faculty of Information Technology and Electrical Engineering (TST).

Required proficiency level:

English must have been the A1 or A2 language at school or equivalent English skills acquired otherwise. If you need to take English, but lack this background, please get in touch with the Languages and Communication contact teacher for your department to discuss individual solutions.

ECTS Credits:

2 credits. The workload is 53 hours.

Language of instruction:

English

Timing:

The course takes place in the autumn semester (periods 1 and 2).

Learning outcomes:

By the end of the course, you can
- create and deliver effective presentations of a product, a company and company processes,
- apply appropriate cultural, linguistic and technical knowledge when presenting a product or company,
- evaluate your own strengths and weaknesses in English-language communication, with a view to developing appropriate skills in future.

Contents:

Scheduled as the first course of your English studies, Professional English for Technology (PET) has a strong focus on developing speaking skills necessary for working life. During PET, you will explore a product or service from your own field, and give a variety of short presentations in connection with your product or service. In addition, PET helps you to develop an awareness of your own language skills, encouraging you to develop strategies and techniques for effective learning.

Mode of delivery:

Contact teaching and independent study

Learning activities and teaching methods:

Lessons 24 hours / independent work 29 hours. Lessons include regular pair and group work in class. Independent homework activities include team work for the preparation of four short presentations, vocabulary study and other small assignments. Active participation is essential.

Target group:

Students in the engineering programmes: TTK (PO1, YMP1, KO1, TuTa1, RaKy), TST (ST2, CSE2).

Prerequisites and co-requisites:

-

Recommended optional programme components:

This course is offered as the first course of your English studies.

Recommended or required reading:

Course materials will be provided by the teacher in electronic form.

Assessment methods and criteria:

The course utilises continuous assessment that is based on the learning outcomes of the course, including full and active participation in class, and the successful completion of module assignments and class presentations.
Lue lisää opintosuoritusten arvostelusta yliopiston verkkosivulta.

Grading:

pass / fail

Person responsible:

Each engineering programme has its own Languages and Communication contact teacher for questions about English studies.

Working life cooperation:

-

Other information:

-

902142Y: Business Correspondence, 2 op

Voimassaolo: 01.08.2014 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Proficiency level:

CEFR B2 - C1 (All Levels)

Status:

This course can be chosen in partial completion of the English language requirement for students in the engineering programmes in the Faculty of Technology (TTK) and Faculty of Information Technology and Electrical Engineering (TST).

Required proficiency level:

English must have been the A1 or A2 language at school or equivalent English skills acquired otherwise. If you need to take English, but lack this background, please get in touch with the Languages and Communication contact teacher for your department to discuss individual solutions.

ECTS Credits:

2 credits. The workload is 53 hours

Language of instruction:

English

Timing:

The course takes place in both autumn (periods 1 and 2) and spring (periods 3 and 4) semesters. Check the study guide for availability in your department.

Learning outcomes:

By the end of the course, you are expected to have demonstrated:

- the ability to write clear and effective business letters conveying information and details accurately,
- the ability to use an appropriate level of formality and style for business communications,

- mastery of the conventional formats and layouts of different types of business letters.

Contents:

The aim of this course is to introduce different types of business correspondence and the format used when communicating in writing. Types of correspondence include communication in business-to-business scenarios and between a business and the public.

Mode of delivery:

Self-access: the course operates within an online workspace, with online support from the teacher.

Learning activities and teaching methods:

Introductory session 2 hours / independent learning 51 hrs / optional text clinics. Assignments, instructions and course resources are available in the online course workspace. Completed assignments are submitted electronically to the teacher. The teacher provides feedback and any problems are discussed either by written electronic communication or at one of the optional text clinics.

Target group:

Students in the engineering programmes (TTK and TST)

Prerequisites and co-requisites:

-

Recommended optional programme components:

This is an elective course which can be taken after 902150Y PET by students in the engineering programmes (TTK and TST).

Recommended or required reading:

Course materials are provided in an electronic form that can be downloaded.

Assessment methods and criteria:

All assignments must be completed to a standard of effective business correspondence based on the learning outcomes of the course. In addition, there is a test at the end of the course.
Lue lisää opintosuoritusten arvostelusta yliopiston verkkosivulta.

Grading:

Pass/Fail

Person responsible:

Susan McAnsh

Working life cooperation:

-

Other information:

-

902145Y: Working Life Skills, 2 op

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Proficiency level:

CEFR B2 - C1
(Alla levels)

Status:

This course can be chosen in partial completion of the English language requirement for students in the engineering programmes in the Faculty of Technology (TTK) and Faculty of Information Technology and Electrical Engineering (TST).

Required proficiency level:

English must have been the A1 or A2 language at school or equivalent English skills acquired otherwise. If you need to take English, but lack this background, please get in touch with the Languages and Communication teachers for your department to discuss individual solutions.

ECTS Credits:

2 ECTS credits. The workload is 53 hours.

Language of instruction:

English

Timing:

The course takes place in both autumn (periods 1 and 2) and spring (periods 3 and 4) semesters. Check the study guide for availability in your department.

Learning outcomes:

By the end of the course, you are expected to

1. have demonstrated a good basic vocabulary related to job applications, meetings and negotiations,
2. have demonstrated an ability to create an effective CV and cover letter for a job application,
3. be able to communicate effectively and with a reasonable degree of fluency at job interviews and in meeting and negotiation contexts.

Contents:

The aim of this course is to help you to develop the English language skills needed to deal with situations related to everyday working life. The course focuses on four basic areas:
i) business communication
ii) social and cultural aspects of English in working life situations,
iii) applying for a job,
iv) a general introduction to the language of meetings and negotiations.

Mode of delivery:

Contact teaching and independent study

Learning activities and teaching methods:

Lessons 26 hours / independent work 27 hours. Active participation is essential. The course includes regular pair and group work in class and independent homework activities.

Target group:

Students in the engineering programmes (TTK and TST).

Prerequisites and co-requisites:

-

Recommended optional programme components:

This is an elective course which can be taken after 902150Y PET by students in the engineering programmes (TTK and TST).

Recommended or required reading:

Course materials will be provided by the teacher in electronic form.

Assessment methods and criteria:

The course utilises continuous assessment that is based on the learning outcomes of the course. In addition, full and active participation is required, course assignments must be completed, and students must achieve a grade of 70% in two tests during the course. Students will be asked to take an end-of course exam if they have not otherwise demonstrated that they have achieved the learning outcomes by the end of the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/fail

Person responsible:

Susan McAnsh

Working life cooperation:

-

Other information:

See contact teachers, https://www.oulu.fi/kielikoulutus/node/56574.)

902147Y: Academic Vocabulary for Science and Technology, 2 op

Opiskelumuoto: Language and Communication Studies
Laji: Course
Vastuuyksikkö: Languages and Communication
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

Proficiency level:

CEFR Level: B2-C1 (All levels)

Status:

This course can be chosen in partial completion of the English language requirement for students in the engineering programmes in the Faculty of Technology (TTK) and Faculty of Information Technology and Electrical Engineering (TST).

Required proficiency level:

English must have been the A1 or A2 language at school or equivalent English skills acquired otherwise. If you need to take English, but lack this background, please get in touch with the Languages and Communication contact teacher for your department to discuss individual solutions.

ECTS Credits:

2 ECTS credits. The workload is 53 hours.

Language of instruction:

English

Timing:

The course takes place in both autumn (periods 1 and 2) and spring (periods 3 and 4) semesters. Check the study guide for availability in your department.

Learning outcomes:

By the end of the course, you are expected to
1) explain and apply general academic / scientific vocabulary from Coxhead's Academic Word List (AWL)
2) differentiate between informal (non-academic) and formal / academic language,
3) demonstrate use of academic vocabulary in a variety of writing and communication contexts.

Contents:

The general aim of this course is to activate and broaden your basic scientific vocabulary, i.e. the core vocabulary of scientific texts, which is principally the same regardless of the field (AWL). During this process, you will become aware of the strategies which best promote your skills to learn and memorise vocabulary. The ultimate aim is to help you gain the skills to read and write academic / scientific text and to discuss related topics. To help you achieve the learning outcomes, you will work on various written and oral activities which focus primarily on practicing vocabulary learning strategies, word formation, and the use of the most frequent academic vocabulary (AWL sublists).

Mode of delivery:

Contact teaching and independent study

Learning activities and teaching methods:

Lessons 26 hours / independent work 27 hours. The independent work includes a written academic essay or report; vocabulary tests; presentations, which will be given in class to small groups of students; and other homework assignments. Active participation is essential.

Target group:

Students in the engineering programmes (TTK and TST)

Prerequisites and co-requisites:

-

Recommended optional programme components:

This is an elective course which can be taken after 902150Y PET by students in the engineering programmes (TTK and TST).

Recommended or required reading:

Course materials will be provided by the teacher in electronic form.

Assessment methods and criteria:

Regular and active participation in the weekly sessions will be observed in continuous assessment that is based on the learning outcomes of the course. Satisfactory completion of the in-class/ homework assignments and the vocabulary tests is required.
See more about assessment criteria, https://www.oulu.fi/forstudents/assesment-criteria.

Grading:

Pass/Fail

Person responsible:

Susan McAnsh. See contact teachers, https://www.oulu.fi/kielikoulutus/node/56574.

Working life cooperation:

-

Other information:

-

902149Y: Mechanics of Writing, 2 op

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Proficiency level:

CEFR B2-C1 (Average - Advanced)

Status:

This course can be chosen in partial completion of the English language requirement for students in the engineering programmes in the Faculty of Technology (TTK) and Faculty of Information Technology and Electrical Engineering (TST).

Required proficiency level:

English must have been the A1 or A2 language at school or equivalent English skills acquired otherwise. If you need to take English, but lack this background, please get in touch with the Languages and Communication contact teacher for your department to discuss individual solutions.

ECTS Credits:

2 credits. The workload is 53 hours.

Language of instruction:

English

Timing:

The course takes place in both autumn (periods 1 and 2) and spring (periods 3 and 4) semesters.

Learning outcomes:

By the end of the course, you will be able to demonstrate that

1. you can organise the structure of sentences and paragraphs for clarity and impact,
2. you can use punctuation appropriately,
3. you can make appropriate stylistic choices in academic writing.

Contents:

The purpose of this course is to help you develop essential writing skills for the production of academic and professional texts in technology.
The module covers three main topics: ordering information in sentences, punctuation and sentence style. During the module, you work independently, studying online handouts and consolidating your learning by working through online exercises.

Mode of delivery:

Web-supported independent study

Learning activities and teaching methods:

This module is completed through independent study of online resources (online handouts and exercises). An online tutor is available to answer questions and give guidance whenever necessary.

Target group:

Students in the engineering programmes (TTK and TST). Especially recommended for students with M or higher for English in matriculation exam.

Prerequisites and co-requisites:

-

Recommended optional programme components:

This is an elective course which can be taken after 902150Y PET by students in the engineering programmes (TTK and TST).

Recommended or required reading:

Course materials are available online.

Assessment methods and criteria:

The module is assessed by a final test, which can be taken on any of three test dates (approximately a month apart) each term in a classroom on the Linnanmaa campus.
Lue lisää opintosuoritusten arvostelusta yliopiston verkkosivulta.

Grading:

Pass/Fail

Person responsible:

Susan McAnsh - See contact teachers

Working life cooperation:

-

Other information:

The course will be organized by online tutoring.
You can enroll for the exam only if you have been accepted for the MoW course during this semester (so enroll first) or in the last two years (do not re-enroll).
You cannot take the exam without registering.
Acceptance information for the course will be sent to your university email address, so make sure your university email address is up to date in WebOodi.
Please, contact the teacher directly if you have any questions about the exam or any other subject related to the course.
Note! Registration for each test separately -> Exams begin on the hour and last 120 minutes.

903024Y: Elementary Course in German 1, 3 - 4 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay903024Y	Elementary Course in German 1 (OPEN UNI)	4.0 op

Proficiency level:

CEFR, A1.

Status:

The course is optional and it may be included in your faculty's Language, Cultural and Communication Studies (KieKuVi) or in other optional studies.

Required proficiency level:

Elementary Course in German 1 requires no previous German studies. This course unit is also intended for those students who have studied German before, in school or during secondary education, but a long time has passed since the previous studies.

ECTS Credits:

3 - 4 credits / 80 - 106 h of student's work

Language of instruction:

Finnish and German

Timing:

The course unit is held every semester. There are three teaching groups in the autumn semester and two in the spring.
The course lasts for one semester.

Learning outcomes:

Upon completion of the course unit the student should be able to communicate by using simple phrases in everyday language use situations both orally and in writing. The student should also know some basic information about German-speaking countries and their customs.

Contents:

The main body of the course unit consists of essential grammatical structures and vocabulary and various listening, reading, writing, discussion and pronunciation exercises. The course unit aims to help you develop your German communication skills and introduce you to the cultures of the German-speaking countries. Both everyday communication needs and professional life have been taken into account when choosing the topics to be discussed during the course unit.

Topics covered by the course unit include German-speaking countries, customs, holidays, talking about oneself, one's family and one's studies, standard professional vocabulary, one's own interests and hobbies, asking for and giving directions, making appointments, scheduling, inquiring about services, receiving services and restaurant and travelling situations.
Grammatical structures covered include verbs in the present tense, separable-prefix verbs, nominative and accusative forms of nouns, personal pronouns and possessive pronouns, accusative prepositions, conjunctions and word order in main clauses and interrogative sentences.

Mode of delivery:

Contact teaching. More detailed information in the beginning of the course.

Learning activities and teaching methods:

Contact teaching 2 times 90 min. / week , independent study
80 h of work for 3 credits
106 h of work for 4 credits

Target group:

Students in all faculties. This course is not offered in English. It is only Finnish-speaking students.
Students of the Oulu University of Applied Sciences (OAMK) students. The quota principle is as follows: at least two OAMK students in a course and if there are more places, they are filled according to the queuing principle.
See more information https://www.oulu.fi/forstudents/crossinstitutionalstudy.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Freut mich 1 (Otava). Authors: Anja Blanco and Pauli Kudel. Chapters 1-7. Also additional study material prepared by the teacher.

Assessment methods and criteria:

Continuous assesment, 2 exams. Regular and active participation, homework assignments and tests.
Students will get feedback during the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1 - 5 scale

Person responsible:

Kaisu Jarde and Marja Pohjola-Effe

Working life cooperation:

-

Other information:

The course with this code will be available last time in 2020-2021.
Registration in WebOodi. If the registration has closed the student can sign up by contacting the teacher by e-mail.

903025Y: Elementary Course in German 2, 3 - 4 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay903025Y	Elementary Course in German II (OPEN UNI)	4.0 op

Proficiency level:

CEFR levels A1 and A2.

Status:

The course is elective and it may be included in your faculty's Language, Cultural and Communication Studies (the KieKuVi module) or in other optional studies.

Required proficiency level:

Completion of Elementary Course in German 1 or A1 proficiency level (CEFR). This course unit is also intended for those students who have studied German before, in school or during secondary education, but a long time has passed since the previous studies.

ECTS Credits:

3 - 4 ECTS credits / 80 - 106 h of student's work.

Language of instruction:

Finnish and German

Timing:

The couse unit is held every semester. There are two teaching groups in the autumn semester and three in spiring. The course unit lasts for one semester.

Learning outcomes:

Upon completion of the course unit the student should be able to communicate by using simple phrases in everyday language use situations both orally and in writing. The student should also know some basic information about German-speaking countries and their customs.

Contents:

The main body of the course unit consists of essential grammatical structures and vocabulary and various listening, reading, writing, discussion and pronunciation exercises. The course unit aims to help you develop your German communication skills and introduce you to the cultures of the German-speaking countries.
Both everyday communication needs and professional life have been taken into account when choosing the topics to be discussed during the course unit. Topics covered by the course unit include shopping and talking about one's home country.
Grammatical structures covered include present tense, perfect tense, accusative and dative, possessive pronouns, dative prepositions, the so called "dual" prepositions (accusative and dative forms), imperative form, conditional form, ordinal numerals, dates, units of time, conjunctions and word order of main clauses

and subordinate clauses. The course unit allows the student to brush-up on the grammar learned during Elementary Course 1.

Mode of delivery:

Contact teaching. More detailed information in the beginning of the course.

Learning activities and teaching methods:

Contact teaching 2 times 90 min / week, independent study
80 h of work for 3 credits
106 h of work for 4 credits.

Target group:

Students in all faculties.

Students of the Oulu University of Applied Sciences (OAMK) students and OAMK's international and exchange students may also participate to this cross-institutional study. The quota principle is as follows: at least two OAMK students in a course and if there are more places, they are filled according to the queuing principle.

See more information https://www.oulu.fi/forstudents/crossinstitutionalstudy.

Prerequisites and co-requisites:

See Required proficiency level

Recommended optional programme components:

-

Recommended or required reading:

Freut mich 1 (Otava). Tekijät: Anja Blanco ja Pauli Kudel. Chapters 8-12. Also additional study material prepared by the teacher.

Assessment methods and criteria:

Continuous assessment, 2 exams. Regular and active participation, homework assignments and tests
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5 / fail

Person responsible:

Kaisu Jarde and Marja Pohjola-Effe

Working life cooperation:

-

Other information:

The course with this code will be available last time in 2020-2021.

Registration in WebOodi or Tuudo. If registration has closed the student can sign up contacting the teacher by email.

903029Y: Intermediate Course in German 1, 3 - 4 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: German

Proficiency level:

CEFR level A2/B1

Status:

The course is optional. It can be approved as a partial completion of the course unit 903010P Technical German 1. This partial completion is worth 3 ECTS credits.

Required proficiency level:

3 years of German studies during secondary education or equivalent knowledge. 903024Y Elementary Course in German 1 & 903025Y Elementary Course in German 2.

ECTS Credits:

3 - 4 ECTS credits / 80 - 106 h of students's work.

Language of instruction:

German

Timing:

The course is held in autumn term (2 groups). Please note: Intermediate Course in German 2 and Intermediate Course in German 1 can be studied in a way that first Course 2 can be taken in spring term and after that Course 1 in autumn term.

Learning outcomes:

The aim of the course is to develop the student's language skills in different areas. Upon completion of the course unit the student should be able to communicate in situations where familiar everyday topics are discussed. He/she should be able to understand relatively simple texts, express his/her opinions and manage in short dialogues. The student should be able to recognise some differences and similarities between Finnish and German-speaking cultures. He/she should be able to communicate in various everyday situations while taking into account the distinctive cultural features of the German-speaking country in question.

Contents:

Discussion exercises, grammar exercises and listening and reading comprehension exercises. Topics covered by the course include family, daily routines, free time, studies, working life and German-speaking countries and their cultures.

Mode of delivery:

Contact teaching. More detailed information in the beginning of the course.

Learning activities and teaching methods:

Contact teaching 2 times 90 min. / week , independent study
80 h of work for 3 credits
106 h of work for 4 credits

Target group:

Students in all faculties.

Students of the Oulu University of Applied Sciences (OAMK) students and OAMK's international and exchange students may also participate to this cross-institutional study. The quota principle is as follows: at least two OAMK students in a course and if there are more places, they are filled according to the queuing principle.

See more information https://www.oulu.fi/forstudents/crossinstitutionalstudy

Prerequisites and co-requisites:

See Required proficiency requirement

Recommended optional programme components:

-

Recommended or required reading:

Material prepared by the teacher.

Assessment methods and criteria:

Regular and active participation, homework assignments and tests. Continuous assesment.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Scale 1 - 5 or pass / fail

Person responsible:

Oliver Jarde

Working life cooperation:

-

Other information:

The course with this code will be available last time in 2020-2021.

Registration in WebOodi or in Tuudo. If the registration has closed the student can sign up by contacting the teacher by e-mail.

903030Y: Intermediate Course in German 2, 3 - 4 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: German

Proficiency level:

CEFR scale A2/B1

Status:

The course is optional and it may be included in your faculty's Language, Cultural and Communication Studies (KieKuVi) or in Other Studies. It may also be included as a partial 3 credit course in the Technical German 1 or 3.

Required proficiency level:

3 years of German studies during secondary education or equivalent knowledge. 903024Y Elementary Course in German 1 & 903025Y Elementary Course in German 2.

ECTS Credits:

3 - 4 ECTS credits / 80 - 106 h of work for the student.

Language of instruction:

German, Finnish and English. Students are using German in Exams etc.

Timing:

The course is held in spring term. Please note: Intermediate Course in German 2 and Intermediate Course in German 1 can be studied in a way that first Course 2 can be taken in Spring term and after that Course 1 in Autumn term.

Learning outcomes:

The aim of the course is to develop the student's language skills in different areas: improve the student's oral and written capabilities, develop his/her listening comprehension and broaden his/her vocabulary. Upon completion of the course the student should be able to manage in everyday communication situations and express and justify his/her opinions. He/she should be able to understand texts about familiar topics written in standard language and produce coherent text on topics and themes interesting to him/her.

Contents:

Grammar exercises, reading and listening comprehension exercises and writing exercises relating to work and study-related situations, small talk, politeness and German-speaking countries.

Mode of delivery:

Contact teaching. More detailed information in the beginning of the course.

Learning activities and teaching methods:

Contact teaching 2 times 90 min. / week , independent study
80 h of work for 3 credits
106 h of work for 4 credits

Target group:

Students in all faculties.

Students of the Oulu University of Applied Sciences (OAMK) students and OAMK's international and exchange students may also participate to this cross-institutional study. The quota principle is as follows: at least two OAMK students in a course and if there are more places, they are filled according to the queuing principle.

See more information https://www.oulu.fi/forstudents/crossinstitutionalstudy.

Prerequisites and co-requisites:

See Required proficiency level

Recommended or required reading:

Material prepared by the teacher.

Assessment methods and criteria:

Regular and active participation, homework assignments and tests. Continuous assesment.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Scale 1 - 5 or pass / fail

Person responsible:

Oliver Jarde

Working life cooperation:

-

Other information:

The course with this code will be available last time in 2020-2021.
Registration in WebOodi or Tuudo. If the registration has closed the student can sign up by contacting the teacher by e-mail.

Compulsory to all

521007P: Orientation to Electronics and Communications Engineering, 3 op

Voimassaolo: 01.08.2020 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Hannu, Timo Kokkonen

Opintokohteen kielet: Finnish

031010P: Calculus I, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Pauliina Uusitalo

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031010P	Calculus I (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish. The course will be lectured also in English.

Timing:

Fall, period 1

Learning outcomes:

Upon completion of the course, the student
- knows how to solve inequalities and equations with absolute value

- identifies the concepts of vector algebra
- can use vector algebra for solving the problems of analytic geometry
- can explain basic characteristics of elementary functions
- is able to analyse the limit and the continuity of the real valued functions of one variable
- can analyse the local minima and maxima of a function
- knows how to find the derivative for a function given with parametric representation
- is able to evaluate the basic calculation of the complex numbers and can rewrite a complex number in its exponential form
- knows the connection between the integral and area
- knows integral techniques such as integration by parts, a substitution method and a partial fraction composition
- can solve problems associated with the differential and integral calculus of the real valued functions of one variable.

Contents:

- Inequalities and absolute value
- Vector algebra and analytic geometry
- Concept of the function and elementary functions
- Monotonicity of the function, the inverse function
- Limit values
- Derivative as limit value of the difference quotient. Derivatives of elementary functions
- The extreme values of a function
- Parameter presentation of the curve, polar coordinates, complex numbers
- Integral function and definite integral, applications
- Integration by parts, substitution method and integration of rational functions

Mode of delivery:

Blended learning, course material is in Moodle learning environment

Learning activities and teaching methods:

Lectures 28 h / Group work 22 h / Self-study 85 h

Target group:

1. year students of technical sciences, mathematics and physics

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Grossman, S.I.: Calculus of One Variable; Grossman, S.I.: Multivariable Calculus, Linear Algebra, and Differential Equations (partly); Adams, R.A.: A Complete Course Calculus (partly)

Assessment methods and criteria:

The course is completed with mid-term exams or a final exam. When completed with mid-term exams, exercise assignments are part of the continuous assessment. The assessment of the course is based on the learning outcomes of the course. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pauliina Uusitalo

Working life cooperation:

The course does not contain working live cooperation.

Other information:

-

521077P: Introduction to Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Hannu

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521077P	Introduction to Electronics (OPEN UNI)	5.0 op
521209A	Electronics Components and Materials	2.0 op

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the 1st period. It is recommended to complete the course at the 1st autumn semester.

Learning outcomes:

1. Student understands the block structures of electronic devices and their signal processing paths.

2. Student can identify the interfaces of analog and digital electronics and the software operations.

3. Student is able to identify and classify electronics components and compare their properties.

4. Students can describe electric conductivity and apply the phenomenon on designing and choosing resistors

5. Student is able to estimate the difference between dielectric materials and how they affect the properties of a capacitor.

6. Student can compare properties of magnetic materials and how identify they effect on inductive components.

7. Student can identify semiconductivity and is able to list typical semiconductor components.

8. Student can classify different circuit board techniques and is able to choose proper coupling techniques.

9. Student can identify the future technologies of electronics materials.

Contents:

Structures and interfaces of electronic devices. Electromagnetic properties of materials (conductivity, dielectricity, magnetism and semiconductivity).Electronics components (resistors, capacitors, inductive components and semiconductors). Interconnection technologies and circuit board technologies. The future of electronic materials and application areas.

Mode of delivery:

Face-to-face teaching and independent work.

Learning activities and teaching methods:

The implementation methods of the course vary. The course will be arranged utilizing activating teaching methods agreed on together with the students. There will be 48 hours of guided teaching events and 84.5 hours of teaching without guidance either privately or in a group.

Target group:

First year electrical engineering students.

Prerequisites and co-requisites:

No prerequisites.

Recommended optional programme components:

-

Recommended or required reading:

Lecture material; Materials science and engineering: an introduction / Willam D. Callister, chapters 1, 18 and 20; Electronic components and technology / S. J. Sangwine. Chapters 1,2,3,5 and 7

Assessment methods and criteria:

This course utilizes continuous assessment. During the course, there are two intermediate exams. In addition students will make course work which are graded. The assessment of the course is based on the learning outcomes of the course. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Jari Hannu

Working life cooperation:

No

Other information:

-

521109A: Electrical Measurement Principles, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Christian Schuss

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 136h

Language of instruction:

Course is lectured in Finnish. Lecture notes are available in English. Laboratory exercises and the exam can be done in English.

Timing:

Periods 1-2.

Learning outcomes:

1. is able to measure basic measurements with a multimeter,

2. is able to measure basic measurements with an oscilloscope,

3. is able to operate signal and function generators.

4. is able to estimate the validity of their measurements.

Contents:

Units of measures, standards of measures, analysis of errors, most commonly used analog and digital measuring methods, equipment and electrical safety regulations.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 20h, laboratory exercises 16 h and self-study 100h.

Target group:

Course is compulsory for electrical engineering, information engineering and wellness technology students. Course is open for all students in University of Oulu.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

None.

Recommended or required reading:

Course material is in English and Finnish and can be found in Optima.

Assessment methods and criteria:

Exam and passed lab exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Grade is based on exam and grade is on numerical scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

None.

Other information:

-

521141P: Elementary Programming, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Mika Oja
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay521141P	Elementary Programming (OPEN UNI)	5.0 op

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 ECTS Cr

Language of instruction:

Lectures and learning material are in Finnish. The course is not available English.

Timing:

Fall, periods 1-2.

Learning outcomes:

1. Is capable of solving problems in the computer's terms

2. Understands the basic concepts of programming

3. Knows the basics of the Python programming language

4. Is able to implement programs independently

5. Is able to use the internet to find information about programming

Contents:

Problem solving with programming, basic concepts of programming, writing Python code.

Mode of delivery:

Web-based teaching + face-to-face teaching

Learning activities and teaching methods:

30h of exercise groups, 105h self-studying in the web.

Target group:

1 st year students of computer science and engineering, electrical engineering, medical and wellness technology and industrial and engineering management, 2nd year students of physics, and other students of the University of Oulu

Prerequisites and co-requisites:

None.

Recommended optional programme components:

The course provides a basis for subsequent programming courses.

Recommended or required reading:

Web material in an online learning environment. Address will be announced at the beginning of the course.

Assessment methods and criteria:

The course is completed by passing all learning assignments, programming exercises and a final exercise project. Read more about assessment criteria at the University of Oulu webpage
Read more about assessment criteria at the University of Oulu webpage.

Grading:

pass/fail.

Person responsible:

Mika Oja

Working life cooperation:

-

Other information:

The course learning platform is Lovelace (lovelace.oulu.fi)

031078P: Matrix Algebra, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Peltola

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031078P	Matrix Algebra (OPEN UNI)	5.0 op
031019P	Matrix Algebra	3.5 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the autumn, during period 2. It is recommended to complete the course at the 1th autumn semester.

Learning outcomes:

The student is able to apply arithmetic operations of matrices and can solve system of linear equations by matrix methods and can apply matrix factorizations to find the solution of the system of linear equations. The student is able to recognize the vector space and understands the concepts of basis and dimension of a vector space and can analyse matrices by the parameters, vectors and vector spaces of matrices. He /She knows how to calculate determinant, eigenvalues and eigenvectors of a square matrix, and is able to diagonalize matrices and apply diagonalization to the simple problems.

Contents:

1. Vectors and matrices 2. Systems of linear equations. 3. Matrix factorizations. 4. Vector spaces. 5. The rank, nullity, row space and the column space of a matrix. 6. The determinant of a matrix. 7. Eigenvalues and eigenvectors of a matrix. 8. The diagonalization with applications.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 22 h / Self-study 85 h.

Target group:

1. year students of technical sciences, mathematics and physics.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Recommented literature: Grossman, S.I: Elementary Linear Algebra; David C. Lay: Linear Algebra and Its Applications.

Assessment methods and criteria:

The course can be completed by intermediate exams (2 exams) or by a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail

Person responsible:

Matti Peltola

Working life cooperation:

-

Other information:

-

031075P: Calculus II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Pauliina Uusitalo

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031075P Calculus II (OPEN UNI) 5.0 op
031011P Calculus II 6.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish. The course can be completed in English by intermediate exams or by a final exam.

Timing:

Spring semester, period 3

Learning outcomes:

Upon completion of the course, the student is able to examine the convergence of series and power series of real terms, can explain the use of power series e.g. in calculating limits, is able to solve problems related to differential and integral calculus of real and vector valued functions of several variables.

Contents:

Sequences, series, power series and Fourier series of real terms. Differential and integral calculus of real and vector valued functions of several variables.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 22 h / Self-study 85 h.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the course 031010P Calculus I.

Recommended optional programme components:

-

Recommended or required reading:

Kreyszig, E: Advanced Engineering Mathematics; Grossman S.I.: Multivariable Calculus, Linear Algebra, and Differential Equations; Adams, R.A.: A Complete Course Calculus.

Assessment methods and criteria:

Intermediate exams or a final exam. The exams are remote exams. It is possibility to take exams also at the university.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pauliina Uusitalo

Working life cooperation:

-

Other information:

-

031021P: Probability and Mathematical Statistics, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Kemppainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031021P	Probability and Mathematical Statistics (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish

Timing:

Spring semester, period 3

Learning outcomes:

After completing the course the student

1. knows the key concepts of probability and the most important random variables,
2. will be able to use them in calculating probabilities and parameters of probability distributions,

3. is capable of analyzing statistical data by calculating interval and point estimates for the parameters,
4. will be able to formulate statistical hypotheses and test them,
5. knows the basics of linear regression.

Contents:

The key concepts of probability, random variable, parameters of probability distributions, estimation of parameters, hypothesis testing, regression analysis.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

Lectures 28 h/Exercises 20 h/Self study 87 h.

Target group:

The students in the engineering sciences. Other students are welcome, too.

Prerequisites and co-requisites:

The recommended prerequisities are the course 031010P Calculus I and some parts of the course 031075P Calculus II.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Milton, J.S., Arnold, J.C. (1992): Introduction to Probability and Statistics.

Assessment methods and criteria:

Intermediate exams or a final exam. The exams are remote exams. It is possibility to take exams also at the university.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Jukka Kemppainen

Working life cooperation:

-

521301A: Digital Techniques 1, 8 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

Leikkaavuudet:

521412A-02	Digital Techniques 1, Exercise Work	0.0 op
521412A	Digital Techniques 1	6.0 op
521412A-01	Digital Techniques, Exam	0.0 op

ECTS Credits:

8

Language of instruction:

Finnish

Timing:

Periods 3-4

Learning outcomes:

1. After the course, students are able to ably binary number system and Boolean algebra in the form of switching algebra to the design and functional analyze of simple digital circuits.
2. In addition, they are also able to use in their designs graphical symbols specified in the dependency notation standard (SFS4612 ja IEEE/ANSI Std.91-1991) and different descriptions of function and structure of state machines.
3. Based on this knowledge, students are able to implement and analyze digital devices consisting of ordinary simple digital components.
4. After having assimilated the basic knowledge of digital technique, students are able to understand also the function and structure of micro controllers and micro processors.

Contents:

The principles of digital devices, Boolean algebra, numeral systems, operating principle, analysis and synthesis of combinational logic, flip-flops, operating principle, analysis and synthesis of sequential logic (state machines), physical characteristics of CMOS technology, registers and register transfers, computer memory, instruction set architecture, computer design basics, interfaces and data transmission.

Mode of delivery:

Classroom

Learning activities and teaching methods:

Lessons 40 h, weekly home assignments.

Target group:

Primarily 1st year electrical engineering and computer science and engineering BSc students. The course can be taken by the students of the university of Oulu.

Prerequisites and co-requisites:

-

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Text books, MIT OpenCourseWare and execise literature.

Assessment methods and criteria:

Project work and home assignments
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Project work and home assignments are assessed on numerical scale 1-5. The average of project work and home assignments will be the final grade.

Person responsible:

Antti Mäntyniemi

Working life cooperation:

-

Other information:

-

031076P: Differential Equations, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031076P	Differential Equations (OPEN UNI)	5.0 op

800320A	Differential equations	5.0 op
031017P	Differential Equations	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring, during period 4. It is recommended to complete the course at the 1th spring semester.

Learning outcomes:

The students can apply differential equations as a mathematical model. They can identify and solve various differential equations and they have knowledge on basic solvability of differential equations. The student can use the Laplace transform as a solution method.

Contents:

Ordinary differential equations of first and higher order.
Laplace transform with applications to differential equations.

Mode of delivery:

Online teaching, Stack/Moodle digital learning environment

Learning activities and teaching methods:

Lectures 28 h / Group work 22 h / Self-study 85 h.

Target group:

1. year students of engineering, mathematics and physics.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the course Calculus I.

Recommended optional programme components:

-

Recommended or required reading:

Recommended literature: Kreyszig, E: Advanced Engineering Mathematics;

Assessment methods and criteria:

The course can be completed by intermediate exams (2 exams) or by a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Keijo Ruotsalainen

Working life cooperation:

No

521150A: Introduction to Internet, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Harjula

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

All materials are in English, lectures are given in Finnish.

Timing:

Spring, period 4.

Learning outcomes:

Upon completion of this course, students know and understand the basic concepts, know the key terminology and can write clearly with justifications about the following key areas of the course, which are:

1. The design principles of the Internet, its architecture, functionality and challenges
2. The role of the data link layer and the most important access network technologies
3. The structure and the most important protocols of the TCP/IP protocol stack
4. The most important internet applications and their protocols
5. The basic principles of internet security and multimedia applications

Additionally, students who have attained grades 2 or 3 have demonstrated satisfactory capability to perform practical software implementation work and/or solving Internet-related problems relevant to most centric course key areas. Students who have attained grades 4 or 5 have demonstrated solid capability to perform practical software implementation work and analytical skills for solving technical and research problems relevant to the course key areas.

Contents:

The design principles and architecture of the Internet, data link layer and most important access network technologies, TCP/IP protocol stack and its most important protocols, most important Internet applications, principles of Internet security and multimedia, internet's challenges and Future Internet.

Mode of delivery:

Remote teaching.

Learning activities and teaching methods:

Remote teaching: Lectures 32h, exercices 16h, laboratory exercises 12h, course work 25h, independent work 48h. Work is done in groups or independently.
Details of arrangement can be found from the course web page in Moodle: https://moodle.oulu.fi/course/view.php?id=4029

Target group:

Communications Engineering, Computer Science and Engineering students, Information Processing Science students, other students of the University of Oulu.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

None.

Recommended or required reading:

Announced at the beginning of the course.

Assessment methods and criteria:

Passing the course requires mastery of the essential core content of the course. Continuous assessment and exams are provided for students to show that they have attained this level. Higher grades are attained by participating in and completing, either alone or in groups, to non-mandatory exercises and exams on advanced course topics. More detailed information on assessment is published yearly in the lecture material.

Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

D.Sc. Erkki Harjula

Working life cooperation:

None.

031077P: Complex analysis, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Applied Mathematics and Computational Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Jukka Kemppainen
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay031077P	Complex analysis (OPEN UNI)	5.0 op
031018P	Complex Analysis	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish

Timing:

Fall semester, period 1.

Learning outcomes:

After completing the course the student

1. is able to calculate the derivative and the integral of functions of complex variable,
2. understands the concept of analyticity
3. is capable of calculating the contour integrals and using the theory of residues for computing the line integrals, will be able to apply the techniques of complex analysis to simple problems in signal processing.

Contents:

Complex numbers and functions, complex derivative and analyticity, complex series, Cauchy's integral theorem, Laurent and Taylor expansions, theory of residues, applications to signal analysis.

Mode of delivery:

Face-toface teaching, Stack(web-based too) exercises.

Learning activities and teaching methods:

Lectures 28 h/Exercises 14 h/Self study 93 h.

Target group:

The students in the engineering sciences. The other students are welcome, too.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses Calculus I and II, Differential Equations.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

The lecture notes

Assessment methods and criteria:

Intermediate exams or a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Jukka Kemppainen

Working life cooperation:

-

521302A: Circuit Theory 1, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Rahkonen, Timo Erkki
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish. Exams can be arranged in English on demand.

Timing:

Spring, period 4

Learning outcomes:

After the course the student can

1. write and solve the equations describing the operation of a given electrical circuit

2. solve the sinusoidal steady-state solution using complex phasor arithmetics

3. solve time responses of electric circuits

4. simplify electrical circuits e.g. using equivalent circuits

5. simulate simple circuits and choose an appropriate circuit simulation method

Contents:

Equation of basic circuit elements, circuit laws and systematic building of network equations. Calculation of time and frequency responses. Use of complex phasor arithmetics. Basics of the use of circuit simulators.

Mode of delivery:

Classroom.

Learning activities and teaching methods:

30h lectures, 22h exercises, and a simulation exercise.

Target group:

Finnish BSc students.

Prerequisites and co-requisites:

Matrix algebra, complex arithmetics, differential equations.

Recommended optional programme components:

Background to all analog electronics cources.

Recommended or required reading:

Nilsson, Riedel: Electric Circuits (6th or 7th ed., Prentice-Hall 1996), Chapters 1-11.

Assessment methods and criteria:

Final exam. Also the simulation exercise must be passed
Read more about assessment criteria at the University of Oulu webpage..

Grading:

1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

Other information:

-

521287A: Introduction to Computer Systems, 5 op

Voimassaolo: 01.08.2016 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Teemu Leppänen
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay521287A	Introduction to Computer Systems (OPEN UNI)	5.0 op
521142A	Embedded Systems Programming	5.0 op

ECTS Credits:

5

Language of instruction:

Lecturing in Finnish, course and exercise material available in English.

Timing:

Autumn, periods 1-2.

Learning outcomes:

Upon completing the course, the student understands the basics of computer architecture and CPU operation.
Student knows number systems and data representations in computer.
Student is familiar of I/O operation with peripheral devices.
Student is able to implement small programs with the C programming language for workstations and embedded systems.
Student recognizes how embedded systems programming is different from programming general-purpose computers.

Contents:

Overview of computer architecture and CPU, data types and memory management, interrupts, registers and I/O, general computer and embedded systems programming, basics of the C programming language.

Mode of delivery:

Web-based teaching + face-to-face teaching.

Learning activities and teaching methods:

Lectures (20h), course exercises (10-20h), laboratory exercise (3h) and course project in a group.

Target group:

Students of the University of Oulu

Prerequisites and co-requisites:

Elementary Programming 521141P

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes and exercise material are available in the course website.
For English speaking students, either of the following material may be useful:
Patterson & Hennessy, Computer Organization and Design: The Hardware/Software Interface, 5th Edition, Chapter 1.
Bryant & O'Hallaron, Computer Systems: A Programmer's Perspective, 3rd Edition, Chapter 1.
Patterson & Hennessy, Computer Organization and Design, 5th Edition: The Hardware/Software Interface, 2014.
Bryant & O'Hallaron, Computer Systems: A Programmer's Perspective, 2016.

Assessment methods and criteria:

The assessment criteria is based on the learning outcomes of the course. Students complete the course exercises, participate to the laboratory exercise and complete the course project in a group. Assessment is based on the exercises and the course project. More detailed information on assessment is published in the lecture material.

Grading:

Numerical grading scale 1-5, zero stands for fail.

Person responsible:

Teemu Leppänen

Working life cooperation:

Visiting lectures with experts from local industry are possible.

Other information:

The course learning platform is Lovelace (lovelace.oulu.fi)
This course replaces the course 521142A Embedded systems programming.

031080A: Signal Analysis, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Kotila, Vesa Iisakki

Opintokohteen kielet: Finnish

Leikkaavuudet:

031050A	Signal Analysis	4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish.
The course can be completed in English by a final exam.

Timing:

The course is held in the autumn semester, during period II. It is recommended to complete the course at the 2nd autumn semester.

Learning outcomes:

Upon completion of the course, the student:
-is able to calculate the energy, the power, the convolution and the frequency spectrum of discrete and analog, periodic and non-periodic deterministic signals
-is able to study the effect of sampling on the signal
-is able to calculate the Hilbert transform and the complex envelope of a signal
-is able to study the stationarity, the mutual dependence and the frequency content of random signals by means of the auto- and cross-correlation functions, and the power- and cross-power spectral densities
-is able to study the effect of an LTI system on a signal

Contents:

Signals, classification, frequency. Fourier analysis, analog and digital signal, fast Fourier transform. LTI system. Hilbert transform. AM- FM- and PM-modulation. Random variable. Covariance matrix. Random signal. Stationarity, autocorrelation. Power spectral density. Random signal in LTI system. Signal estimation.

Mode of delivery:

The lectures and exercise classes will be arranged as distance learning via Zoom. The Zoom-links, directions and other material (in Finnish) will be made available in the Moodle-workspace for the course, which can be found at https://moodle.oulu.fi/course/view.php?id=5361

Learning activities and teaching methods:

Lectures 28 h / Exercises 14 h / Self-study privately or in a group 93 h. The independent work includes individual STACK-assignments as online work.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses 031078P Matrix Algebra, 031021P Probability and Mathematical Statistics and 031077P Complex Analysis.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Additional reading: Proakis, J.G., Manolakis, D.K.: Introduction to Digital Signal Processing. Shanmugan, K.S., Breipohl, A.M.: Random Signals, Detection, Estimation and Data Analysis.

Assessment methods and criteria:

The course is completed with mid-term exams or a final exam. When completed with mid-term exams, exercise assignments are part of the continuous assessment. The assessment of the course is based on the learning outcomes of the course.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Vesa Kotila

Working life cooperation:

-

521303A: Circuit Theory 2, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rahkonen, Timo Erkki

Opintokohteen kielet: Finnish

Leikkaavuudet:

521306A	Circuit Theory 2	4.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn, period 2

Learning outcomes:

After the course the student can:
1. use Laplace transform for solving time and frequency response of electric circuits;
2. derive continuous-time transfer functions.;
3. solve their poles and zeros and understand the meaning of those;
4. draw the pole-zero map and Bode plots of any given transfer function;

5. construct 2-port parameter models of a given circuit

Contents:

Use of Laplace transform in network analysis. Properties of network functions, poles and zeros, Boden magnitude and phase plots. 2-port parameter models.

Mode of delivery:

Classroom

Learning activities and teaching methods:

30h lectures, 22 h exercises, and simulation excerices.

Target group:

Finnish BSc students

Prerequisites and co-requisites:

Basics of circuit theory, differential equations.

Recommended optional programme components:

Continuation for Circuit theory 1. Needed in most analog electronics courses.

Recommended or required reading:

Nilsson, Riedel: Electric Circuits (6th or 7th ed., Prentice-Hall 1996), Chapters 12-18.

Assessment methods and criteria:

Final exam. Also the simulation exercise must be passed.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical 1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

521071A: Principles of Semiconductor Devices, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jani Peräntie, Juha Hagberg

Opintokohteen kielet: Finnish

Leikkaavuudet:

521205A	Principles of Semiconductor Devices	4.5 op

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish

Timing:

Spring semester period 3

Learning outcomes:

1. will be able to explain physical phenomena in semiconductor materials and junctions; describe main types and characteristics of semiconductor diodes and transistors
2. will be able to explain physical principles of operation and to estimate ideal characteristics of the devices

Contents:

Junctions. Semiconductor diodes and lasers. Bipolar junction transistors. Field effect transistors. Switching devices.

Mode of delivery:

Will be notified in the beginning of lectures.

Learning activities and teaching methods:

Spring term 2021, distance learning, Moodle and Zoom used.
Moodle link will be send for students registered the course. First lecture 11.1.2021 at 14:15-16:00

Target group:

Second year electrical engineering students

Prerequisites and co-requisites:

521104P Introduction to materials physics.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes (in Finnish). Book: Streetman, B.: Solid state electronic devices, Prentice-Hall, New Jersey, 2000 (chapters 5 - 8, 11).

Assessment methods and criteria:

Will be notified in the beginning of lectures.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Hagberg

Working life cooperation:

No.

Other information:

-

521337A: Digital Filters, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Olli Silven

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521337A	Digital Filters (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish, English study material available

Timing:

Spring, period 3.

Learning outcomes:

1. Student is able to specify and design respective frequency selective FIR and IIR filters using the most common methods.

2. Student is able to solve for the impulse and frequency responses of FIR and IIR filters given as

difference equations, transfer functions, or realization diagrams, and can present analyses of the aliasing and imaging effects based on the responses of the f

3. Student is able to explain the impacts of finite word length in filter design.

4. Student has the necessary basic skills to use signal processing tools available in Matlab environment and to judge the results.

Contents:

1. Sampling theorem, aliasing and imaging, 2. Discrete Fourier transform, 3. Z-transform and frequency response, 4. Correlation and convolution, 5. Digital filter design, 6. FIR filter design and realizations, 7. IIR filter design and realizations, 8. Finite word length effects and analysis, 9. Multi-rate signal processing.

Mode of delivery:

Online teaching (Lectures), independent work, group work

Learning activities and teaching methods:

Online lectures and exercises 50 h. The design exercises familiarize the students with the methods of digital signal processing using the Matlab software package. The rest as independent work.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

031077P Complex Analysis, 031080A Signal Analysis

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes and exercise materials. Material is in Finnish and in English. Course book: Ifeachor, E., Jervis, B.: Digital Signal Processing, A Practical Approach, Second Edition, Prentice Hall, 2002.

Assessment methods and criteria:

The course can be passed either with week exams or a final exam. In addition, the exercises need to be returned and accepted.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Olli Silven

Working life cooperation:

None.

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.
Open University students enroll for studies through an open website.

521431A: Principles of Electronics Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish.

Timing:

Spring, period 3

Learning outcomes:

1. should be able to analyze and design such electronic building blocks as rectifiers, clamping circuits, amplifiers and CMOS logic elements using diodes, operational amplifiers and MOS and bipolar junction transistors.

Contents:

Analogue and digital circuits, basic amplifier related concepts, diodes and diode circuits, single stage bipolar and MOS transistor amplifiers, small signal modeling and analyzing ac properties of amplifiers, internal structures of digital circuits (mainly CMOS), MOS/CMOS switch, operational amplifier.

Mode of delivery:

Remote teaching.

Learning activities and teaching methods:

Lectures 30 h and exercises 20 h. Link to Moodle https://moodle.oulu.fi/course/view.php?id=5894.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Circuit Theory I

Recommended optional programme components:

Recommended course Principles of Semiconductor Devices.

Recommended or required reading:

Lecture notes and Behzad Razavi, “Microelectronics”, 2nd Edition, ISBN 9781-118-16506-5
John Wiley & Sons 2015

Assessment methods and criteria:

Final or 2 mid-term exams.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Respon responsible: Ilkka Nissinen
Lecturer: Juha Häkkinen
Assistant: Tuomo Talala

Working life cooperation:

-

521070A: Introduction to Microfabrication Techniques, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Niina Halonen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521218A	Introduction to Microelectronics and Micromechanics	4.0 op
521218A-02	Introduction to Microelectronics and Micromechanics, demonstration	0.0 op

521218A-03	Introduction to Microelectronics and Micromechanics, exercise	0.0 op
521218A-01	Introduction to microelectronics and micromechanics, exam	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

2nd period

Learning outcomes:

1. Can present the process of source materials used to manufacture micro- and nanoelectronics /mechanics and analyse the required material properties depending of the application

2. Can explain the fabrication methods and discuss the characteristic features of each fabrication method, inculding their utilisation and restrictions.

3. Is capable of designing a fabrication process for a simple microelectronics application and is able to indetify the process steps also in complex application.

Contents:

The content of the course covers fabrication methods of micro-, nano- and optoelectronics as well as MEMS systems. 1. Fabrication methods for silicon based electronics and MEMS systems 2. Additive manufacturing methods 3. Nanomaterials and fabrication.

Mode of delivery:

Face-to face teaching

Learning activities and teaching methods:

Lectures (20 hours) and exercises (10 +10).

Target group:

Electrical engineering bachelor degree students.

Prerequisites and co-requisites:

Course content of 521104P Introduction to Materials Physics and 521071A Principles of Semiconductor Devices.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes, Franssila Sami: Introduction to Microfabrication

Assessment methods and criteria:

Final written exam and passes laboratory exercises.

Grading:

Numerical grading 1-5.

Person responsible:

Merja Teirikangas

Working life cooperation:

No

521330A: Telecommunication Engineering, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Heikki Antero Kärkkäinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521357A	Basics of Analog Communications	3.0 op
521361A	Basics of Digital Communications	3.0 op

ECTS Credits:

5 ECTS, equals 125 hours of student’s work

Language of instruction:

Finnish. The course can be completed in other languages e.g. in English as a book examination of specified pages of course book specified pages of course book shown below.

Timing:

The course is lectured on period 4. Recommended for second study year.

Learning outcomes:

1. can tell and explain the essential blocks and their operation in time & frequency domains for frequently used analog and digital carrier and pulse modulation methods.
2. understands essential differences both between linear and non-linear modulations, and between coherenr and non-coherent modulations.
3. understands in which system applications each analog or digital modulation is typically used.
4. can tell limitations on system performance caused by noise interference and various transmission channels, and can propose methods to suppress interference both in analog and digital transmission.
5. can perform system analysis, and can calculate performances of analog and digital modulations based on simple assumptions regarding channel models.
6. can compare modulations from the standpoints of resource use (transmitted power and bandwidth needed) and implementation complexity.
7. understands the meanings of various equalizing, diversity and coding methods from the standpoint of improvement for digital transmission reliability.
8. understands various standards and specifications of new digital transmission systems.
9. can apply gained knowledge in working life to design of systems and their sub-system units, and can also perform computer simulations.
10. understands the principles of information theory, source coding and error-control coding, and masters various most commonly used coding methods.

Contents:

Essential and optional blocks of coherent and non-coherent analog and digital transmission systems and their operation principles. Linear (amplitude modulation) and non-linear (angle modulation) modulation principles, and differences in their performance and operation. Carrier and pulse modulation principles and their differences. The most important analog (DSB, AM, SSB, VSB, PM, FM, PAM, PWM, PPM) and digital (ASK/MASK, PSK/MPSK, FSK/MFSK, DPSK, QPSK/OQPSK, MSK/GMSK, QAM, MCM/OFDM, TCM, DM, PCM) carrier and pulse modulation methods and their performance analysis (SNR, BEP) and comparison based on the AWGN channel model. Influence of single-tone carrier radiofrequency interference (RFI) in the case of analog modulations. The threshold effect in the case of non-linear modulations and non-linear detectors. Mixing-principle and superheterodyne receiver. Phase-lock loop techniques, and FDM, TDM and QM-multiplexing methods. Matcher filter and correlation receiver principles. Basic characteristics and modelling of radio channels. Influence of band-limiting channel and multi-path propagation: inter-symbol interference (ISI) and fading, and their influence on system performance. Diversity, channel equalizing and MCM/OFDM methods for reducing channel interference. Spread-spectrum technique in brief, and benefits & limitations & applications of that principle. Cellular system idea. Basics of information theory, source coding and error-control coding methods.

Mode of delivery:

Distance learning teaching with Zoom lectures on spring 2021.

Learning activities and teaching methods:

Online teaching 52 h (Zoom). No separate times for class-exercises. Exercises have been integrated as part of face-to-face teaching event. Self-study 73 h. Total 125 h.
The lectures are keep as distance lectures by Zoomin and links to them will be distributed in March on the Moodle course page.

Target group:

Second year B.Sc.(Tech.) students both in electronics and telecommunication engineering (ECE) degree programme, and in some specialization options of computer science and engineering (CSE) degree programme.

Prerequisites and co-requisites:

031080A Signal analysis course.

Recommended optional programme components:

No connections to other courses.

Recommended or required reading:

Lecture slides in Finnish are stored into digital learning environment (Optima / Moodle). The course and lecture slides are based on the book: R.E. Ziemer & W.H. Tranter: Principles of Communications: Systems, Modulation and Noise, 7th edition, 2015, John Wiley & Sons, Partially chapters: Ch 1 (ss. 1-16), Ch 3 (112-151), Ch 4 (ss. 156-184, 194-209), Ch 5 (ss. 215-216, 225-239), Ch 8 (ss. 349-361, 370-380, 384-390), Ch 9 (ss. 396-468), Ch 10 (ss. 477-516, 528-532, 540-546, 553-557), Ch 12 (ss. 615-647, 657-664, 668-670, 679-683).

Assessment methods and criteria:

Course can be passed either with four mid-term exams, or with final exam. Course does not contain discrete exercise work. Candidate-level course 521329A Hands-on course in wireless communications is recommended to be taken on 3rd study year as a sequel for this course to practice modulation principles in real life using NI USRP-2900 software radio platform.
1st midterm exam Thursday, March 25, 2021 from 10:15 a.m to 12:00 p.m. The Moodle distance exam will appear in the spring of 2021 to the Moodle course page.
2nd midterm exam Thursday, April 8, 2021 from 10:15 a.m to 12:00 p.m. The Moodle distance exam will appear in the spring of 2021 to the Moodle course page.
3rd midterm Thursday, April 22, 2021 from 10:15 a.m to 12:00 p.m. The Moodle distance exam will appear in the spring of 2021 to the Moodle course page.
4th midterm exam Thursday, May 6, 2021 from 10:15 a.m to 12:00 p.m. The Moodle distance exam will appear in the spring of 2021 to the Moodle course page.
Final exam Thursday 20.5.2021 from 4:15 p.m. -7:15 p.m. Moodle distance exam will be published in the spring of 2021 to the Moodle course page.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Kari Kärkkäinen

Working life cooperation:

No

Other information:

This course replaces the following candidate level courses: 521357A Telecommunication Engineering I (3 ECTS) and 521361A Telecommunication Engineering II (3 ECTS).

The course uses the Moole environment:
https://moodle.oulu.fi/course/view.php?id=691

521432A: Electronics Design I, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Nissinen

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish.

Timing:

Spring, period 4.

Learning outcomes:

1. should be able to recount the principles covering the design of multistage amplifiers

2. should be able to analyze and set the frequency response of a transistor amplifier

3. should be able to make use of feedback to improve the properties of an amplifier in the desired manner

4. should be able to analyze the stability of a given degree of feedback amplification and to dimension an amplifier correctly to ensure stability

5. should be able to describe the principles governing the design of power amplifiers

6. should be able to make widespread use of operational amplifiers for realizing electronic circuits and to take account of the limitations imposed by the non-idealities inherent in operational amplifiers

7. should be able to design low-frequency oscillators, to explain the operating principles of radio frequency oscillators and tuned amplifiers

Contents:

Frequency response of a transistor amplifier, differential amplifier, feedback, power amplifiers, oscillators and tuned amplifiers, non-idealities of an operational amplifier, applications of operational amplifiers.

Mode of delivery:

Remote teaching.

Learning activities and teaching methods:

Link to Moodle will be given later. Lectures 30 h and exercises 20 h.

Target group:

Students of Electrical engineering. Other students of the University of Oulu may also participate.

Prerequisites and co-requisites:

Principles of electronic design

Recommended optional programme components:

This course is required when participating in Laboratory Exercises on Analogue Electronics.

Recommended or required reading:

Lecture notes, book: Behzad Razavi, “Microelectronics”, 2nd Edition, ISBN 9781-118-16506-5
John Wiley & Sons 2015

Assessment methods and criteria:

Final or 2 mid-term exams.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen

Working life cooperation:

-

Other information:

-

761312A: Electromagnetism 2, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766319A	Electromagnetism	7.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

Second spring term

Learning outcomes:

The student will be able to derive the individual results like electric fields produced by charge distributions, magnetic field by current systems and solve problems related to electromagnetic induction. The student can derive the wave equation for electromagnetic waves.

Contents:

The foundations of the electromagnetic field theory. Exact contents to be specified later.

Mode of delivery:

face-to-face teaching

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Anita Aikio

521404A: Digital Techniques 2, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish. Exams can be arranged in English on demand.

Timing:

Autumn, period 2

Learning outcomes:

1. knows the common architectures of synchronous digital logic circuits, and the building blocks they consist of, and can design digital circuits that realize complex data and signal processing functions.
2. knows most common combinational and sequential logic based buildning blocks, and can use them to design and realize complex digital circuits.
3. knows digital logic design methods, such as use of hardware description languages, functional verification using simulation, realization of logic with a logic synthesis program, and functional and timing verification of gate-level models.

Contents:

1. Logical and physical properties of digital logic components. 2. Representation of digital designs. 3. Combination logic design. 4. Sequential logic design. 5. Digital artithmetics. 6. Semiconductor memories. 7. Register transfer level architecture design. 8. Register transfer level modeling and synthesis. 9. Timing design. 10. Digital interface design. 11. Design verification

Mode of delivery:

Classroom

Learning activities and teaching methods:

Lectures 24h/ exercises 30h (group work)/independent work 84h.

Target group:

Primarily electrical and computer science and engineering students. Also other student of University of Oulu can take the course.

Prerequisites and co-requisites:

Digital techniques 1

Recommended optional programme components:

No

Recommended or required reading:

Lecture textbook (in finnish) and literature announced during course.

Assessment methods and criteria:

Final exam and a design excercise, or weekly assignments consisting of theoretical and design exercises.
Read more about assessment criteria at the University of Oulu webpage.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5, The grade is the average of the exam and the design exercise.

Person responsible:

Jukka Lahti

Working life cooperation:

No

Other information:

-

521307A: Laboratory Exercises on Analogue Electronics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521316A	Broadband Communications Systems	4.0 op
521433A	Laboratory Exercises on Analogue Electronics	3.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn, periods 1-2

Learning outcomes:

1. is able to design basic electronic structural blocks and verify their functionality in a CAD simulation environment.

2. is able independently to realize and test a small-scale design object employing analogue circuit techniques.

Design exercises to deepen the understanding of the material presented in Principles of Electronics Design and Analogue Electronics I.

Contents:

Passive RC-circuits, diodes and their applications, bipolar transistor amplifiers, operational amplifiers and their applications, MOS-transistor, tuned circuit and amplifier, oscillator.

Mode of delivery:

Face-to-face teaching, partially independent work

Learning activities and teaching methods:

Independent design and simulating excercise 26 h and guided laboratory work 15 h. Group size is 1 - 2 students.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course.

Prerequisites and co-requisites:

Student must participate to courses Principles of Electronics Design and Electronics Design I, or he/she must have passed these courses earlier.

Recommended optional programme components:

No

Recommended or required reading:

Lecture notes of Principles of Electronic design and Electronics design 1.

Assessment methods and criteria:

Teacher accepts student’s design work and measurement results in laboratory.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes verbal grading scale pass or fail

Person responsible:

Kari Määttä

Working life cooperation:

No

Other information:

-

521241A: Optical systems, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Anssi Mäkynen

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Lectures are in Finnish. All written material is also in English. In guided labworks the assistant can English.

Timing:

Period 1.

Learning outcomes:

1. is capable of explaining the basic facts of geometrical and physical optics
2. is able of explaining the operating principles of simple optical components and instruments
3. is able to describe an optical system as a principal point representation
4. is able to trace the most important paraxial rays through the system
5. is able to explain the properties of a laser beam
6. is able to estimate the radiometric properties and resolving power of an ideal optical system
7. is capable of recognizing and explaining the difference between imaging, non-imaging and laseroptics as well as able to conclude from which of these viewpoints he/she should approach a given design task
8. is capable of designing and optimizing simple imaging and non-imaging lens systems as well as optics for laser beam modification using optical design software tools and 3D printing.

Contents:

Basics of geometrical and physical optics, optical components and instruments. Optical design software tools.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 24 exercises 12 h and self-study 100 h.

Target group:

Cource is mandatory for Electrical Engineering students. All students of the University of Oulu can attend the course.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

-

Recommended or required reading:

Material in Optima

Assessment methods and criteria:

Final exam and passed lab exercises.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1 - 5

Person responsible:

Anssi Mäkynen

Working life cooperation:

-

Other information:

-

521384A: Basics in Radio Engineering, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi, Aarno Pärssinen

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn, 1st period

Learning outcomes:

1. can define what radio engineering is and list its separate areas and applications from FM-radio to 5G systems.

2. understands the meaning of Maxwell's equations and can solve the propagation of radio waves in a homogeneous medium.

3. can solve EM-fields at an interface of two lossless media.

4. knows main properties of most common transmission line types and can solve EM-fields for coaxial lines and rectangular waveguides.

5. can utilize the methods based on the Smith chart for the impedance matching of microwave circuits and antennas.

6. understands the meaning of Y-, Z-, and S-matrix and can use S-parameters for solving characteristics of microwave circuits.

7. can describe the operation of passive transmission line devices, resonators, filters and circuits based on the semiconductor devices.

8. knows the terms to describe antenna characteristics and can define radiation patterns of simple antennas and antenna arrays.

9. knows different propagation phenomena and can evaluate, which phenomena are relevant in different radio systems in different frequency bands.

10. can describe the structure of a typical radio system and can calculate the S/N-ratio link budget for a radio system on a free-space radio link.

Contents:

Introduction to radio waves and radio engineering. Maxwell’s equations. Fundamentals of electromagnetic fields. Transmission lines and waveguides. Impedance matching. Microwave circuit theory. Passive transmission line and waveguide devices. Resonators and filters. Circuits based on semiconductor devices. Antennas. Propagation of radio waves. Radio system. Applications of radio engineering.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 26 h and exercises 16 h including graded exercise problems.

Target group:

3 rd year bachelor’s degree students.

Prerequisites and co-requisites:

Elementary knowledge of the electromagnetic theory.

Recommended optional programme components:

\-

Recommended or required reading:

In Finnish: Antti Räisänen & Arto Lehto: Radiotekniikan perusteet. Otatieto, 2011; also older versions of the book can be used as a course book.
Additional reading in Finnish: Jyrki Louhi & Arto Lehto: Radiotekniikan harjoituksia. Otatieto, 1995.
In English: Antti V. Räisänen & Arto Lehto: Radio Engineering for Wireless Communication and Sensor Applications, Artech House, 2003.
Additional literature in english: D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012.

Assessment methods and criteria:

The course is passed with a final examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Risto Vuohtoniemi, Aarno Pärssinen.

Working life cooperation:

No

Other information:

-

030005P: Information Skills, 1 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Faculty of Technology

Arvostelu: 1 - 5, pass, fail

Opettajat: Ursula Heinikoski

Opintokohteen kielet: Finnish

Leikkaavuudet:

030004P	Introduction to Information Retrieval	0.0 op

ECTS Credits:

1 ECTS credit / 27 hours of work

Language of instruction:

Finnish

Timing:

Architecture 3. spring semester, period III;
biochemistry 3. autumn semester;
biology 3. autumn semester, period I;
chemistry 3. autumn semester, period I;
civil engineering 2. spring semester, period IV;
computer science and engineering 2. spring semester, period IV;
electronics and communications engineering 3. spring semester;
geosciences 2. spring semester, period IV;
geography 3. semester, periods I and III;
industrial engineering and management 3. year;
information processing sciences 1. or 3. year;
mathematics and physics 1. spring semester, period III;
mechanical engineering 3. year;
mining engineering and mineral processing 3. year;
process and environmental engineering 2. year, period II;
Master's degree students in industrial engineering and management 1st year.

Learning outcomes:

Upon completion of the course, the students:
- can search scientific information,
- can use the most important databases of their discipline,
- know how to evaluate search results and information sources,
- can use the reference management tool.

Contents:

Scientific information retrieval process, the most important databases and publication channels of the discipline, evaluation of the reliability of information sources and reference management tool.

Mode of delivery:

Blended teaching: classroom training, web-based learning material and exercises, a group assignment.

Learning activities and teaching methods:

Training sessions 8 h, group working 7 h, self-study 12 h

Target group:

Compulsory for all bachelor degree students of Faculty of information technology and electrical engineering, Faculty of Technology and Faculty of science. Compulsory also for those Master's degree students in Industrial Engineering and Management who have no earlier studies in the information skills. Optional for the students of biochemistry.

Recommended optional programme components:

In biochemistry the course is completed as a part of 740376A Bachelor's Thesis.

Recommended or required reading:

Web learning material Tieteellisen tiedonhankinnan opas

Assessment methods and criteria:

Passing the course requires participation in the training sessions and successful completion of the course assignments.

Grading:

pass/fail

Person responsible:

Ursula Heinikoski

523990A: Bachelor's Thesis / Electronics and Communications Engineering, 8 op

Voimassaolo: 01.08.2007 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Hannu

Opintokohteen kielet: Finnish

ECTS Credits:
8
Language of instruction:
Finnish, can be written in English if needed.
Timing:
Periods 1-6
Learning outcomes:
The student is able to set objectives for a given assignment. He/she is able to analyze the theme coherently, with emphasis on the key issues. The student is able to use sources of information critically. The student is able to present the planned and implemented solution clearly and to justify the choices he/she took, and to assess the functionality of the solution using relevant testing and evaluation methods. In addition, he/she is able to compare the results against the set objectives. The student is able to produce impeccable, clear and finalized text, in line with technical and scientific writing practices.
Contents:
The student chooses the theme for the thesis in cooperation with his/her supervisor.
Mode of delivery:
The thesis is written towards the end of the BSc studies, typically during the third year.
Learning activities and teaching methods:
Independent work.
Target group:
Students of Electrical Engineering.
Prerequisites and co-requisites:
Basic studies.
Recommended optional programme components:
BSc preparatory module, Technical communication.

Recommended or required reading:
-
Assessment methods and criteria:
BSc thesis and related maturity essay.
Grading:
Grading: pass/fail.
Person responsible:
Professors and researchers in the Departments of Electrocal Engineering and Communications Engineering.
Working life cooperation:
Yes.
Other information:
-

521010A: Maturity Test for Bachelor's Degree, Electronics and Communications Engineering, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
0; The maturity test is integrated in the BSc Thesis credits (8 ECTS).
Language of instruction:
Finnish/Swedish/other
Timing:
Periods 1-4
Learning outcomes:
After the maturity test, the student has demonstrated that his/her language skills meet the requirements of the work life.
Contents:
The aim of the maturity test is to confirm the student's familiarity of the thesis area as well as his/her command of the domestic language of his/her school education.
Mode of delivery:
The maturity test is written in a controlled event, on a topic provided by the thesis supervisor.
Learning activities and teaching methods:
Written essay, approximately 3 pages.
Target group:
-
Prerequisites and co-requisites:
The maturity test can be written after all other components of the BSc thesis are completed.
Recommended optional programme components:
-
Recommended or required reading:
BSc Thesis.
Assessment methods and criteria:
The maturity test is evaluated and approved by the thesis supervisor.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass/fail.
Person responsible:
Thesis supervisor.
Working life cooperation:
-
Other information:
-

521036A: Seminar for Bachelor`s Degree, Electronics and Communications Engineering, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Hannu

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
0
Language of instruction:
Finnish
Timing:
Autumn and spring, periods 1-4.
Learning outcomes:
1. Student can prepare a presentation of predetermined length of her/his thesis.
2. Student has experience on presenting her/his topic.
3. Student has experience on evaluating other students' presentations.
4. Student has a general view of other completed bachelor thesis.
Contents:
The content is determined by the bachelor thesis topics.
Mode of delivery:
Seminar presentations.
Learning activities and teaching methods:

Seminar sessions when necessary during the whole year.
Target group:
3rd year ECE students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Course is mandatory part of bachelors thesis.
Grading:
Pass / fail
Person responsible:
Jari Hannu

900060A: Technical Communication, 2 op

Voimassaolo: 01.08.2005 - 31.07.2021

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Languages and Communication

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900060A	Technical Communication (OPEN UNI)	2.0 op
470218P	Written and Oral Communication	3.0 op

Proficiency level:
This course is not offered in English. It is only Finnish-speaking students.
Status:
This course unit is compulsory for students of Electrical Engineering, Computer Science, Communications Technologies and Engineering Mechanical Engineering, Process and Environmental Engineering.
Required proficiency level:

-
ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
1st year: Process and Environmental Engineering
2nd year: Communications Technologies
3rd year: Geoscience; Mechanical Engineering; Electrical Engineering, Computer Science and Engineering Technologies

Mode of delivery:
Multimodal teaching
Learning activities and teaching methods:
Contact hours ca. 20 h and independent group work or self-study ca. 34 h.
Target group:
Bachelors students of Electrical Engineering, Computer Science, Communications Technologies and Engineering Mechanical Engineering, Process and Environmental Engineering.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
Kauppinen, Anneli & Nummi, Jyrki & Savola, Tea: Tekniikan viestintä: kirjoittamisen ja puhumisen käsikirja (EDITA); Nykänen, Olli: Toimivaa tekstiä: Opas tekniikasta kirjoittaville (TEK) and material in Moodle study environment.
Assessment methods and criteria:
Active participation in contact teaching, independent study and completion of given assignments.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass / fail
Person responsible:
Kaija Oikarainen

Working life cooperation:
-
Other information:
All students are required to attend the first meeting of the course unit so the work groups can be formed and work started in a timely and efficient manner. When signing up for the course unit, you should keep in mind that completing it requires a responsible attitude and a strong commitment to the work because the teamwork-based exercises rely heavily on the participation and activity of the students.
If the student is involved in the University's student associations or functions in a position of trust in university government, student union administration or Oulun Teekkariyhdistys ry (or in its subordinate guilds), he/she may be relieved of some of the group communication exercises. These compensatory actions must always be agreed upon separately with the course unit's teacher. The student must present an official statement from a person in charge of the governing body or association, which details the student's tasks and involvement with that body or association. Participation that took place over five years ago does not entitle the student to any compensation.

H453223: Supplementary Module (Electronics and Communications Engineering), 15 - 55 op

Voimassaolo: 01.08.2021 -

Opiskelumuoto: Other Entity

Laji: Study module

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Supplementary Module: 1. Electronics and Communications Engineering

521329A: Hands-on Course in Wireless Communication, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Heikki Antero Kärkkäinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521316A	Broadband Communications Systems	4.0 op

ECTS Credits:

5 ECTS, equals 125 hours of student's work

Language of instruction:

Finnish

Timing:

The course is organized in the autumn semester during tehe 1st period. It is recommended to complete the course at the 3rd year autumn semester.

Learning outcomes:

After completing course a student

1. is acquainted with the principles of universal software radio peripheral (USRP) technologies and their implementation and understands the basic idea of software radio concept. That is obtained with the aid of small laboratory exercise work tasks which require understanding theories of basic analog and digital carrier modulation methods learned before this course.
2. understands the idea of complex-valued I&Q vecor-signals, which exist behind software radios and measurement techniques, and understands how such signals are linked to real-valued RF-signals.
3. has learned how to use universal software radio peripheral transceivers, and how to observe them in laboratory environment. Student also understands how to control these FGPA-based (field-programmable gate array) devices with the aid of control software platforms (e.g. Matlab-Simulink, LabVIEW, GNU Radio) and understands their limitations in real engineering work.
4. has implemented and tested various basic modulation methods both in radio channel and coaxial cable channel, and has made real observations and measurements in time-frequency domain using USRP control software.
5. has learned to find and deduct radio signal spectras and time waveforms with the aid of time-frequency analysis.
6. can test and model in laboratory environment during course and later in work life various problems and solutions dealing with wireless communication before construction of a prototype device.

Contents:

Students are introduced to the wireless communication systems and their phenomena with the aid of guided laboratory exercises. The course utilizes National Instruments USRP-2900 universal software radio peripheral tranceiver.

Mode of delivery:

Face-to-face contact teaching for theory lectures and guided laboratory exercises in a classroom. Self-studying at home between work themes of each week. Writing of exercise work report for each conducted work task.

Learning activities and teaching methods:

Course consist of small wireless communication tasks using various analog and digital carrier modulations. Total number of exercise works is 8. The course utilizes mainly National Instruments USRP-2900 universal software radio peripheral tranceiver which is controlled via laptop computer's USB connection. Transmission and receiving of I&Q signals are controlled with Matlab. Students are required to have competent laptop with Matlab-Simulink campus licence. Students have to participate in short briefing lectures. Exercise works are done by a group of 2 students. Results are summarized in a written report for each task according to given instructions. Students have to return report two weeks after each work session.

Course contains 14 hours lectures for work instructions and 32 hours of measurement work. In addition, students perform 79 hours of self-study and reporting at home. Total 125 hours.

Target group:

Third year bachelor level students in electronics and communications engineering degree programme.

Prerequisites and co-requisites:

031080A Signal analysis and 521330A Telecommunication engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

No course book. Lecture slides, and problem assignments together with work instruction are given during the course. Materials will be placed into Moodle environment. In addition, some NI USRP-2900 related material will be placed into Moodle.

Assessment methods and criteria:

All students of a group have to participate in introductory face-to-face teaching and briefing lecture, and will prepare a final report according teacher's instructions. Before student's mandatory absence, a student has to negotiate that with a teacher. Participation in all introductory lectures and laboratory exercises is mandatory for all members of a group. Presence of each student is monitored by a teacher. In addition, final report has to be in form required by a course teacher, and the content has to be satisfying from acceptance standpoint. Course does not contain final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Course grading is done with the numbers 0…5. Grade 0 is interpreted as failed. Student group has to get acceptable number of points for each task. Final grade is based on the total number of points from each sub-work theme using standard rounding techniques.

Person responsible:

Kari Kärkkäinen

Working life cooperation:

No

Other information:

-

521328A: Simulations and Tools for Telecommunications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Johanna Vartiainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521369A	Simulations and Tools for Telecommunications	3.0 op
521369A-01	Simulations and Tools for Telecommunications, exam	0.0 op
521369A-02	Simulations and Tools for Telecomm. exercise	0.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, period 2

Learning outcomes:

1. A student recognizes problems and limitations related to simulations.

2. She/he can select a suitable simulation method and knows how to validate the model.

3. Student knows how to generate signals, random numbers and noise.

4. She/he knows how to model fading channels.

5. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results.

6. She/he can explain principles of network level simulations.

7. A student knows basics of one or two fundamental simulation programs

Contents:

Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs/availability).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h (including program introductions), and the compulsory assignment with a simulation program (40 h).

Target group:

3rd year bachelor's degree students and M.Sc. students

Prerequisites and co-requisites:

Telecommunication Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition. Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

Assessment methods and criteria:

The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5.

Person responsible:

Johanna Vartiainen

Working life cooperation:

No

Other information:

In 2020, the whole course including compulsory exercise and exam is organized in Moodle https://moodle.oulu.fi/enrol/index.php?id=3757 (opens no later than one week before the start of the course)

521304A: Filters, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rahkonen, Timo Erkki

Opintokohteen kielet: Finnish

Leikkaavuudet:

521331A	Filters	4.0 op

ECTS Credits:

5

Language of instruction:

Finnish. Exams can be arranged in English on demand.

Timing:

Spring, period 3

Learning outcomes:

After the course the student can:
1. draw a pole-zero map for a given transfer function;
2. perform impedance and frequency scaling for component values;
3. choose an appropriate prototype filter and filter degree;
4. synthesize passive RLC filters;
5. synthesize active opamp based filters;
6. can compare various filter technologies;
7. understands the basics of scaling the dynamic range of active filters

Contents:

Filter types and prototypes, component scaling. Synthesis of active and passive filters. Sensitivity analysis and scaling of the dynamic range.

Mode of delivery:

Lectures, excercise and design excercise

Learning activities and teaching methods:

30 h lectures, 16 h exercises. A design excercise.

Target group:

Finnish electrical engineering students

Prerequisites and co-requisites:

Basics of circuit theory, Bode plots and analog design.

Recommended optional programme components:

Course Digital filters expands the topic into digital domain.

Recommended or required reading:

van Valkenburg: Analog Filter Design, 1982, chapters1-14, 18 ja 20 ; or year 2001 edition chapters 1-13.

Assessment methods and criteria:

Circuit is examined by a final exam. Also the obligatory design exercise must be passed.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

Other information:

-

521210A: Electronics Materials, 5 op

Voimassaolo: 01.08.2020 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Hagberg
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521092A: Electronic Measurement Techniques, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Christian Schuss
Opintokohteen kielet: Finnish
Leikkaavuudet:

521171A Electronic Measurement Techniques 6.5 op
521171A-01 Electronic measurement techniques, exam 0.0 op
521171A-02 Electronic measurement techniques, exercise work 0.0 op
521430A Electronic Measurement Techniques 6.0 op

ECTS Credits:

5 ECTS credits / 132 h

Language of instruction:

In Finnish or in English if two or more foreign students participate.

Timing:

Period 4 academic year 20-21 and 21-22. Period I from academic year 22-23 forward.

Learning outcomes:

1. remembers the electrical measurement technique terminology associated to measurement systems, sensors and buses.
2. can name most important analog signal conditioning structures
3. can plan and implement basic measurements with electrical thermometers
4. can plan and implement basic measurements with optical meters
5. can name common sources of noise and interference and means to control them
6. can name methods to realize electrical quantities

Contents:

Broad view to electronic measurements.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 28h and self-study 100h.

Target group:

Course is compulsory for electrical engineering students. Course is open for all students in University of Oulu.

Recommended optional programme components:

The course replaces previous courses with same name, but different credits and code.

Recommended or required reading:

Course material is in English and Finnish and can be found in Moodle.

Assessment methods and criteria:

The course is passed with a final exam.

Grading:

Numerical grading scale 1-5.

Person responsible:

Christian Schuss

Working life cooperation:

None.

Other information:

-

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English/Finnish.

Timing:

Period 1

Learning outcomes:

1. is able to choose the optimum method of the choices presented in the course in the field of power supply, thermal design, grounding, and routing of the high speed signals.
2. is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components.
3. can calculate reliability of an electrical device or system.
4. The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.

Contents:

Power supplies, thermal design, grounding, transmission of fast signals by using transmission lines, electrical disturbances, crosstalk, non-idealities of electrical components.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 30 h of lectures and 20 h of exercises.

Target group:

Primarily in electrical engineering students. Other University of Oulu students can complete the course.

Prerequisites and co-requisites:

Both Principles of Electronics Design and Analogue Electronics I must have been accepted.

Recommended optional programme components:

The course is an independent entity and does not require other studies carried out at the same time.

Recommended or required reading:

Lecture notes. Ward & Angus: Electronic Product Design, Hall&Hall&McCall: High speed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques. Eric Bogatin: Signal and Power Integrity – Simplified, 2. ed.

Assessment methods and criteria:

The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.

Person responsible:

Kari Määttä

Working life cooperation:

No.

Other information:

-

521015A: Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

1-4

Learning outcomes:

After the practical training the student can describe one possible future job and its working environment from the point of view of his or her studies. The student can identify problems in the work and suggest improvements. The student can find connections between work and studies. The technical goal of the training is to give a student a general insight into the field on which he or she will work after graduation, as well as support and promote theoretical studying. Likewise the training has to acquaint the trainee with the social aspects of industrial production and with industrial safety.

Contents:

Learning about the requirements of working life, responsible contribution to the chosen work community, reporting.

Mode of delivery:

The students find their training jobs themselves. It is recommended to participate University tuition sessions on training, career planning and employment issues, when available.

Learning activities and teaching methods:

Independent work.

Target group:

BSc students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Students submit a training report of the min. 2 month training to the person responsible. More detailed instructions for the training report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/fail.

Person responsible:

Jari Hannu

Working life cooperation:

Yes

Other information:

Practical training is compulsory in the BSc. Tech (Electrical Engineering) degree for students who started in 2010 or earlier. For students starting 2011 or later, Practical Training is optional.

Supplementary Module: 2. Computer Science and Engineering

521159P: Principles of Digital Fabrication, 5 op

Voimassaolo: 01.01.2017 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Georgi Georgiev
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay521159P	Principles of Digital Fabrication (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits/ 135 hours of work

Language of instruction:

Finnish/English

Timing:

The course will be held in the spring semester, during period IV.

Learning outcomes:

In this course the students will learn the whole process of digital fabrication in FabLab. They will learn how to create an interactive 3D prototype, design mechanical parts for prototype, create basic electronics, implement a control logic for open hardware embedded board, and work in teams on project.

Contents:

The course teaches students to (1) design mechanical components with solid modeling tools, (2) build necessary electronics, and (3) implement software to a microcontroller, to create in FabLab a physical gadget that interacts with the world around it.

Mode of delivery:

Online (Lectures and TA sessions)/ Individual work towards project.

Learning activities and teaching methods:

Lectures 30h / Individual work 123h. There are sessions each week online where guidance is available (min total 16 h).

Target group:

This course is included in the computer science bachelor degree program. It is also available for all degree programs in the university. The course is offered to high-school students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

There is no recommended or required reading. The tutorials for tools and software (or links to such tutorials) will be provided in the course.

Assessment methods and criteria:

The course will be evaluated on the basis of the project delivered by the teams of students. Essential part of this reporting is the documentation of the project.

Grading:

pass/fail

Person responsible:

Georgi Georgiev

Working life cooperation:

-

Other information:

The course is also offered to high-school students with special study right and gives 5 ECTS credits that can be included in some bachelor's degrees at University of Oulu.
Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi

521160P: Introduction to Artificial Intelligence, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Riku Hietaniemi

Opintokohteen kielet: English

Leikkaavuudet:

ay521160P	Introduction to Artificial Intelligence (OPEN UNIV)	5.0 op

ECTS Credits:

5 ECTS credits /135 hours of work

Language of instruction:

Finnish, English
Lectures and main material in Finnish. English material for self study available.

Timing:

Period IV in spring semester. Recommended completion year: first or second.

Learning outcomes:

Upon completion the student the student will have the elementary skills to identify the potentially applicable artificial intelligence techniques for solving problems. He/she can recognize search, regression, classification, and clustering problems, and to explain the use of supervised and nonsupervised learning, performance measurements and metrics.

Contents:

- Introduction to artificial intelligence
- Search methods
- Supervised learning
- Regression
- Classification
- Data preprocessing
- Unsupervised learning
- Reinforcement learning
- Neural networks

Mode of delivery:

Face-to-face teaching. Online learning option available.

Learning activities and teaching methods:

Mode of delivery: Online teaching. Lectures 42h / exercise work 70 h / self-study 23 h. The exercises can be completed individually or as group work in multi-disciplinary teams.

Target group:

All Bachelor level students.

Prerequisites and co-requisites:

No prerequisites. Python programming skills are highly recommended.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

All course material (lectures and exercises) are available in course Moodle space.

Assessment methods and criteria:

The course utilizes continuous assessment. During the course there are five intermediate exams which will be used in final evaluation. The course also includes five exercises of which at least four need to be passed. These exercises can be completed individually or in groups.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Riku Hietaniemi

Working life cooperation:

Experts from industry are invited to present real world artificial intelligence solutions.

Other information:

Course learning environment is in Moodle moodle.oulu.fi.

031023P: Mathematical Structures for Computer Science, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Peltola

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031023P	Mathematical Structures for Computer Science (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the autumn, during period 1. It is recommended to complete the course at the 2nd autumn semester.

Learning outcomes:

The student is able to apply result of logic to find the truth value of logical statement and can express sentences of natural language by symbols of logic.. He/She can use arithmetic operations on different number bases. The student recognize the main types of graphs and understand the basis concepts of graphs and is able to apply formal methods of discrete mathematics to model simple information processing problems.

Contents:

1. Elementary logic 2. Mathematical induction 3. Elementary number theory 4. Set theory 5. Elementary graph theory 6. Elementary theory of formal languages 7. Theory of automata and Turing machines

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 14 h / Self-study 93 h.

Target group:

2. year students of computer science.

Prerequisites and co-requisites:

No prerequisites

Recommended optional programme components:

-

Recommended or required reading:

Recommented literature: Rosen K.H.: Discrete Mathematics and Its Applications. Gersting J.L.: Mathematical Structures for Computer Science.

Assessment methods and criteria:

The course can be completed by intermediate exams (2 exams) or by a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail

Person responsible:

Matti Peltola

Working life cooperation:

-

521457A: Software Engineering, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Röning

Opintokohteen kielet: English

Leikkaavuudet:

ay521457A	Software Engineering (OPEN UNI)	5.0 op

ECTS Credits:

5

Language of instruction:

Finnish. Material available in English.

Timing:

Spring, period 3.

Learning outcomes:

1. After finishing the course, the student knows the basic concepts of software engineering
2. The student also knows the different areas of project management, the phases of software development
3. The student can defines goals and tasks for each phase of development
4. The student knows the principles of secure software development
5. The student knows the metrics used in software engineering and is able to apply them
6. The student is familiar with tools commonly used in software engineering.

Contents:

Problematics of software development and the special features of real-time systems in this regard. Software development is viewed in regard to project management and actual implementation: 1. process models, 2. requirements specification, 3. project management basics: design, metrics, risk management, resource management, follow up, quality control, product control, 4. software testing methods and strategies, 5. introduction to object-oriented analysis and design. 6. Agile software development. 7. Secure software engineering

Mode of delivery:

Online course

Learning activities and teaching methods:

The course consists of lectures and independent practical exercises. The course is completed by a final exam or learning diaries and successfully completed practical exercises. Lectures 30 h, laboratory design (in period 3) 8 h, the rest of the self-study.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521141P Elementary Programming, 521286A Computer Systems or 521142A Embedded Systems Programming.

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

R.S. Pressman: Software Engineering - A Practitioner's Approach. Eight Edition. McGraw-Hill 2010. Older editions (6. and 7.) can also be used with some additional material.

Assessment methods and criteria:

Final exam and accepted laboratory exercise.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning

Working life cooperation:

-

521453A: Operating Systems, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Röning

Opintokohteen kielet: English

Leikkaavuudet:

ay521453A	Operating Systems (OPEN UNI)	5.0 op

ECTS Credits:

5

Language of instruction:

In Finnish, material available in English

Timing:

Spring, period 4

Learning outcomes:

1. is capable of explaining the basic structure and functioning of operating system

2. is able to point the problems related to process management and synchronization as well as is able to apply learned methods to solve basic problems

3. is capable of explaining the cause and effect related to deadlocks and is able to analyse them related to common circumstances in operating systems

4. is able to explain the basics of memory management, the use of virtual memory in modern operating systems as well as the structure of the most common file-systems.

Contents:

Operating system structure and services, process management, process synchronization, deadlocks, memory management, virtual memory, file-systems

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

Lectures 36 h, laboratory exercise 4 h, the rest as independent work. The laboratory work, including pre-exercise and guided exercise performed in a group of one or two students in the unix environment, covers core topics of the course.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521141P Elementary Programming, 521286A Computer Systems or 521142A Embedded Systems Programming and 521267A Computer Engineering

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Lecture notes (in Finnish) and exercise material. Silberschatz A., Galvin P., and Gagne G.: Operating System Concepts, 6th edition (or newer), John Wiley & Sons, Inc., 2003. Chapters 1-12.

Assessment methods and criteria:

The course is passed the final examination and accepted laboratory working.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Juha Röning (lectures)
Anna-Mari Wartiainen (exercises)

Working life cooperation:

-

Other information:

-

521467A: Digital Image Processing, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Heikkilä, Janne Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521467A	Digital Image Processing (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Lectures in Finnish and exercises in English. Course can be passed in Finnish and English.

Timing:

Spring, period 4.

Learning outcomes:

Upon completion of the course the student:
- understands the basic theory of digital image processing and knows its main applications,
- is able to apply spatial and frequency domain and wavelet based methods in image enhancement, restoration, compression and segmentation.

Contents:

1. Introduction
2. Fundamentals of digital image
3. Intensity transformations and spatial filtering
4. Image processing in frequency domain
5. Restoration
6. Color image processing
7. Wavelets and multi-scale processing
8. Compression
9. Morphological image processing
10. Segmentation

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 24 h, exercises 14 h and homework assignments 30 h. The rest is independent work.

Target group:

Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521141P Elementary Programming or equivalent Python programming skills.

Recommended optional programme components:

None.

Recommended or required reading:

Gonzalez, R.C., Woods, R.E.: Digital Image Processing, Third Edition, Prentice-Hall, 2008, Chapters 1-10.
Lecture notes and exercise

Assessment methods and criteria:

The course is completed by passing the exam and homework assignments.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Janne Heikkilä

Working life cooperation:

None.

Other information:

Course is in Moodle: https://moodle.oulu.fi/course/view.php?id=6840

521495A: Artificial Intelligence, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jaakko Suutala, Pekka Sangi

Opintokohteen kielet: English

Leikkaavuudet:

ay521495A	Artificial Intellig (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

English

Timing:

The course in held in the spring semester, during period III. For bachelor students of Computer Science and Engineering specializing to artificial intelligence, it is recommended to complete the course at the 3rd spring semester.

Learning outcomes:

After completing the course, students

1. know the basic search strategies that can be applied in problem solving and optimization.
2. understand how search-based decisions are made in game-like competitive applications.
3. know the basic principles of probabilistic reasoning in artificial intelligence systems.
4. know how rational decision making under uncertainty can be formulated using utility theory.
5. understand the fundamentals of machine learning and how some of the established methods can be applied to problems in AI.
6. are familiar with advanced AI applications of perception and robotics and how probabilistic inference and machine learning can be used in these settings.

In the course projects, students get some experience in programming and using search methods.

Contents:

intelligent agent types, uninformed search methods, informed (heuristic) search, local search, constraint satisfaction problems, adversarial search, uncertainty handling, probabilistic reasoning, utility, machine learning, decision networks, Markov decision process, reinforcement learning, applications

Mode of delivery:

The tuition is implemented as web-based teaching. Moodle environment is used in the course.
Due to Covid-19 pandemic, teaching in Spring 2021 will be implemented remotely. Course work space can be found from University of Oulu Moodle platform.
Moodle page in Spring 2021 will be https://moodle.oulu.fi/course/view.php?id=3211, where details of implementation will be provided. The page will be available from December 21, 2020.
Online lectures will be given with Zoom and link for them will be provided in Moodle.

Learning activities and teaching methods:

Lectures 28 h / Group work (programming projects) 42 h / Self-study 65 h

Target group:

The primary target group is the students of the Computer Science and Engineering specializing in Artificial Intelligence.

Prerequisites and co-requisites:

Completion of the course "521160P Introduction to Artificial Intelligence" (lectured in Finnish) is recommended, but is not a prerequisite. It is also recommended that a student has completed studies related to probability and statistics (e.g. course "031021P Probability and Mathematical Statistics") and Python programming (e.g. course "521141P Elementary Programming").

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

The course is based on the book Stuart Russell, Peter Norvig (2010, global edition 2016): Artificial Intelligence: A Modern Approach (3rd Edition), Chapters 1-6, 13-18, 20-21, partly 24-25.
The course utilizes materials of an introductory course on artificial intelligence taught at UC Berkeley (http://ai.berkeley.edu).

Assessment methods and criteria:

The assessment of the course is based on the final exam. Both the final exam and the course projects must be passed. Well-done course projects can increase the grade by one unit.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Pekka Sangi, Jaakko Suutala

Working life cooperation:

The course does not contain working life cooperation.

Other information:

Course work space can be found from University of Oulu Moodle platform moodle.oulu.fi.
Moodle page in Spring 2021 will be https://moodle.oulu.fi/course/view.php?id=3211

521157A: Introduction to Social Network Analysis, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mourad Oussalah

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 120 hours of works

Language of instruction:

English

Timing:

Period 4. It is recommended to complete the course at the end of period 4

Learning outcomes:

Upon completing the course, the student is expected to i) understand social aspects of the web; ii) learn to collect, clean and represent social media data; iii) quantify important properties of social media; iv) find and analyze (online) communities; v) understand the diffusion process in social network; vi) familiarize with simple modelling toolkits for social media analysis

Contents:

The course describes basics of social network analysis, allowing the students to understand structure and evolution of the network, while enabling them to use appropriate tools and techniques to draw inferences and discover hidden patterns from the network. The course is designed to accommodate computer science, mathematical and social science student background, which helps in emergence of multi-disciplinary research in the university

Mode of delivery:

Face- to-face teaching and laboratory sessions

Learning activities and teaching methods:

Lectures (24 h), tutorial/laboratory sessions (12h), seminar (6 h) and practical work. The course is passed with an approved practical work and class test. The implementation is fully in English.

Target group:

Students with moderate logical reasoning skills

Prerequisites and co-requisites:

None

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time

Recommended or required reading:

R. Zafarani, M. A. Abbasi, and H. Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014

Assessment methods and criteria:

One class test (30%) in the middle of the term + Project work (70%)
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Mourad Oussalah

Working life cooperation:

-

Other information:

We hope to attract students from humanties, economics and political in order to encourage multidisciplinary studies and enforce interesting student projects where each group contains at least one student from computer science and one from another faculty.

521040A: 3D Virtual Environments and Applications, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Pouke

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS / 135 hours of work.

Language of instruction:

Primary instruction language is Finnish. The course can also be completed in English.

Timing:

The course is held in the spring semester, during period IV. It is recommended to complete the course during the 3rd year.

Learning outcomes:

Upon completion of the course, the student will be able to: Upon completion of the course, the student will be able to:

- Independently develop 3D applications containing an interactive environment utilizing contemporary game engines
- Develop game-engine compatible 3D objects utilizing low-polygon modeling
- Develop game-engine compatible materials utilizing Physically Based Rendering workflow
- Understand the principles of 3D application design for different platforms (mobile, desktop, VR)

Contents:

Game engine architecture, basics of 3D graphics, 3D modeling and animation, textures and materials, audio, interaction, multiplayer, game AI, performance and profiling, virtual reality.

Mode of delivery:

Online teaching.
The course consists of online lectures, exercises and a independent assignment.

Learning activities and teaching methods:

The course consists of online lectures (20h), exercises (16h), a group assignment (60), self-study (35h) and a seminar (4h).

Target group:

B.Sc. students from applied computing. The course might also be useful for students of Information processing science and students taking VR and XR related studies.

Prerequisites and co-requisites:

No prerequisites. Programming experience is an advantage.

Recommended optional programme components:

The course is an independent entity, and does not require other simultaneous courses from the student.

Recommended or required reading:

Online-material that is delivered throughout the course.

Assessment methods and criteria:

The students are assessed accorging to the quality of the group assignment (an interactive 3D application and related documentation) that is presented at the seminar. The assessment criteria of the application is based on the learning goals of the course.

Grading:

Numerical (1-5).

Person responsible:

Matti Pouke

Working life cooperation:

When possible, one or multiple visiting lectures by local companies are organized. The topic of the guest lecture can be related to the special knowledge of the visitor, or industry needs for 3D application development.

Other information:

This course uses Moodle learning environment (moodle.oulu.fi).

Supplementary Module: 3. Biomedical Engineering

080925A: Anatomy and Physiology for Biomedical Engineering, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Health Sciences

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Proficiency level:

-

Status:

-

Required proficiency level:

-

ECTS Credits:

5 ECTS, 135 hours of work

Language of instruction:

English

Timing:

Master studies, autumn term 1st period – THE COURSE WILL BE ORGANIZED NEXT TIME IN AUTUMN 2021

Learning outcomes:

-

Contents:

-

Mode of delivery:

-

Learning activities and teaching methods:

-

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

-

Grading:

-

Person responsible:

University lecturer Mikko Finnilä

Working life cooperation:

-

Other information:

THE DESCRIPTION WILL BE UPDATED FOR STUDY GUIDE 2021-2022

764327A: Virtual measurement environments, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Health Sciences
Arvostelu: 1 - 5, pass, fail
Opettajat: Jämsä, Timo Jaakko
Opintokohteen kielet: Finnish
Leikkaavuudet:

764627S	Virtual measurement environments	5.0 op

Proficiency level:

-

Status:

-

Required proficiency level:

-

ECTS Credits:

5 ECTS, 135 hours of work

Language of instruction:

Finnish (or English)

Timing:

Bachelor studies, autumn term, 2nd period

Learning outcomes:

The student will learn how to construct software environments for measurements and data analysis important in biomedical engineering and physics

Contents:

The course gives basic skills to use measuring and analyzing programmes applied not only in academic research but also in R&D of the companies, and their programming environments (Matlab, LabView).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 12 h, project work 65 h, self-study 58 h

Target group:

Bachelor students of Medical and Wellness Technology and Physics. Also for other students of the University of Oulu.

Prerequisites and co-requisites:

Basics / basic skills in programming

Recommended optional programme components:

The course is independent entity and does not require additional studies carried out at the same time. The course can also be completed as a part of advanced studies with the course code 764327S.

Recommended or required reading:

Lecture and exercise notes, other given material

Assessment methods and criteria:

Completion of projects. Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5 or fail. In the numerical grading scale zero stands for a fail. Grading is made based on the projects.

Person responsible:

Professor Timo Jämsä

Working life cooperation:

-

Other information:

-

080901A: Introduction to Technology in Clinical Medicine, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Health Sciences

Arvostelu: 1 - 5, pass, fail

Opettajat: Jämsä, Timo Jaakko

Opintokohteen kielet: Finnish

Proficiency level:

-

Status:

-

Required proficiency level:

-

ECTS Credits:

5 ECTS, 135 hours of work

Language of instruction:

Finnish

Timing:

Bachelor or Master studies, autumn term, 1st and 2nd periods

Learning outcomes:

The student can identify technologies in different fields of clinical medicine, can describe operating principles behind these technologies and evaluate the advantages and limitations of the technologies.

Contents:

Course introduction lectures. Specialists from different clinical areas give lectures and demonstrations, in which main themes and terms of the field are introduced and technical methods and development needs are presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Initial exam. Lectures, demonstrations, course assignment and self-study. Final exam which is based on lectures and all given materials.

Target group:

Students of medical and wellness technology, information technology, electrical engineering, mechanical engineering, industrial engineering and management, physics or of other related degree programmes interested in biomedical engineering and medical technologies.

Prerequisites and co-requisites:

-

Recommended optional programme components:

The course is independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

T. Sora, P. Antikainen, M. Laisalmi, S. Vierula: Sairaanhoidon teknologia, WSOY 2002.
P. Pölönen, T. Ala-Kokko et al.: Akuuttihoidon laitteet, Duodecim 2013. Available as an e-print: http://www.terveysportti.fi/dtk/aho/koti
The material addressed during the lectures.

Assessment methods and criteria:

Initial exam with multiple-choice questions. Taking part in the lectures and demos. Learning assignment. Final exam, which includes essays. Before participation in the final exam, the student must complete and pass the initial exam and learning assignment.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 1-5 or fail. Grading is based on the final exam.

Person responsible:

Professor Timo Jämsä

Working life cooperation:

The course will be mainly organized in the hospital, and lectures are given by clinical specialists.

Other information:

-

521242A: Introduction to Biomedical Engineering, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Myllylä

Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Period 1

Learning outcomes:

After completing the course, the student has a basic knowledge of the biomedical engineering discipline and the applications of engineering science to biomedical problems.

Contents:

Biomedical engineering is a multidisciplinary field of study that ranges from theory to applications at the interface between engineering, medicine and biology. This course will introduce the subdisciplines within biomedical engineering, including such as systems physiology, bioinstrumentation, bioimaging, biophotonics and biomedical signal analysis. General issues of the subdisciplines will be presented together with selected examples and clinical applications. A number of lectures will be given by professionals working in health tech companies, University of Oulu and Oulu University Hospital, presenting different fields of the biomedical engineering. In addition, course offerings of biomedical engineering at the University of Oulu are introduced.

Mode of delivery:

Face-to-face teaching. Under some circumstances distance learning using online material is possible (please, ask the teacher).

Learning activities and teaching methods:

The course includes online material, lectures and a group project. Lectures 28h and laboratory exercises 4 h and self-study 100h

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Participation in lectures or using the online material and writing a work report.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1 - 5, pass, fail

Person responsible:

Teemu Myllylä

Working life cooperation:

Guest lecturers

Other information:

-

080926A: Introduction to Biomedical Imaging Methods, 1 - 3 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Health Sciences
Arvostelu: 1 - 5, pass, fail
Opettajat: Lassi Rieppo
Opintokohteen kielet: English

Proficiency level:

-

Status:

-

Required proficiency level:

-

ECTS Credits:

1-3 ECTS credit points / 27-81 hours of work

Language of instruction:

English

Timing:

Master studies, spring term 4th period

Learning outcomes:

The student understands and can describe the basic principles and main applications of imaging methods used in biomedical research.

Contents:

Differences between in vivo, ex vivo and in vitro imaging.
Light and electron microscopy.
Optical projection and coherence tomography.
Optical in vivo imaging.
Magnetic resonance imaging.
Fourier transform infrared imaging spectroscopy and Raman imaging spectroscopy.
Micro-computed tomography.
Basics of image analysis and interpretation

Mode of delivery:

Face-to-face teaching. Compulsory participation in lectures.

Learning activities and teaching methods:

Number of ECTS cr of the course and the methods of implementation vary. The course includes lectures 19h, demonstrations 8h and final exam 3 h. Number of hours left for independent study depends on the number of the ECTS cr the student wishes to complete and is from 8 to 51 hours.

Target group:

All Bachelor´s, Master´s and postgraduate students interested in methods of biomedical imaging.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Handouts and literature given in the lectures

Assessment methods and criteria:

In this field, write with which method the teacher will monitor/
Participation in the lectures and demonstrations. Exam. The course can be completed with 1, 2 or 3 ECTS cr.
1 ECTS ¬# compulsory participation in lectures
2 ECTS ¬# compulsory participation in lectures and demonstrations
3 ECTS ¬# compulsory participation in lectures, demonstrations and final exam
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The 1 and 2 ECTS cr courses utilize verbal grading “pass” or “fail”. The 3 ECTS cr course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Dr Lassi Rieppo

Working life cooperation:

-

Other information:

-

Supplementary Module: 4. Information Processing Science, Can choose freely from the courses below.

810136P: Introduction to Information Processing Sciences, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Henrik Hedberg

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay810136P	Introduction to information processing sciences (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work.

Language of instruction:

Finnish

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st autumn semester of the Bachelor's studies. Another implementation, targeted especially for Open University and minor students, is held in the spring semester, during period 4.

Learning outcomes:

After passing the course, a student will be able to:
* describe the disciplines of Information Processing Science,
* explain the essential Information Processing Science concepts,
* name historically significant and current research topics in Information Processing Science,
* identify the characteristics and requirements of work tasks in the field of Information Processing,
* describe the principles of responsible conduct of research and professional ethics in Information Processing Science,
* retrieve, analyse, contest and classify information related to those, as well as
* discuss and report in written form on those using one reference convention of the scientific discipline.

Contents:

The course consists of lectures on disciplines, essential concepts, historically significant and current research, practical work life as well as responsible conduct of research and professional ethics in Information Processing Science. In addition, the student will familiarize with scientific work skills by listening, discussing, reading, thinking critically and creatively, retrieving data, classifying and presenting in written form.

Mode of delivery:

Distance or blended teaching

Learning activities and teaching methods:

Distance and potentially blended studies 133 h

Target group:

BSc students

Recommended optional programme components:

Recommended or required reading:

Digital study material, material searched by students themselves.

Assessment methods and criteria:

Exercise tasks.

Grading:

Numerical scale 1-5 or fail.

Person responsible:

Henrik Hedberg

Working life cooperation:

Cooperation with persons studied Information Processing Science and currently working.

811168P: Information Security, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tero Päivärinta

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay811168P	Information Security (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work.

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course in the 1st spring semester of the Bachelor's studies.

Learning outcomes:

After completing the course, the student will be able able to:
* define essential information security concepts and components of information systems security,
* recognize the common types of security threats, and their managerial and technical protection mechanisms,
* describe the tasks and responsibilities of information security professionals,
* explain the different phases of secure systems development/acquisition,
* recognize the fundamental characteristics of risk management and evaluate information security risks,
* recognize basics of technical information security methods and cryptography, as well as
* explain areas of behavioral information security research and their practical implications.

Contents:

* Basic concepts of information security
* Information security threats, vulnerabilities, and risks
* Legal issues and information security frameworks
* Risk management
* Cryptography
* Information security technologies
* Behavioral information security research

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures and related quizzes or final exam 26 h, weekly assignments and scientific essay 107 h

Target group:

BSc students.

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses are accomplished: Introduction to Information Processing Science as well as Devices and Data Network

Recommended optional programme components:

Recommended or required reading:

Lecture materials, selected articles, and book: Whitman & Mattord (2015). Principles of information security.

Assessment methods and criteria:

Weekly assignments. Group or individual assignment.

Grading:

Numerical scale 1-5 or fail.

Person responsible:

Tero Päivärinta

811174P: Introduction to Software Business, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Marianne Kinnula

Opintokohteen kielet: Finnish

Leikkaavuudet:

811178P	Technology Business and Innovations	5.0 op
ay811174P	Introduction to Software Business (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work.

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course at the 1st spring semester of the Bachelor's studies.

Learning outcomes:

After completing the course, a student will be able to:
* explain how the industry is structured;
* describe the software industry's business logic as typically used in business models and the reasoning behind their use;
* describe the important areas of the software business; as well as
* describe legal issues related to software business.

Contents:

This course provides an overview of software business from three different viewpoints: software industry, business logic, and functions of a software company.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Blended teaching 100 h, home essay 30 h

Target group:

BSc students.

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses are accomplished: Introduction to Information Processing Science

Recommended optional programme components:

-

Recommended or required reading:

Course material and related literature.

Assessment methods and criteria:

Assignments, take home examination.

Grading:

Numerical scale 1-5 or fail.

Person responsible:

Marianne Kinnula

811325A: Databases, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Iisakka, Juha Veikko

Opintokohteen kielet: Finnish

Leikkaavuudet:

811395A	Basics of Databases	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the autumn semester, during period 1. It is recommended to complete the course in the 2nd year autumn semester of the Bachelor's studies.

Learning outcomes:

After completing the course, the student will be able to:
* apply the theory of the relational databases and the basics of the set theory,
* build a good quality relational database and use queries,
* use a relational database for storing persistent objects,
* use conceptual modelling for designing databases, as well as
* normalise a database and assess its quality.

Contents:

* Conceptual modelling
* Relational model and database
* SQL
* Quality of database
* Storing objects to the relational database

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h, computer exercises 25 h, self-study 68 h

Target group:

BSc students

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses and their predecessors are accomplished: Programming 2.

Recommended or required reading:

Coronel C & Morris S (2018), Database systems : design, implementation, and management, Australia: Cengage Learning

Assessment methods and criteria:

Continuous evaluation. The course will be divided to parts. Every part will be evaluated and all parts must pass.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Juha Iisakka

811322A: Programming 2, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Päivi Raulamo-Jurvanen

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay811322A	Programming 2 (OPEN UNI)	5.0 op
812341A	Object-Oriented Programming	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during periods 3 and 4. It is recommended to complete the course at the 1st spring semester of the Bachelor's studies.

Learning outcomes:

After completion of this course, the student will be able to:
* describe the principles of object paradigm (encapsulation, polymorphism, inheritance, composition), generics, and design patterns and is able to utilise these concepts when creating software,
* describe exception and error management and create fault tolerant programs,
* explain the connection between the UML models and the source code,
* test an application and interpret the structure and functionality of the source code, as well as
* use basic programming tools, such as a version control system, an IDE, and code analysis tools.

Contents:

The concept of an object, encapsulation, composition, inheritance, polymorphism, exceptions, UML charts and code, generics (templates), libraries, containers, design patterns, development tools, version control, documenting, unit testing.

Mode of delivery:

Face-to-face teaching, can also be implemented as blended teaching

Learning activities and teaching methods:

Lectures 32 h and laboratory exercises 24 h (or an equivalent amount of independent learning) plus weekly assignments and independent work 72 h

Target group:

BSc students

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses are accomplished: Programming 1

Recommended or required reading:

Timothy Budd: Introduction to object-oriented programming, 3rd edition, and other material announced in the beginning of the course.

Assessment methods and criteria:

The weekly assignments (preferred) or a final exam in Examinarium + a programming assignment.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Päivi Raulamo-Jurvanen

811367A: Programming 3, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Kelanti

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course at the 2nd spring semester of the Bachelor's studies.

Learning outcomes:

After completion of this course, the student will be able to:
* recognise the influence and requirements of the interface specification on the server development and is able to apply them in his/her own work.
* implement and document a good quality database and use it in an application.
* iImplement and document the server functionality of a client-server application and apply concurrency when appropriate.
* use existing programming interfaces and message passing protocols in a server application
* test a server application and interpret code written by someone else.
* use programming tools, such as a version control system, an IDE, and code analysis tools in the server development.

Contents:

Databases, database programming, data formats, the design, implementation, and testing of a server interface, the safety and security of a server, concurrency.

Mode of delivery:

Face-to-face teaching, may also be implemented as blended teaching

Learning activities and teaching methods:

Lectures 32 h and laboratory exercises 24 h (or an equivalent amount of independent learning) plus weekly assignments and independent work 72 h

Target group:

BSc students

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses are accomplished: Data Structures and Algorithms

Recommended or required reading:

Announced in the beginning of the course.

Assessment methods and criteria:

Programming assignments and coursework defined during the course.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Markus Kelanti

811368A: Programming 4, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Lappalainen, Jouni Esko Antero

Opintokohteen kielet: Finnish

Leikkaavuudet:

811375A	User Interface Programming	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 4. It is recommended to complete the course at the 2nd spring semester of the Bachelor's studies.

Learning outcomes:

After completion of this course, the student will be able to:
* recognise the influence and requirements of the design/implementation interface on the user interface development process and is able to apply them in his/her own work,
* utilize UI libraries and frameworks in his/her application,
* implement and document the client functionality of a client-server application,
* test the application and test and interpret the code and the application structure with its effects to testing, maintenance and further development,
* use programming tools, such as a version control system, an IDE, and code analysis tools, as well as
* act as a member of a software development team.

Contents:

User interface elements, foundations of user interface libraries, user interface design principles, user interface layout, the relationship between user interfaces and software architectures, web usability, web user interfaces, web programming.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Exercise 24h, coursework 75h, independent study 35h

Target group:

BSc students

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses are accomplished: Programming 3

Recommended or required reading:

Provided reading material during the course. In addition, Lauesen, S. 2005. User Interface Design: A Software Engineering Perspective.

Assessment methods and criteria:

The student must submit coursework that fulfils the given requirements (defined with the student during the course), as well as answers to given study questions.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Jouni Lappalainen

811391A: Requirements Engineering, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Kelanti

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay811391A	Requirements Engineering (OPEN UNI)	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work.

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 4. It is recommended to complete the course in the 1st spring semester of the Bachelor's studies.

Learning outcomes:

After completing the course, the student will be able to:
* apply requirements engineering skills and techniques individually and in teams, and understands the requirements fundamentals,
* choose and apply some of the requirements elicitation techniques,
* choose and apply some of requirements specification and documentation techniques, as well as
* apply appropriate requirements validation techniques, as well as learn new requirements engineering methods and techniques.

Contents:

* Requirements traceability
* Different stakeholder viewpoints and requirement categories
* Requirements change
* Problem structuring methods
* Requirements engineering skills and techniques in iterative development environment
* Requirements identification, elicitation, specification and documentation techniques
* Requirements prioritization and validation techniques

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures and exercises 32h; independent work, group project and individual work 101h. Alternatively, independend study and book exam 133h.

Target group:

B.Sc. students.

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses and their predecessors are accomplished: Introduction to Software Engineering

Recommended optional programme components:

Recommended or required reading:

Wiegers, Karl & Beatty, Joy (2013). Software Requirements, 3rd Edition.

Assessment methods and criteria:

Active participation (lectures, weekly assignments, group project and individual project), or alternatively book exam

Grading:

Numerical scale 1-5 or fail.

Person responsible:

Markus Kelanti

Working life cooperation:

Guest lectures

811306A: Software Quality and Testing, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Mäntylä

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the autumn semester, during period 2. It is recommended to complete the course at the 2nd autumn semester of the Bachelor's studies.

Learning outcomes:

After passing the course, the student will be able to:
* describe of different views on software quality and the role of testing in software engineering,
* detect defects in software using different techniques,
* describe testing levels, and techniques,
* create test cases and conduct unit testing with appropriate testing tools,
* describe the basics of test-driven development and test automation, as well as
* define the scope of software testing and quality assurance projects.

Contents:

1. Why Testing and Software quality are important
2. Testing as a process
3. Testing as a technique
4. Designing tests (using testing techniques and domain knowledge)
5. Oracles and Coverage
6. Unit testing and TDD

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Independent work, Group exercise sessions, Lectures, Project Based Learning, Visiting Lectures from Industry

Target group:

BSc students

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses are accomplished: Software Modeling and Design

Assessment methods and criteria:

Lab Exercises, Quiz, Final exam, Student project

Grading:

Numerical scale 1-5 or fail

Person responsible:

Mika Mäntylä

Working life cooperation:

Guest lectures when available

811319A: Data Modeling and Design, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Iisakka, Juha Veikko

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course in the 2nd spring semester of the Bachelor's studies.

Learning outcomes:

After completing the course, the student will be able to:
• compare traditional relational database to modern distributed databases, as well consider the influence of CAP-theorem to distributed databases,
• identify features affecting the quality of non relational databases and choose appropriate implementation of non relational database for use,
• explain data persistency concepts and can apply database transaction management principles while using databse systems, as well as
• describe (typical) contemporary database solutions and their role in large-scale software systems (such as ERP).

Contents:

Modern database solutions and the use of them as well transactions, concurrency and recovery.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 4 h, Exercises 12 h, Study groups 8 h (+preparation 32 h), online assignments 36 h, litterature reviews 40 h

Target group:

BSc students

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses and their predecessors are accomplished: Software Quality and Testing, Databases

Recommended or required reading:

Will be anounced in the course. Scientific articles.

Assessment methods and criteria:

Continuous evaluation.
Study groups, online assignments, litterature reviews

Grading:

Numerical scale 1-5 or fail

Person responsible:

Juha Iisakka

815345A: Software Architectures, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Pertti Seppänen

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 4. It is recommended to complete the course at the 2nd spring semester of the Bachelor's studies.

Learning outcomes:

After passing the course, the student is able to:
* describe the concepts and techniques of the software architecture design – especially in case of object-oriented design,
* describe typical architecture solutions of main-stream modern software solutions – for instance apps of smart devices and server-based systems,
* identify and analyze the pros and cons of different software architectures from the viewpoints of software design & implementation, software execution, software quality and software maintainability,
* use UML modeling techniques to describe different perspectives of a software architecture,
* create different optional architectural solutions for a software based on its functional and non-functional requirements and evaluate the applicability of the optional architectures to the problem in question, as well as
* describe the role of architectural design in agile and iterative software development processes.

Contents:

The fundamentals of software architectures. Documenting software architectures. Components and interfaces, Software dependencies. Design patterns. Architectural styles. Evaluation methods of software architectures. Agile and iterative software development processes and software archteture desing.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 24 h, exercises 20 h, exercise work as group work 90 h.

Target group:

BSc students.

Prerequisites and co-requisites:

The required prerequisite is that the learning outcomes of the following courses and their predecessors are accomplished: Data Modeling and Design

Recommended or required reading:

Robert Hanmer: Pattern-Oriented Software Architecture For Dummies, 2013; K. Koskimies, T. Mikkonen: Ohjelmistoarkkitehtuurit. Talentum 2005; L. Bass, R. Clements, R. Kazman: Software Architecture in Practice Third Edition. Addison-Wesley 2013; Agile Software Architecture 1st Edition Aligning Agile Processes and Software Architectures (2013) to an applicable extend.

Assessment methods and criteria:

The course is passed by participating in the course assignments as well as by evaluation of the exercise work.

Grading:

Numerical scale 1-5 or fail.

Person responsible:

Pertti Seppänen

Working life cooperation:

Guest lectures

811379A: Basics of Human Computer Interaction, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Helena Tokkonen

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay811379A Basics of Human Computer Interaction (OPEN UNI) 5.0 op

812327A Introduction to HCI design 4.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the autumn semester, during period 2. It is recommended to complete the course at the 2nd autumn semester of the Bachelor's studies.

Learning outcomes:

Upon completion of the course, the student will be able to define basic concepts of user interface design, introduce basic design process with design and evaluation methods and tasks, and apply graphical user interface design from the viewpoint of a certain user group and system.

Contents:

Basic concepts of user interface design and usability evaluation; user-centred design process; gathering of user data, analysis, expert evaluation and design by prototyping, user-based evaluation; universal design and user support; user interface description.

Learning activities and teaching methods:

Lectures 20 h, guided group assignment tasks in exercises 21 h and without guidance in assignment groups 58 h; seminar 3 h; individual tasks 31 h

Target group:

BSc students

Prerequisites and co-requisites:

Humans as Users and Developers of Information Technology (811177P) -course or related knowledge.

Recommended or required reading:

Dix et al. (2003, third or later edition) Human-Computer Interaction, lectures in Moodle and excersises material.

Assessment methods and criteria:

During the course, the students will be compiling the group assignments and individual integration tasks on their implementation. These will be assessed based on the learning outcomes of the course. The assessment criteria and the requirements will be explained in detail during the opening lecture of the course.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Helena Tokkonen

Other information:

Kurssin aloitusluento 26.10 klo 12.15 -14.00 (Zoom: https://oulu.zoom.us/j/3613543762, meeting ID: 361 354 3762)

Kurssiavain Moodle-ympäristöön: KLP2020 (Kurssi avautuu 20.10.)

812332A: Information Systems Design, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Liisa Kuonanoja

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is held in the spring semester, during period 3. It is recommended to complete the course in the 2nd or 3rd year spring semester of the Bachelor's studies.

Learning outcomes:

After completing the course, the student is able to understand the link between information system design and organizational development, and to apply such a system design method in an organizational context.

Contents:

During the course the students complete a group exercise (typically in groups of 4 persons) using Contextual Design method and its design stages that lead to actual information systems implementation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 20 h, exercises 12 h, group work 90 h, seminar 11 h

Target group:

BSc students

Prerequisites and co-requisites:

Prerequisite is 811169P Introduction to Information Systems Design

Recommended or required reading:

Preferable: Beyer, H. Holtzblatt, K. (1998): Contextual Design: Defining Customer-Centered Systems. San Francisco: Morgan Kaufmann Publishers, Inc. Alternative: Holtzblatt, K., & Beyer, H. (2016). Contextual design: Design for life. Morgan Kaufmann.

Assessment methods and criteria:

The course is normally completed as group work, and the output is presented in a course seminar. The work follows the stages of Contextual Design method and the exercise assignments support the completion of the course work. Course work reports are presented and reviewed in a final seminar. In special circumstances the course can also be completed as individual work.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Liisa Kuonanoja

811375A: User Interface Programming, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Lappalainen, Jouni Esko Antero

Opintokohteen kielet: Finnish

Leikkaavuudet:

811368A	Programming 4	5.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is not lectured anymore, because it is not part of the new curriculum. However, it can be taken as a self-study course during the academic year 2020-2021. In that case, contact the responsible teacher. Later, if the course is obligatory in your degree programme structure, it must be replaced with another course. In that case, contact your tutor teacher or academic affairs.

Learning outcomes:

After completing the course, the student can implement a software application that has a graphical user interface. The GUI (as well as the entire application) must be developed by implementing usability design principles from the beginning of the development process.

Contents:

User interface elements, foundations of user interface libraries, user interface design principles, user interface layout, the relationship between user interfaces and software architectures, event-driven programming, web usability, web user interfaces, web programming.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Coursework 75h, independent study 59h

Target group:

BSc students

Prerequisites and co-requisites:

Fundamentals of user interface design. In addition, the knowledge and skills of object-oriented programming are needed.

Recommended or required reading:

Provided reading material during the course. In addition, Lauesen, S. 2005. User Interface Design: A Software Engineering Perspective.

Assessment methods and criteria:

The student must submit coursework that fulfils the given requirements (defined separately), as well as answers to given study questions.

Grading:

Numerical scale 1-5 or fail

Person responsible:

Jouni Lappalainen

813316A: Business Process Modeling, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Karin Väyrynen

Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 133 hours of work.

Language of instruction:

English

Timing:

The course is held in the spring semester, during period 4. It is recommended to complete the course at the 3rd spring semester of the Bachelor's studies.

Learning outcomes:

After completing the course, the student will be able to:
* model and design business processes;
* use a computer-based process modeling tool;
* distinguish between business process change on the enterprise level, business process level and the implementation level; as well as
* design process architecture in teamwork with other students.

Contents:

Process architecture and how it can be fitted to the organisation, process modelling, process performance measurement, understanding process-related problems, process development, software tools for modelling and analysing processes, exercises.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 26 h (or exam), exercises 13 h, individual assignments (lecture assignments, small process model, etc.) 34 h, large process model (group work) 60 h.

Target group:

BSc students.

Recommended or required reading:

Harmon, Paul (2007). Business Process Change. A Guide for Business Managers and BPM and Six Sigma Professionals. Morgan Kaufmann Publishers. Additional material to be announced during the course.

Assessment methods and criteria:

This course unit utilizes continuous assessment. Students can either participate in the lectures (min. 85 % attendance required) or take the exam. All students will write lecture assigments, and will create a process architecture / model with a software tool. The assessment of the course unit is based on the learning outcomes of the course unit.

Grading:

Numerical scale 1-5 or fail.

Person responsible:

Karin Väyrynen

Supplementary Module: 5. Industrial Engineering and Management

555225P: Basics of industrial engineering and management, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Industrial Engineering and Management

Arvostelu: 1 - 5, pass, fail

Opettajat: Elina Jääskä

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay555225P	Basics of industrial engineering and management (OPEN UNI)	5.0 op
555221P	Introduction to Production	2.0 op
555220P	Basic Course in Industrial Engineering and Management	3.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

Finnish. English material is also used.

Timing:

Period 1.

Learning outcomes:

Upon completion of the course, the student will be able to:

- describe what industrial engineering and management (or operations management) means
- explain the core concepts of business operations and utilise these concepts in describing and analysing operations of an organisation
- explain in general terms the factors that affect economic performance of organisations
- utilise the terminology used in industrial engineering and management (operations management), describe the financial processes of companies and based on this describe the use of cost accounting in organisational decision-making
- calculate unit costs in various simplified settings, calculate various alternatives, as well as perform planning and goal oriented calculations based on given data, and draw conclusions based on the calculation results

Contents:

Operations and productivity, operations strategy, forecasting, accounting and cost accounting, investments and financial planning, sustainability, capacity management, location decisions, layout strategies, human resources management, supply chain management, subcontracting, inventory management, production planning, MRP & ERP, production scheduling, Just-in-Time & Lean operations, maintenance.

Mode of delivery:

Web-based teaching 20 hours / practices 14 hours / Independent studying 100 hours.

Learning activities and teaching methods:

Web-based lectures 20 h / exercises 14 h / self-study 100 h.

Target group:

Industrial Engineering and Management students and other students taking Industrial Engineering and Management as minor.

Prerequisites and co-requisites:

No prerequisites exist.

Recommended optional programme components:

This course is part of the 25 ECTS module of Industrial engineering and management that also includes 555285A Project management, 555242A Product development, 555264P Managing well-being and quality of working life, and 555286A Process and quality management.

Recommended or required reading:

Lecture and exercise materials. Heizer, J. & Render, B. (2014) Operations management: sustainability and supply chain management, 11th ed. Pearson. In addition, recommended materials include Martinsuo, M. et al. (2016) Teollisuustalous kehittyvässä liiketoiminnassa chapters 7-9, 16 and 26.

Assessment methods and criteria:

This course utilises continuous assessment. During the course, there are seven mandatory weekly assignments.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

MSc (Tech.) Elina Jääskä

Working life cooperation:

-

Other information:

Substitutes courses 555220P Basic Course in Industrial Engineering and Management 3 ECTS cr and 555221P Introduction to Production 2 ECTS cr.

555285A: Project management, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Industrial Engineering and Management

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

555288A Project Management 5.0 op

ay555285A Project management (OPEN UNI) 5.0 op

555282A Project Management 4.0 op

555280P Basic Course of Project Management 2.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

Finnish. Check the course in English 555288A Project Management.

Timing:

Period 2.

Learning outcomes:

Upon completion of the course, the student will be able to:

- describe explain the essential concepts and methods related to project management
- apply project management methods to create a schedule for a project and calculate critical path
- understand essential concepts related to project cost management and able to apply earned value method and three point estimate to manage project costs
- recognises the essential tasks of project risk management

Contents:

Defining project management, project goals and objectives, project phases and project life-cycle management, project planning, organising and scope management, schedule management, cost management, earned value calculation and project risk management, project stakeholder management, project communications management, the role of project manager, new modes of project delivery

Mode of delivery:

The tuition will be implemented as web-based teaching.

Learning activities and teaching methods:

Web-based lectures 16h, self-study 118h

Target group:

Industrial Engineering and Management students and other students taking Industrial Engineering and Management as minor.

Prerequisites and co-requisites:

No prerequisites exist.

Recommended optional programme components:

This course is part of the 25 ECTS module of Industrial engineering and management that also includes555225P Basics of industrial engineering and management, 555242A Product development, 555264P Managing well-being and quality of working life, and 555286A Process and quality management.

Recommended or required reading:

Lecture material, exercise book, Artto, Martinsuo & Kujala 2006. Projektiliiketoiminta. WSOY

Assessment methods and criteria:

Weekly assignments and final online exam

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Assistant professor Kirsi Aaltonen

Working life cooperation:

Videos from the industry’s projects

Other information:

Substitutes courses 555280P Basic Course of Project Management + 555282A Project Management.

555242A: Product development, 5 op

Voimassaolo: 01.01.2014 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Industrial Engineering and Management
Arvostelu: 1 - 5, pass, fail
Opettajat: Haapasalo, Harri Jouni Olavi
Opintokohteen kielet: English
Leikkaavuudet:

ay555242A	Product development (OPEN UNI)	5.0 op
555240A	Basic Course in Product Development	3.0 op

ECTS Credits:

5 ECTS credits**.**

Language of instruction:

English.

Timing:

Periods 1-2.

Learning outcomes:

This course introduces product development and innovations management in a company environment. The course provides fundamental understanding over tools and frameworks that can be used for analysing and managing products, innovations, and technology development. The aim is to create a connection between product development and other company functions. Upon completion of the course, the student will be able to

- explain the role of product development as a company function
- understand the difference between innovation activities and systematic product development, and knows the difference between different phases of product development process and its activities
- transform customer needs into requirements for product development process and finally into product features
- define the meaning of other company functions to product development activities

Contents:

Meaning of products for the operations of an industrial enterprise, product development paradigm and defining relevant concepts, realising product development methodologically (U&E model, Cooper's stage-gate model, QFD), managing innovations, and product development success factors.

Mode of delivery:

The tuition will be implemented as face-to-face teaching.

Learning activities and teaching methods:

Lectures 20 h / exercises 6 h / group work and self-study 108 h.

Target group:

Industrial Engineering and Management students and other students taking Industrial Engineering and Management as minor.

Prerequisites and co-requisites:

555226A Operations and supply chain management (Operations and production)

Recommended optional programme components:

This course is part of the 25 ECTS module of Industrial engineering and management that also includes 555225P Basics of industrial engineering and management, 555285A Project management, 555264P Managing well-being and quality of working life, and 555286A Process and quality management.

Recommended or required reading:

Handouts, course work, and a collection of articles. Ulrich, K. & Eppinger, S. (2008) Product Design and Development. McGraw-Hill. 358 p.

Assessment methods and criteria:

Exam and group work.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Professor Harri Haapasalo.

Working life cooperation:

No.

Other information:

Substitutes course 555240A Basic Course in Product Development.

555286A: Process and quality management, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Industrial Engineering and Management

Arvostelu: 1 - 5, pass, fail

Opettajat: Osmo Kauppila

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay555286A	Process and quality management (OPEN UNI)	5.0 op
555281A	Basic Course of Quality Management	5.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

Finnish.

Timing:

Period 4.

Learning outcomes:

Upon completion of the course, the student will be able to:

- explain the role of process and quality management in a business organisation
- develop business processes based on the principles of quality management and appropriate tool

Contents:

Foundations of total quality management, planning of quality, performance measurement, process management, people management in relation to quality management, implantation of total quality management.

Mode of delivery:

The tuition will be implemented as face-to-face teaching (integrated classroom lectures and exercises).

Learning activities and teaching methods:

20 h lectures, 114 h independent study

Target group:

Industrial Engineering and Management students and other students studying Industrial Engineering and Management as minor.

Prerequisites and co-requisites:

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Recommended optional programme components:

This course is part of the 25 ECTS module of Industrial engineering and management that also includes 555225P Basics of industrial engineering and management, 555285A Project management, 555242A Product development, and 555264P Managing well-being and quality of working life.

Recommended or required reading:

Oakland, J.S. (2014) Total quality management and operational excellence (4th ed.). Routledge, 529 pp. and material handed out during the course.

Assessment methods and criteria:

To pass the course, the student must pass the weekly course exercises (50 % of the course grade) and an exam (50 %).

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

University lecturer Osmo Kauppila.

Working life cooperation:

No.

Other information:

Substitutes course 555281A Basic Course of Quality Management.

555264P: Managing well-being and quality of working life, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Industrial Engineering and Management

Arvostelu: 1 - 5, pass, fail

Opettajat: Arto Reiman

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay555264P	Managing well-being and quality of working life (OPEN UNI)	5.0 op
555261A	Basic Course in Occupational Psychology	3.0 op
555262A	Usability and Safety in Product Development	3.0 op

ECTS Credits:

5 ECTS credits.

Language of instruction:

Finnish. English material is also used.

Timing:

Periods 3-4.

Learning outcomes:

Upon completion of the course, the student will be able to:

- set targets and choose appropriate methods of developing well-being at work both at personal and organizational levels
- develop well-being at work in the contexts of labor legislation, good practices, productivity, occupational safety expertise, management and human resources
- know the key sources of information, typical goal-setting and management practices and the methods for assessing the performance at individual and organizational levels
- assess the economic impacts of well-being at work, especially in cases of work ability, occupational health, job satisfaction, occupational safety, productivity and the overall quality of working life
- know essential national and international regulation and strategic goal setting practices, good practices of the case companies, current trends, and methods in research.

Contents:

The course gives the student a vision of building sustainable, productive and satisfactory career. The contents cover the whole area of basic quality issues of working life analysing them in the following framework "Well-being at work means safe, healthy, and productive work in a well-led organisation by competent workers and work communities who see their job as meaningful and rewarding, and see work as a factor that supports their life management".

Mode of delivery:

The tuition will be implemented as blended teaching (web-based teaching and face-to-face teaching).

Learning activities and teaching methods:

Lectures 10 h / self-study 70 h / group work & exercises 42 h.

Target group:

Industrial Engineering and Management students and other students taking Industrial Engineering and Management as minor.

Prerequisites and co-requisites:

No prerequisites exist.

Recommended optional programme components:

This course is part of the 25 ECTS module of Industrial Engineering and Management that also includes 555225P Basics of industrial engineering and management**,** 555285P Project Management, 555242A Product development, and 555286A Process and quality management.

Recommended or required reading:

Applicable parts of Arnold, J. et al. (2010), Work Psychology; Understanding Human Behaviour in the Workplace. 5th Edition. Financial Times/Prentice Hall and Aura, O. & Ahonen, G. Strate-gisen hyvinvoinnin johtaminen, Alma Talent. Other literature will be informed during the course.

Assessment methods and criteria:

This course utilises continuous assessment including exercises during the lectures (weight 20 %), group work (weight 40 %) and examination (weight 40 %).

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Dr. Arto Reiman

Working life cooperation:

-

Other information:

Substitutes courses 555261A Basic Course in Occupational Psychology + 555262A Usability and Safety in Product Development.

761108P: Physical world view, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761112P	Physical world view	3.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

Autumn

Learning outcomes:

After the course student can see the position of physics in the advancement of scientific world view and technology. The student has a comprehensive view of different learning and studying methods (s)he can use later on.

Contents:

The forming of key concepts in physics, using models and observations in advancing both classical and modern physics. The meaning of applying physics in modern society. Getting to know different areas of physics research and employment opportunities for physicists.

Mode of delivery:

Multiform teaching

Learning activities and teaching methods:

48 h face-to-face teaching, 85 h independent work including course work and group work

Target group:

Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.

Prerequisites and co-requisites:

No specific prerequisites

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously.

Recommended or required reading:

Feynman, R. The Character of Physical Law, Penguin Books 1992 (or equivalent, there are several prints). The original Massenger Lectures by Richard Fenyman in 1965 (7x55min) can be found online with search "Richard Feynman messenger lectures".

Assessment methods and criteria:

Passed course work or final exam

Grading:

Numerical grading scale 0-5, where 0 = fail

Person responsible:

Pauli Väisänen

Working life cooperation:

No work placement period

761118P: Mechanics 1, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Aku Venhola

Opintokohteen kielet: Finnish

Leikkaavuudet:

766343A	Mechanics	7.0 op
761111P	Basic mechanics	5.0 op
761101P	Basic Mechanics	4.0 op
766323A	Mechanics	6.0 op
761323A	Mechanics	6.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work
- 761118P-01, Lectures and exam (4 cr)
- 761118P-02, Lab. exercises (1 cr)

Language of instruction:

The lectures will be in Finnish. The textbook is in English and exercises are selected from the textbook. For further information, contact the responsible person of the course.

Timing:

Autumn

Learning outcomes:

The student is able to describe the basic concepts of mechanics and to apply those when solving the problems related to mechanics.

Contents:

We encounter many phenomena related to mechanics in our everyday life. Most engineering sciences are based on mechanics and mechanics forms the basis of many other fields of physics, including modern physics. Contents in brief: Short summary of vector calculus. Kinematics, projectile motion and circular motion. Newton’s laws of motion. Work and different forms of energy. Momentum, impulse and collisions. Rotational motion and moment of inertia. Torque and angular momentum. Rigid body equilibrium problems. Gravitation. Periodic motion. Fluid mechanics.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, 7 exercises (14 h), 2 laboratory exercises (3 hours/exercise), self-study 83 h

Target group:

For the students of the University of Oulu.

Prerequisites and co-requisites:

Knowledge of vector calculus and basics of differential and integral calculus.

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously.

Recommended or required reading:

Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 13th edition, 2012, chapters 2-14. Also older and newer editions can be used. Lecture material: Finnish lecture material will be available on the web page of the course.

Assessment methods and criteria:

Both parts (761118P-01 and 761118P-02) will be graded separately. The final grade of the course is the weighted average of the grades of part 1 (4 cr) and part 2 (1 cr).
761118P-01: Two midterm exams or final examination
761118P-02: Two laboratory exercises.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Aku Venhola

Working life cooperation:

No work placement period

761119P: Electromagnetism 1, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Timo Asikainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

761113P-01 Electricity and magnetism, lectures and exam 0.0 op

761113P-02 Electricity and magnetism, lab. exercises 0.0 op

761113P Electricity and magnetism 5.0 op

766319A Electromagnetism 7.0 op

761103P Electricity and Magnetism 4.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work
- 761119P-01, Lectures and exam (4 cr)
- 761119P-02, Lab. exercises (1 cr)

Language of instruction:

Finnish

Timing:

Second fall term

Learning outcomes:

The student will be able to understand the basic concepts of electromagnetism and can apply this understanding to solve problems related to electromagnetism.

Contents:

Basic principles of electromagnetic phenomena and their physical and geometric interpretation. More detailed contents will be presented later.

Mode of delivery:

face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h, 7 exercises (14 h), 2 laboratory exercises (3 hours/exercise), self-study 83 h

Target group:

For the students of the University of Oulu.

Prerequisites and co-requisites:

Knowledge of vector calculus and basics of differential and integral calculus.

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously.

Recommended or required reading:

Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 13. ed., chapters 21-31. Also other editions can be used. Lecture material in finnish.

Assessment methods and criteria:

Both parts (761119P-01 and 761119P-02) will be graded separately. The final grade of the course is the weighted average of the grades of part 1 (4 cr) and part 2 (1 cr).
761119P-01: Three small midterm exams or final examination
761119P-02: Two laboratory exercises
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Timo Asikainen

761313A: Atomic physics 1, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Saana-Maija Aho

Opintokohteen kielet: Finnish

Leikkaavuudet:

766326A	Atomic physics	6.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

Second autumn term

Learning outcomes:

Student can explain the development of the atomic model. Student is able to describe some interaction mechanisms of electromagnetic radiation and matter. Student can resolve easy quantum mechanical problems. Student can describe the principles used when the wave functions and energies of some simple systems are determined. Student can take advantage of the periodic table of elements in finding the chemical and physical properties of atoms based on its electronic structure.

Contents:

In the beginning of the course, the historical events which led to the development of the quantum mechanics and the modern atomic model in the early 20th century are discussed. In this context, the interaction processes between matter and electromagnetic radiation, like black-body radiation, the photoelectric effect, and scattering, are examined. In quantum mechanics, particles are usually described with the aid of wave functions. De Broglie wavelength, the group and phase velocities of particles, and Heisenberg uncertainty principle serve as an introduction to the wave properties of particles. The Bohr's atomic model, electronic transitions of atoms, and emission spectra of atoms are also discussed. The first touch to the quantum mechanics is the solutions of wave functions and energies for some simple systems, like hydrogen atom, are described. Additionally, many-electron atoms are discussed briefly. Some modern research methods which are used to study the atomic physics are introduced. Applications which exploit the atom physical phenomena in everyday life are also discussed.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h, 7 exercises, self-study 90 h

Target group:

No specific target qroup

Prerequisites and co-requisites:

No specific prerequisites

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Books: A. Beiser: Concepts of Modern Physics, McGraw-Hill Inc.

Assessment methods and criteria:

Group or individual excercises, webexcercises or final exam.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Saana-Maija Huttula

Working life cooperation:

No work placement period

761314A: Thermophysics, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Perttu Lantto

Opintokohteen kielet: Finnish

Leikkaavuudet:

766348A	Thermophysics	7.0 op
766328A	Thermophysics	6.0 op
761328A	Thermophysics	4.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

Third autumn semester

Learning outcomes:

The student can explain the basic concepts of thermophysics and can show how the following results (see Contents) arise from them at the level they are presented in lectures. In addition, the student can solve such problems that necessitate deep understanding of the content represented in the course.

Contents:

The goal of the course is to explain how the macroscopic thermophysical properties of a system (e.g., equation of state) can be derived from its fundamental microscopic properties (e.g., from the behavior of the molecules). For this purpose, the students are given a physically clear understanding of the basic principles of thermophysics, recognizing the fundamental role of its statistical nature. Topics will include: Basic concepts, The first law, Thermal expansion, heat transfer, and diffusion, The second law, The combined law, Heat engines and refrigerators, Thermodynamic potentials, Phases of matter, Classical ideal gas, Classical and open systems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

14 lectures (28 h), 7 exercises (14 h), self-study 91 h

Target group:

Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.

Prerequisites and co-requisites:

No specific prerequisites

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Textbooks: H. D. Young and R. A. Freedman: University Physics, 13th edition, Pearson Addison-Wesley, 2012, or earlier editions (in part), F. Mandl: Statistical Physics, second edition, John Wiley & Sons Ltd., 1988 (in part).
Lecture notes: Juhani Lounila: 766328A Termofysiikka, Oulun yliopisto, 2016.

Assessment methods and criteria:

One final examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Perttu Lantto

Working life cooperation:

No work placement period

761310A: Wave motion and optics, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766349A	Wave motion and optics	7.0 op
761114P	Wave motion and optics	5.0 op
761114P-02	Wave motion and optics, lab. exercises	0.0 op
761114P-01	Wave motion and optics, lectures and exam	0.0 op
766329A	Wave motion and optics	6.0 op
761104P	Wave Motion	3.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish. The course material and exercises are available in English.

Timing:

First spring

Learning outcomes:

The student is able to treat different types of waves by methods of general theory of wave motion. The student is also able to solve problems related to basic optics and apply her/his knowledge to teaching and research in physics.

Contents:

General principles of wave motion, sound, electromagnetic waves, propagation of light, image formation in mirrors and lenses, optical instruments, interference, Fraunhofer diffraction, diffraction grating.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h, exercises 14 h, 2 laboratory exercises (3 hours/exercise), self-study 90 h

Target group:

No specific target qroup

Prerequisites and co-requisites:

Basic skills in mathematics.

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

H. D. Young and R. A. Freedman, University Physics, Addison-Wesley, 2000 ja 2004, F. L. Pedrotti ja L. S. Pedrotti, Introduction to optics, Prentice-Hall, 2. ed., 1993 ja E. Hecht, Optics, (3rd ed.), Addison Wesley Longman, 1998.

Assessment methods and criteria:

Two written intermediate examinations or one final examination

Grading:

Numerical grading scale 0 – 5, where 0 is fail

Person responsible:

Seppo Alanko

Working life cooperation:

No work placement period

Other information:

Includes parts:
761310A-01 Wave motion and optics, lectures and exam
761310A-02 Wave motion and optics, lab. exercises

763343A: Solid state physics, 5 op

Voimassaolo: 01.12.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766330A Structure of matter 6.0 op

766330A-02 Structure of matter, part 2: Nuclear and particle physics 0.0 op

766330A-01 Structure of matter, part 1: Solid state physics 0.0 op

763333A Structure of matter I 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd spring

Learning outcomes:

To learn to explain the basics of solid state physics such as lattice structure, binding interactions, lattice vibrations, band structure and its effect on conductivity, conductivity of semiconductors, the interaction between light and matter, magnetism and superconductivity, and to apply these to different materials.

Contents:

The rapid development of technology is largely based on understanding the properties of the solid state. There are many interesting phenomena in solid state physics, which are consequences of very large number of particles and their interactions. The course starts with symmetry of crystal lattices and their experimental determination. Different binding forces of solids are discussed. Lattice vibrations and their contribution to specific heat are studied. Especial emphasis is put on electronic structure, and it is used to explain the electric conduction in metals, insulators and semiconductors. Also experimental methods, magnetism and superconductivity are discussed.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 16 h, self-study 87 h

Target group:

Primarily for the students of the degree programme in physics.
Also for the other students of the University of Oulu.

Prerequisites and co-requisites:

Atomic physics 1 (766326A), Electromagnetism (766319A). An important supporting course is Thermophysics (766328A/766348A).

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously.

Recommended or required reading:

E. Thuneberg: Kiinteä aineen fysiikka (lecture notes), C. Kittel: Introduction to solid state physics.

Assessment methods and criteria:

Examination

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Matti Alatalo

Working life cooperation:

No work placement period

Supplementary Module: 7. Chemistry

780117P: General and Inorganic Chemistry A, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Chemistry

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

780120P	Basic Principles in Chemistry	5.0 op
ay780117P	General and Inorganic Chemistry A (OPEN UNI)	5.0 op
780115P	General and Inorganic Chemistry II	6.0 op
780114P	General and Inorganic Chemistry I	6.0 op
780113P	Introduction to Chemistry	12.0 op
780102P	Introduction to Inorganic Chemistry	5.0 op
780109P	Basic Principles in Chemistry	4.0 op

ECTS Credits:

5 credits / 134 hours of work

Language of instruction:

Finnish

Timing:

1st autumn

Learning outcomes:

After this course, the student:
- can explain organic and inorganic chemistry fundamentals, basic concepts and terminology.
- understand basic concepts of chemistry as described in international general chemistry curriculum.

Contents:

Basic concepts of chemistry, chemical formula, chemical reaction, chemical equation, oxidation-reduction reactions, stoichiometry, gases, chemical equilibrium, acids and bases, additional aspects of acid-base equilibria, solubility and complex-ion equilibria.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

30 hours of lectures and applications, 20 hours of exercises and 85 hours of self-study.

Target group:

Biochemistry, Chemistry compulsory. In the entity of 25 credits (minor studies), compulsory.
Physical sciences, Mathematical sciences, optional.

Prerequisites and co-requisites:

Upper secondary school chemistry.

Recommended optional programme components:

-

Recommended or required reading:

Petrucci, R.H., Herring, F.G., Madura, J.D. ja Bissonnette, C.: General Chemistry: Principles and Modern Applications, 11. edition (also 7., 8., 9. ja 10. edition), Pearson Canada Inc., Toronto, 2017. Chapters 1-6, 14.2, 15-18.

Assessment methods and criteria:

Two intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Johanna Havia

Working life cooperation:

No

Other information:

No

780118P: General and Inorganic Chemistry B, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Chemistry

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay780118P	General and Inorganic Chemistry B (OPEN UNI)	5.0 op
780114P	General and Inorganic Chemistry I	6.0 op
780115P	General and Inorganic Chemistry II	6.0 op
780113P	Introduction to Chemistry	12.0 op
780101P	Introduction to Physical Chemistry	7.0 op
780102P	Introduction to Inorganic Chemistry	5.0 op

ECTS Credits:

5 ECTS credits / 134 hours of work

Language of instruction:

Finnish

Timing:

1st autumn

Learning outcomes:

After this course, the student:
- can explain inorganic chemistry fundamentals, basic concepts and terminology
- understand basic concepts of chemistry as described in international general chemistry curriculum.

Contents:

Thermodynamics, reaction kinetics, electrochemistry, electrons in atoms, periodic table, chemical bond, intermolecular forces.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

32 hours of lectures and applications, 18 hours of exercises, 85 hours of self-study.

Target group:

Biochemistry, Chemistry, compulsory. In the entity of 25 credits (minor studies), compulsory.
Physical sciences, Mathematical sciences, optional.

Prerequisites and co-requisites:

Upper secondary school chemistry.

Recommended optional programme components:

-

Recommended or required reading:

Petrucci, R.H., Herring, F.G., Madura, J.D. ja Bissonnette, C.: General Chemistry: Principles and Modern Applications, 11. edition (also 7., 8., 9. ja 10. edition), Pearson Canada Inc., Toronto, 2017. Chapters 7-11.1- 11.7, 12.1, 13, 19-20.

Assessment methods and criteria:

Two intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Matti Niemelä

Working life cooperation:

No

Other information:

No

780116P: Introduction to Organic Chemistry, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Chemistry

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay780116P	Introduction to Organic Chemistry (OPEN UNI)	5.0 op
780103P2	Organic Chemistry I	6.0 op
780108P	Basic Course in Organic Chemistry	6.0 op
780112P	Introduction to Organic Chemistry	4.0 op
780103P	Introduction to Organic Chemistry	6.0 op

ECTS Credits:

5 ECTS credits / 134 hours of work

Language of instruction:

Finnish. Book-examination in English as well.

Timing:

1st spring

Learning outcomes:

After this course, the student:
- can recognize and name basic organic compunds and explain their properties.
- can explain organic chemistry basic consepts.
- can deduce basic recation types and solve their mechanisms.

Contents:

Classification of organic compounds and their properties. Basic reactions of organic compounds: addition, elimination and substitution along with the reaction mechanisms. Basics of stereochemistry.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

38 hours of lectures plus 12 hours of exercises, 84 hours of independent self-study.

Target group:

Biochemistry, Chemistry, Biology, Process Engineering, Environmental Engineering and in the study entity of 25 credits, compulsory.
Physical Sciences, Geology, Geograhpy, Mathematical Sciences, optional.

Prerequisites and co-requisites:

Upper secondary school chemistry

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Hart, H.: Organic Chemistry: A Short Course, 10. ed. or newer, Houhgton Mifflin, Boston, 1999; Hart, H. ja Hart, D.: Study Guide & Solutions Book, Organic Chemistry: A Short Course, 10. ed. or newer, Houghton Mifflin, Boston, 1999 and material in Moodle.

Assessment methods and criteria:

Two intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Johanna Kärkkäinen

Working life cooperation:

No

780127P: Principles of Chemistry Labwork, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Chemistry

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

780123P	Introductory Laboratory Works in Chemistry	5.0 op
780330A-01	Laboratory Course I in Inorganic Chemistry (1. part)	2.0 op
780122P	Introductory Laboratory Course in Chemistry	3.0 op

ECTS Credits:

5 credits / 135 hours of work

Language of instruction:

Finnish

Timing:

1st spring

Learning outcomes:

After this course, the student can apply laboratory safety instructions and act accordingly. He/she can communicate by using basic laboratory terminology, identifies basic laboratory equipment and can use them properly. He/she recognizes the importance of the planning of the laboratory work. The student is able to utilize the basic chemistry techniques and determination methods in the given task. Furthermore, the student can also make laboratory notes and write a report on the performed task.

Contents:

Laboratory safety, basic laboratory equipment, basic chemistry techniques and determination methods as well as some of their theoretical background, problems related to the studied determination methods, keeping a laboratory notebook, writing a report.

Mode of delivery:

Supervised laboratory work, independently done preparatory problems and reports.

Learning activities and teaching methods:

Safety in laboratory 2 hours, 60 hours of laboratory works, 73 hours of self-study.

Target group:

Chemistry, compulsory

Prerequisites and co-requisites:

General and Inorganic Chemistry A (780117P) and Introduction to Organic Chemistry (780116P). Student is allowed to participate to the course simultaneously when participating the prerequisites. Attendance at the lecture of Safety in laboratory is compulsory.

Recommended optional programme components:

Participation in the courses General and Inorganic Chemistry (780117P, 5 cr) and Introduction to Organic Chemistry (780116P, 5 cr).

Recommended or required reading:

Instruction Book (in Finnish)

Assessment methods and criteria:

Accomplishment of the course requires accepted preparatory problems, laboratory exercises and problems related to them.

Grading:

The course utilizes verbal grading scale pass/fail.

Person responsible:

Teija Kangas

Working life cooperation:

No

Other information:

Attendance at the lecture of Safety at work is compulsory.

780119P: Introduction to Analytical Chemistry, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Chemistry

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

780111P	Introduction to Analytical Chemistry	4.0 op
780110P	Analytical Chemistry I	5.5 op

ECTS Credits:

5 ECTS credits / 134 hours of work

Language of instruction:

Finnish

Timing:

2nd autumn

Learning outcomes:

Upon completion the student should have acquired knowledge and understanding of basic concepts of quantitative chemical analysis employing classical methods of analysis.

Contents:

Steps in quantitative analysis, statistical evaluation of analytical data, chemical equilibrium in aqueous solutions, gravimetry, titrimetry, spectrophotometry.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

30 hours of lectures + 20 hours of exercises + 84 hours of self-study

Target group:

Chemistry, compulsory. In the study entity of 25 credits compulsory.
Mathematical Sciences, Physical Sciences, optional.

Prerequisites and co-requisites:

General and Inorganic Chemistry A (780117P) and General and Inorganic Chemistry B (780118P), or General and Inorganic Chemistry I (780114P) and General and Inorganic Chemistry II (780115P), or Introduction to Chemistry (780113P), or Basic Principles in Chemistry (780109P).

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Harvey, D.: Analytical Chemistry 2.0-an open-access digital textbook (can be loaded from Internet).
Saarinen, H. ja Lajunen, L.H.J.: Analyyttisen kemian perusteet, Oulun yliopistopaino, 2004.

Assessment methods and criteria:

Two intermediate examinations or one final examination.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Paavo Perämäki

Working life cooperation:

No

Supplementary Module: 8. Basic Business Studies

724835P: Basics of Management and Organizations, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

The course material and assignments are in English. The individual assignments may be completed in Finnish if a student wishes to do so.

Timing:

February– mid-April 2021 (weeks 6–14) + exam resits

Learning outcomes:

Upon successful completion of the course, the student will be able to:

· name the key concepts and theories in the areas of organization, management and leadership,
· name the key concepts and evaluate the functions of human resource management,
· understand the major tools of strategic management,
· understand business in the network of global interactions, and
· apply theory on practical leadership and management situations.

Contents:

· Management and leadership
o Development of leadership thinking and leadership theory
o Key concepts of management leading culture, innovation and change
· Organizations and organizational behaviour
o Organizational structure
o Organizational culture
o Organizational life
· Human resource management
o Human resource management
o Leading individuals, teams and groups
o Motivation and coaching
· Strategic thinking and strategic tools
o Development of strategic thinking and strategy
o Strategic tools
o Strategic management in a global environment

Mode of delivery:

Online teaching
· Individual assignments
· Electronic exam
The deadline for the weekly assignments is flexible; students can submit them at their convenience. The exams are open for a period of one week, during which, the exam can be taken at a time of the student's choice.

Learning activities and teaching methods:

	Hours
Online lectures	10 hours
Individual assignments and exam	60 hours
Literature (268 pages)	64 hours
Total	**134 hours (5 ECTS)**

Prerequisites and co-requisites:

No prerequisites.

Recommended or required reading:

Robbins, Stephen P. – Judge, Timothy A. – Campbell, Timothy T. (2017) Organizational Behavior. 2nd edition. Pearson.
The course instructors may ask students to read additional literature (e.g. articles). The details of additional readings are indicated in the course program.

Assessment methods and criteria:

The grade comprises an exam and individual assignments.
The dates for taking the exam and submission of assignments are given in the course instructions on the course platform.

Grading:

Students are graded on a scale from 1 to 5.

Person responsible:

Teachers 2020-21; Mirjami Ikonen (UEF), Hilpi Kangas (University of Vaasa) and Ida Okkonen (University of Jyväskylä)
Contact persons: Autumn term 2020, Minna Liikanen (minna.liikanen@jyu.fi) and Spring term 2021, Ida Oksanen (University of Jyväskylä)
Organizing university: University of Jyväskylä (academic year 2020-21)

Other information:

No restrictions for the number of students admitted. **Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.**
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi.

724836P: Introduction to Corporate Social Responsibility, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

25 January–22 March 2021 (weeks 4–12).

Learning outcomes:

Upon completion of the course, the students will be able to:
· define and apply key concepts and perspectives regarding CSR,
· identify relevant issues and analyse the challenges related to corporate responsibility in selected industries,
· describe the role of CSR in business and in relation to wider international political and economic issues,
· describe the different aspects through which organizational practices can be CSR-oriented, and
· apply key concepts of CSR in their daily work.

Contents:

· Definitions and historical roots
o Historical roots – sustainable development
o Definitions of CSR
o Why CSR matters – the business case
o Stakeholder salience
· Regulatory aspects
o Political CSR
o CSPs and CSR
o MSIs and CSR
o CSR and human rights
· Human resource, supply and consumption
o HRM and CSR
o CSR and supply chain
o CSR and sustainable consumption
o CSR – minimum wage and living wage
· Relational aspects
o CSR and communication
o CSR and corruption
o CSR and leadership
o CSR and responsible investment

Mode of delivery:

Online teaching

Learning activities and teaching methods:

· Weekly assignments: There are four weekly assignments in the course; one for each week for the first four weeks of the course. These assignments measure the students' understanding of the reading materials.
· Final assignment: The final assignment can be completed in a group or individually. The deadline for submitting the final assignment is the middle of the sixth week of the course.
133 hrs (5 ECTS)

Prerequisites and co-requisites:

No prerequisites

Recommended or required reading:

The link to primary reading materials will be provided on the learning platform.

Assessment methods and criteria:

The grade is composed of:
- weekly assignments/short essays (60 %)
- case analysis: final assignment (40%)

Grading:

Students are graded on a scale from 1 to 5.

Person responsible:

Yewondwossen Tesfaye Gemechu
E-mail yewondwossen.tesfaye@hanken.fi
Organizing university: Hanken School of Economics

Other information:

No restrictions for the number of students admitted, except for Åbo Akademi, for which the number of participants is limited to 30 students. **Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.**
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi.

724830P: Introduction to Accounting and Financial Management, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

Finnish

Timing:

The course site opens on 15 September 2020. The graded course assignments are open between 15 September and 9 November 2020.
Exam dates: 16–23 November 2020
1st resit: 7–14 December 2020
2nd resit: 18–25 January 2021

Learning outcomes:

After completing the course, students will be able to:
· identify the role of accounting in organizations and society,
· understand the content and structure of financial statements and the purposes for which the statements can be used,
· read financial statements and calculate and interpret key financial ratios,
· understand the key role of accounting systems in providing information for decision-making within organizations and how this information can be used to manage both the organization and the behaviour of individuals within the organization,
· evaluate and assess the financial profitability of products, services, customers and investments and make sound business decisions based on this information,
· identify the role of corporate governance in organizations and society,
· be familiar with the basic questions of corporate finance and able to identify the answers, and
· use the basic functions of Excel.

Contents:

· Financial management: an overall view
· Concept of accounting and what it means for companies and society
· Substance of and differences in management and financial accounting
· Basic functions of Excel
· Financial accounting
o Goals, content and structure of statements, central accounting principles, basics of bookkeeping
o Balance sheets, income statements, cash flow statements and their connections
o International Financial Reporting Standards (IFRS), principles of group accounts
o Connections between income statements and taxation
o Financial statement analysis

· Management accounting
o Accounting for strategic management; implementing strategy, scorecards
o Management of a profit centre organization (including Economic Value Added and WACC)
o Budgeting and budgetary system
o Cost accounting tasks and cost concepts, product, service and customer profitability
o Ad hoc calculations, cost-volume-profit analysis and pricing
o Estimating the profitability of investments
· Key concepts of corporate governance and corporate finance
o Key issues in corporate governance (incl. ownership, board of directors, rewarding systems)
o Key issues in managing capital structure (equity and non-equity capital, capital cost)
o Key issues in managing working capital (inventory and cash management, sales receivables and accounts payable)

Mode of delivery:

Online course
Most themes contain short videos, reading material and exercises. Some themes have graded assignments.

Learning activities and teaching methods:

	Hours
Watching video material	15 hours
Reading literature	60 hours
Exercises	40 hours
Graded course assignments	15 hours
Exam	3 hours
Total	**133 hours (5 ECTS)**

Prerequisites and co-requisites:

Upper secondary school mathematics. Students should have Microsoft Excel software at their disposal during the course. All course material is available on the course site.

Recommended or required reading:

Ikäheimo, S. – Malmi, T. – Wallden, R. (2019) Yrityksen laskentatoimi. Talentum, Helsinki.

Assessment methods and criteria:

Students are graded on a scale from 1 to 5. The grade comprises
· graded course assignments: 30 %
· exam: 70 %
The course exam is open on three occasions. The dates for taking the exam are given on the course platform.

Grading:

Numeric, scale 1–5

Person responsible:

Teemu Malmi ja Seppo Ikäheimo
E-mail: teemu.malmi@aalto.fi, seppo.ikaheimo@aalto.fi
Organizing university: Aalto University

Contact person for students: Tomi Vuolteenaho (tomi.vuolteenaho@aalto.fi)

Other information:

No restrictions for the number of students admitted. **Proper registration for a course is obligatory and required to receive course credits. Late registrations will not be accepted.**
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi

724832P: Economics and The Business Environment, 5 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Oulu Business School
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

Course slides, weekly assignments and exams are available in Finnish and English. The videos and the course book are in English.

Timing:

Pre-assignment in week 8. Online course March–April 2021 (weeks 9–14). Exam in week 16. Exam resits in weeks 19 and 21.

Learning outcomes:

Upon successful completion of the course, students will be able to:
· define basic economic concepts, and
· understand economic thinking and apply economic theory in the analysis of a business environment and market economies.

Contents:

The course provides students with basic skills in analysing the business environment and an overview of its evolution from an economic perspective. Proactive identification of opportunities in and threats to the business environment is increasingly important for successful businesses in the global economy.
During the course, the students will familiarize themselves with:
· the decision-making processes in companies and among consumers and how the markets function (microeconomics),
· economic growth, business cycles, labour markets, inflation, monetary policy and economic policy (macroeconomics),
· the role of the public sector and the focal public policy instruments in market economies (public economics), and
· international trade, financial markets, European integration and multinational companies (global economy).

Mode of delivery:

Online course

Learning activities and teaching methods:

The course includes a compulsory preliminary assignment that has to be completed successfully by a pre-defined date. The instructions for the pre-assignment are given to the students who have registered for the course within the registration period.
Students will take the course independently as an online course. It is divided into weekly modules with different themes (6 modules in total). Students will complete weekly assignments that open at the beginning of each week.
To be eligible to take the final exam, students must complete and pass the assignment in each weekly module.
133 hours (5 ECTS)

Prerequisites and co-requisites:

No prerequisites.

Recommended or required reading:

The CORE Team, The Economy. Available at: http://www.core-econ.org.
Additional literature will be assigned by the instructors at the beginning of the course.

Grading:

Students are graded on a scale from 1 to 5.
The course exam is open on three occasions. The dates for taking the exam are announced on the course platform.

Person responsible:

Sami Remes (sami.remes@tuni.fi) ja Juha-Matti Tauriainen (juha-matti.j-m.tauriainen@jyu.fi)
Organizing university: University of Tampere (academic year 2020-21)

Other information:

No restrictions for the number of students admitted. **Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.**
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi

724833P: Introduction to Entrepreneurship, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

All the course material is in English. Should there be any foreign students in a group, the language of group work and assignments is English.

Timing:

Early October–December 2020 (weeks 41–50). Pre-assignment in week 41.

Learning outcomes:

During the course, students will learn to understand the significance of an entrepreneurial team and will form an understanding of entrepreneurship as a creative activity that occurs in the form of business. After completing the course, students will be able to:
· define business-related principles, possibilities and challenges,
· plan business initiation based on customer needs, value creation, testing and agility, and
· interpret business-related substance areas where competence is needed.

Contents:

· Deciding to become an entrepreneur
o Introduction to entrepreneurship
· Creating viable business ideas
o Creating business opportunities
o Preliminary research
o Industry analysis
o Business plan
· From idea to an entrepreneurial firm
o Building a team
o Analysing start-up strengths and weaknesses from the funding perspective

- o Ethical and legal issues in starting a company
- o Creating a business plan and constructing a story
- o Attracting funding
- · Managing an entrepreneurial firm and generating growth
- o Marketing
- o Understanding VC operations
- o IPRs
- o Challenges of growth and managing growth
- o Growth strategies
- o Forms of operation

Mode of delivery:

The course includes a compulsory preliminary assignment that has to be completed successfully by a pre-defined date. The instructions for the pre-assignment are given to the students who have registered for the course within the registration period.
Course assignments include:
- · reading the course book, and
- · learning and reflection assignments,

Students complete the assignments on the online learning platform individually and as groupwork.

Learning activities and teaching methods:

	Hours
Reading the course materials	48 hours
Learning and reflection assignments individually and in groups	85 hours
Total	**133 hours (5 ECTS)**

Prerequisites and co-requisites:

No prerequisites

Recommended or required reading:

Barringer, B. – Ireland. D. (2012) Entrepreneurship: Successfully Launching New Ventures. 4th Edition. Prentice Hall. Later editions can also be used.

Assessment methods and criteria:

The course consists of five modules. Each module is linked to two chapters in the course book, and there are related assignments to be completed by the end of each module. They are evaluated on the scale pass /fail. To pass the course, students must receive a passing grade for all the assignments.
A final essay composed and submitted at the end of the course, and covering the entire course content, determines the final grade.

Grading:

Students are graded on a scale from 1 to 5.

Person responsible:

Teachers 2020-21: Markku Ikävalko, LUT (markku.ikavalko@lut.fi), Satu Korhonen (LUT), Terhi Virkki-Hatakka (LUT) and Abdollah Mohammadparast Tabas (University of Oulu)

Organizing university: University of Oulu (academic year 2020-21)

Other information:

At least 75 students per university in the order of when they registered for the course. The total number of participants should not exceed 700. If there are fewer than 75 students from any university, the number of students in the other universities may be increased.
Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi.

724834P: Basics of Marketing and Sales, 5 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Oulu Business School
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

The literature is mainly in English. The student may submit the assignments either in Finnish or in English

Timing:

March - early May 2021 (weeks 9-18), Pre exercises in week 9.

Learning outcomes:

Upon completion of the course, students will be able to:
· describe the role of marketing in an organization and identify the significance of customer-orientation in both the development of the organization and personal actions,
· apply the key concepts of marketing (e.g., customer-perceived value, value creation process, brand, marketing mix and segmentation) in decision-making and the evaluation of made decisions,
· describe the diverse emphasis of B-to-B and consumer marketing and the key characteristics of both logics,
· identify and utilize key marketing communication channels in the fickle business environment, and
· understand sales processes in their entirety, the different parts of them in both consumer and in B-to-B sales.

Contents:

- key marketing concepts, definitions and phenomena now and before such as value, value creation and marketing mix
- understanding these concepts in diverse contexts: the differences between consumer and B-to-B logics
- customer-centric thinking and value creation
- customer-oriented strategy in a changing business environment
- the key concepts and phenomena in consumer marketing
- B-to-B marketing and organizational buying behaviour
- marketing communication channels and content
- sales process in consumer and B-to-B contexts, as well as personal sales and interaction skills, at different phases of the sales process

Mode of delivery:

On-line teaching

Learning activities and teaching methods:

The course includes a compulsory preliminary assignment that has to be completed successfully by a pre-defined date. The instructions for the pre-assignment are given to the students who have registered for the course within the registration period.
Students will complete weekly assignments during the course.

	Hours
Independent reading of the course materials	70 hours
Weekly assignments	60 hours
Feedback	3.5 hours
Total	**133.5 hours (5 ECTS)**

Prerequisites and co-requisites:

No prerequisites.

Recommended or required reading:

The instructors will specify the literature at the beginning of the course.

Assessment methods and criteria:

The course includes a compulsory preliminary assignment that has to be completed successfully by a pre-defined date. The instructions for the pre-assignment are given to students who have registered for the course within the registration period.
Students will complete weekly exercises.

Grading:

Students complete the course by submitting weekly assignments. Grading on scale 1–5/fail.

Person responsible:

Minna-Maarit Jaskari (minna-maarit.jaskari@uva.fi) ja Tuula Lehtimäki (tuula.lehtimaki@oulu.fi)
Organizing university: University of Vaasa (academic year 2020-21)

Other information:

No restrictions for the number of students admitted. **Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.**
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi.

724837P: Understanding and managing a business as a dynamic whole - business simulation game, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

The language of instruction is English, but a student may return individual assignments in Finnish if s/he so wishes. The simulation teams may speak Finnish, if there are no non-Finnish speaking members in the team.

Timing:

1st course period: late September–mid-November 2020 (weeks 39–46). Pre-assignment in week 39.
2nd course period: late January–February 2021 (weeks 4–11). Pre-assignment in week 4.
3rd course period: mid-March–mid-May 2021 (weeks 11–19). Pre-assignment in week 11.

Learning outcomes:

After completing the course, students will:
· understand how different areas in business studies are connected in the entity of enterprise functions and in making a profit,
· understand the role of ERP and its significance in managing a company,
· be able to apply different business analysis tools in planning and managing a business and to understand the essential role of strategy in the process, and
· be able to apply various methods of collaboration in a virtual team.

A central part of the course is to see the business as a whole, students will understand why it is not practical to optimize single functions separately and why the management needs to have a holistic perspective of the company.

Contents:

· The foundation for this course is a business simulation game that engages the students in real-time decision-making and provides them with various tasks related to various business topics.
· The participation takes place in small virtual groups, in which the team members (3–4 students) all come from different universities.
· The thematic core for the simulation is supply chain management and the entity formed by different functions of a company. The relevant themes include several areas of cross-company logistics: purchase, inventory management, delivery, customer relations and the reporting related to these topics. The course emphasizes effective management of the supply chain and the impact it has on the company's profit and cash flow.
· During the course, students are also introduced to the dynamics of supply chains in company networks, where the students' company is part of a network of suppliers, competitors and customers.
· In addition, the course gives an overall picture of the role of a company's information systems in steering the business as a whole: how the different functions utilize common enterprise resource planning and how the ERP works as an essential tool in decision-making.
· The theoretical material and the exercises distributed in the course are related to supply chain management and other LITO learning themes.

Mode of delivery:

Online teaching

Learning activities and teaching methods:

The course includes a compulsory preliminary assignment that has to be completed successfully by a pre-defined date. The instructions for the pre-assignment are given to the students who have registered for the course within the registration period.
The course assignments are mainly related to the planning of the simulation company operations and the analysis of materialized operations. These include:
· developing a business plan,
· analysing the profitability in light of various parameters and reporting these to the different stakeholders,
· various strategic analyses of the company operations and competitive situation (SWOT, Pester, benchmarking),
· calculations related to the company's basic supply chain and ERP parameters,
· income statement and profitability, gross margin and cash flow analysis (the essential parameters covered in the course Introduction to Accounting and Financial Management), and
· market analysis.
Furthermore, there will be a written assignment on team dynamics and a team functionality analysis and reflections.

	Hours
Reading the theoretical supplementary material	50 hours
Planning and analysis tasks	66 hours
Business simulation game	3 x 6 hours = 18 hours
Total	**134 hours (5 ECTS)**

Prerequisites and co-requisites:

The course serves as a capstone, bridging together the other modules in the LITO entity. The course provides an overall picture of business dynamics and explains how the different fields in business studies are related to it.
It is recommended that before taking this course, the student has taken at least the following LITO courses: Introduction to Accounting and Financial Management and Basics of Management and Organization.

Recommended or required reading:

Simulation game instructions, description of the simulation environment, learning videos, course hand-out and a selection of other articles (to be announced).

Grading:

The evaluation scale of pass/fail is used. Performance will be evaluated based on the assignments given during the course.

Person responsible:

Eeli Saarinen (eeli.saarinen@utu.fi)
Organizing university: University of Turku (academic year 2020-21)

Other information:

When registering for the course, bear in mind that the simulation game requires your commitment to the entire duration of the course, as the implementation of the simulation game requires that there are at least 50 attendees from the LITO universities.
A max. 20 of students per university are admitted in the order of registration for each business simulation game period. If there are fewer students from any university, the number of students from the other universities may be increased; the total number of students should not exceed 180.
Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi.

724831P: Introduction to Business Law, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

Finnish

Timing:

Mid October - mid December 2020 (weeks 43-50)

Learning outcomes:

After the course, the student will:
- know the main features of the Finnish legal system, its connections to other legal systems and the most important legal concepts and structures, particularly from the business perspective,
- know the different sources of law and the fundamentals of how to solve legal problems,
- understand the role of law as a system that steers society and its importance at the heart of business activities,
- understand how and why a company should prepare for the legal risks of a business, how to manage the risks and how to take the legal aspect into account in the company's decision-making, and
- know the basic key areas of business law, corporate law in particular, contract law, immaterial law, labour law, competition law and tax law (tax law accounts for 30 % of the course).

Contents:

- Structure of the Finnish legal system and its relationship to other legal systems
- Basic legal concepts and structures
- Relevance of law at the heart of societal decision-making and business activities
- Risks and possibilities that law provides for business
- Legal risk management in business
- Sources of law and their mutual relationships
- Fundamentals of solving legal problems
- Basics of corporate law
- Basics of contract law
- Basics of immaterial law

- Basics of labour law
- Basics of tax law (tax law accounts for 30 % of the course)
- Basics of competition law

Mode of delivery:

Online course

Learning activities and teaching methods:

The purpose of the course assignments is to review the main issues learned in the course and to deepen the students' understanding by transferring theoretical knowledge into practice. The assignments deal with, for example, the basic concepts and structures of the legal system, recognizing legal problems and the basics of different fields of business law. They also include case assignments.
133 hours (5 ECTS). The course consists of three modules, the schedules of which are as follows:

- Introduction to legal thought 25 hours
- Business law 68 hours
- Tax law 40 hours

Prerequisites and co-requisites:

No prerequisites.

Recommended or required reading:

The literature will be assigned by the instructors at the beginning of the course.

Assessment methods and criteria:

Each of the module exams can be taken three times. The dates for taking the exams are given on the course platform.

Grading:

Students are graded on a scale from 1 to 5 based on the module exams (3 exams).

Person responsible:

Martti Nieminen, Jenni Similä & Lassi Salminen
Martti Nieminen (contact person)
E-mail martti.nieminen@tuni.fi
Organizing university: Tampere University

Other information:

No restrictions for the number of students admitted. **Proper registration for the course at the home university is obligatory and required for credit. Late registrations will not be accepted.**
LITO courses are organised in co-operation with multiple universities. To receive credits for the courses, students must be granted the right to attend the courses for which they have registered from the host university. To grant the right to attend a course(s), the home university will transfer personal student information to the host university responsible for organizing the course. The data to be transferred includes surname, first name, possible middle name(s), gender, nationality, e-mail address, personal identification number and home university. If a student does not have a Finnish personal identification number, his/her date of birth will be transferred. Data classified as secret will not be transferred. Receiving credit for the course(s) is not possible without transferring personal student information.
The latest information about the course is updated and published on the course platform at www.lito.fi.

Supplementary Module: 9. Entrepreneurship

724814P: Introduction to Business Development, 5 op

Voimassaolo: 01.08.2017 - 31.07.2021

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti Muhos

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

Period 1

Learning outcomes:

Students are familiar with basic business concepts and theories in SME context. On successful completion of the course, students understand the business development process from opportunity recognition to a launch and development of a sustainable business. The students are able to identify basic business processes in practice.

Contents:

The course focuses on the basic concepts of SME business management and development including opportunity recognition, experimentation and testing of a new business idea, strategy, business model development and business planning, financing and planning and management of growth and change.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Face-to-face teaching including lectures, guest lectures, company visit/s and variable action-based learning methods (36h). Individual assignment (20h) and reading of course materials (76 h).

Target group:

Open to all university students

Prerequisites and co-requisites:

No

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Selected readings from e.g.: Spinelli & Adams. 2012, 2016. New Venture Creation: Entrepreneurship for the 21st Century. McGraw-Hill, New York. Allen, K. 2012. New venture creation. South-Western. Moreover, additional materials are provided during the course.

Assessment methods and criteria:

Learning diary, group assignment/s

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for fail.

Person responsible:

Matti Muhos

Working life cooperation:

This course is designed as an integral part of entrepreneurship studies. This course will include real life case studies of established and emerging businesses by company visits.

Other information:

The number of students is limited

724813P: Entrepreneurship in Action, 5 op

Voimassaolo: 01.08.2017 - 31.12.2020

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opettajat: Niina Karvinen

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

Periods 1-4

Learning outcomes:

Upon completion of the course, the students can apply the core competencies of his/her studies in a real-life entrepreneurship context. Students can realize and start working with a business opportunity or social problem in practice to find a solution. The student will improve his/her entrepreneurial skills; multicultural group working, problem solving, communicating and presenting.

Contents:

In these studies students generally co-operate in workshops where they learn practical methods of entrepreneurship like business model creation and validation processes, lean methodology, marketing, branding, basic financial management and presenting ideas e.g. pitching.

Mode of delivery:

Face-to-face teaching and coaching.

Learning activities and teaching methods:

Bootcamps, workshops, group work, individual guidance. Most of the exercises are completed as group work (132 h).

Target group:

Open to all University Students

Prerequisites and co-requisites:

No

Recommended optional programme components:

No

Recommended or required reading:

Selected readings are provided during the course

Assessment methods and criteria:

Programme specific assessment that may include both group and individual assessment methods.

Grading:

The course utilizes grading scale “pass/fail”

Person responsible:

Niina Karvinen ja Anne Keränen

Working life cooperation:

The programs of this course are run in close co-operation with relevant business partners or applied to practice. Students also learn practical entrepreneurship skills.

Other information:

The number of students is limited

724815P: Entrepreneurial Assignment, 5 op

Voimassaolo: 01.06.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opettajat: Sari Perätalo

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

The schedule for the course is dependent on the entrepreneurial event or training in which student takes part in.

Learning outcomes:

Upon completion of the course the students are familiarized with entrepreneurial activity in society and possess skills that help to solve entrepreneurial problems and make change. Students will have an insight into the diversity of entrepreneurship and gain understanding of the specific aspects of entrepreneurship.

Contents:

Studies are tailored upon acceptance by the course instructor. The course consists of two parts: practice, and theory. Students compile the course through participating in different entrepreneurship supporting activities. The students can for example participate in Tellus boot camps, events or volunteering program. In addition, students can include activities organized by other stakeholders (e.g. faculties, public organizations or third sector organizations). In addition, the students reflect their learning in a report.

Mode of delivery:

Face-to-face teaching including entrepreneurial project, event, workshop, etc. Individual written assignment and reading the agreed materials.

Learning activities and teaching methods:

Individual and group work (132h). Teaching methods vary depending on the entrepreneurial project, event, workshop, etc. a student has participated in.

Target group:

Open to all university students

Prerequisites and co-requisites:

No

Recommended optional programme components:

The course does not require additional studies carried out at the same time.

Recommended or required reading:

Materials will be provided during the course.

Assessment methods and criteria:

Assessment is based on an individual report that a student is expected to deliver after participating in an entrepreneurship-related event, workshop, project, etc.

Grading:

The course utilizes verbal grading scale “pass/fail”.

Person responsible:

Sari Perätalo

Working life cooperation:

The course allows the students to gain first-hand entrepreneurial experience in various forms.

Other information:

Contact the responsible teacher to enroll in the course.

724811P: Entrepreneuring for Sustainability, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opettajat: Anne Keränen

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

Period 2

Learning outcomes:

After the course the students should:
Understand the roles of entrepreneurship in creating socially responsible change in society, know how to map and analyze alternative sustainable entrepreneurial business ideas based on individual strengths, values and the UN SDGs, know creative problem solving assessment methods, know how to communicate about entrepreneurial ideas.

Contents:

Course description
The course outlines interdisciplinary skills and knowledge that foster the creation of a sustainable entrepreneurial mindset. These skills include problem solving, creativity, networking, communications, risk-taking and adaptability. Entrepreneurship is approached through its different forms and roles in various contexts of society, ecosystems, and businesses. The focus is on entrepreneurial mindsets, responsible business and what entrepreneurship requires from individuals and teams, especially from the “me/us as entrepreneur” standpoint. During the course students familiarize themselves with the role of business and entrepreneurship in building sustainable societies. In addition, students have the opportunity to present their sustainable business ideas to responsible business experts.
Course objectives
Students develop skills for creative problem solving; students understand that entrepreneurial behavior can take place within many contexts (new ventures, associations, government agencies, and existing businesses); students identify their alternative roles, opportunities, and viewpoints regarding entrepreneurial choices they can make; students strengthen their skills of responsible business and are able to assess choices for business as promotor of social change based on the UN Sustainable Development Goals; students are able to define and assess alternative contexts for entrepreneurial action and to create and assess alternative business scenarios for their future; students are able to recognize and analyze business opportunities and social/customer problems and challenges; students are able to create and evaluate alternative solutions to the identified opportunities, problems, and challenges of responsible business; students are able to communicate effectively about their entrepreneurial ideas.

Mode of delivery:

Lectures, workshops and online learning

Learning activities and teaching methods:

Learning takes place mostly in groups by means of intensive lectures and workshops, visitor presentations and discussions, both in class and via online learning platform. The course includes 36 contact hours. Reading the course literature (20 h), Groupwork (80 h) and learning diary report (35 h).

Target group:

Open to all University Students

Prerequisites and co-requisites:

No

Recommended optional programme components:

No

Recommended or required reading:

Selected readings are provided during the course

Assessment methods and criteria:

Further details will be provided by the responsible persons in the first session.

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Anne Keränen and Jan Hermes

Working life cooperation:

The course incorporates real life case examples and meetings with sustainable entrepreneurship practitioners and experts. Students learn interdisciplinary skills that can be applied in real working life.

Other information:

The number of students is limited.

724812P: Building Change Through Entrepreneurship, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opettajat: Ahmad Arslan

Opintokohteen kielet: English

Leikkaavuudet:

ay724812P	Building Change Through Entrepreneurship (OPEN UNI)	5.0 op

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

Period 3

Learning outcomes:

After the course completion, the students should:
1. Have the basic knowledge about start-ups and new business creation
2. Have the ability to find and utilize information for new business creation
3. Have the knowledge how to analyze own business-case
4. Have the knowledge how the to plan a new start-up
5. Have the ability to present own business-case

Contents:

Lectures will focus on the following themes:
Introduction to Entrepreneurship
Recognizing Opportunities and Generating Ideas
Feasibility Analysis
Industry and Competitor Analysis
Developing an Effective Business Model
Building a New Venture Team
Assessing New Venture’s Financial Strength and Viability
Writing a Business Plan
Getting Finance or Funding
Preparing for and Evaluating Challenges of Growth

Mode of delivery:

Face-to-face teaching complemented with online resources

Learning activities and teaching methods:

The course consists of lectures and workshops (32 h), preparation for lectures and workshops (18 h), and, reading the literature and preparation for assignments (50 h), and writing the assignments (40 h).

Target group:

B.Sc. and M.Sc. students from different faculties in the university as well as exchange students

Prerequisites and co-requisites:

None

Recommended optional programme components:

None

Recommended or required reading:

- Bruce R. Barringer and R. Duane Ireland (2006). Entrepreneurship: Successfully Launching New Ventures. Pearson Education.
- Slides and relevant online resources

Assessment methods and criteria:

Individually written assignments. Completion of 10 assignments correspond to revving grade 5, while minimum two are needed to get 1 in order to pass the course

Grading:

The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for fail.

Person responsible:

Ahmad Arslan and Anne Keränen

Working life cooperation:

Practical insights to new business creation tested through several assignments addressing different aspects associated with it.

Other information:

The student number is limited to 50.

724816P: Building Business Through Creativity and Collaboration, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Oulu Business School

Arvostelu: 1 - 5, pass, fail

Opettajat: Anne Keränen

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5 credits

Language of instruction:

English

Timing:

Period 4

Learning outcomes:

During the course the student will explore entrepreneurship from the perspective of an artistic process and learn the process of designing improbable solutions. The students are challenged to question mainstream values, assumptions taken for granted, and ways of doing things. The course gives the student tools that are needed in developing improbable business models and solutions that can shift paradigms.
During the intensive workshops of the course, the student will work in teams and learn to regulate emotions, such as uncertainty, frustration, enthusiasm, and joy.
Upon completion of the course, the student will:
- develop entrepreneurial leadership
- increase abilities to build new inspiring visions
- master agile methods of creation to deal with uncertainty and risks
- learn how to use diversity and improbable encounters to develop business
- connect passion and convictions with a project which creates value
- leverage failure to increase creativity and resilience

Contents:

Entrepreneurs develop activities that aim to challenge the status quo, break rules and subvert systems. Furthermore conflicts, emotional strains and uncertainties are often part of entrepreneurship. But how can such things be taught/learnt?
The course introduces Art Thinking, an agile method to create improbable outcomes with certainty. The method enables out-of-the-box thinking and creative productions where encounters of all sorts are key resources. Instead of writing business plans, the participants create during the Improbable workshops artistic prototypes and organize an art exhibition.
During the Improbable workshops students will are taught the Art-Thinking Method which involves 6 main activities. The students will:
(1) engage in gift-giving practices which foster new and unusual partnerships (Donate);
(2) “steal” from others to create unique propositions (Deviation);
(3) follow a journey without a clear goal but which will eventually make a lot of sense (Drift);
(4) challenge existing rules and values as well as their taken-for-granted assumptions (Destruction);
(5) accept criticism to learn from others (Dialogue), and
(6) exhibit their work to get feedback and find new partners (Display).

Mode of delivery:

Face-to-face sessions and workshops

Learning activities and teaching methods:

Participation in the workshops. Producing a piece of art and presenting it at an art exhibition together with others. Completion of the group work and individuals tasks, such as reading course materials and reflecting the learning experiences.

Target group:

Open to all University Sstudents

Prerequisites and co-requisites:

No

Recommended optional programme components:

The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:

Materials will be provided during the course

Assessment methods and criteria:

Compulsory participation and commitment to the teamwork. Assessment of the course tasks.

Grading:

The course utilizes verbal grading scale “pass/fail”

Person responsible:

Mia Kemppaala, Anne Keränen

Working life cooperation:

Students learn practical entrepreneurial skills through artistic process.

Other information:

The number of students is limited

Supplementary Module: 0. Exchange Studies and Supplementary Module: 10. OAMK - Sähkövoimatekniikka (15 -20 op) and Supplementary Module: 11. OAMK - tieto ja viestintätekniikka (15 op)

030009M: Studies in Other Universities/Institutes, 0 - 60 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Faculty of Information Technology and Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

Ei opintojaksokuvauksia.

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

521026S: Advanced practical training, 5 op

Voimassaolo: 01.01.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521016A	Advanced Practical Training	3.0 op

ECTS Credits:
5 ECTS credits
Language of instruction:
Finnish or English
Timing:
This course can be taken in periods I-IV. The recommended time to take this course is during summer of the fourth year.
Learning outcomes:
Student can apply knowledge and skills learned during university studies to complete work assignments in his/her own field.
Student can evaluate and develop himself/herself as a learner and worker.
Student can plan and evaluate his/her time management and working methods.
Student is capable of working in systematic and goal-oriented manner in group as well as independently.
Student can name important factors that direct the actions of work community and the employer.
Student can name duties where he/she can work after graduating from university.

Contents:
Planning and preparation, carrying out work assignments in the students field of studies, documentation of own accomplishments, writing report and reflection.
Mode of delivery:
Independent work.
Learning activities and teaching methods:
Student independently finds a place to work to complete the course. To pass the course minimum of two months of full time work is required. Work can also be carried out in multiple periods. The course works includes a) Making a practice plan for the working period 4 h, b) Documentation of progress during working 20 h, c) Learning while working 108 h, d) Final raport and reflection 8 h.
Target group:
Master level students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
The course does not require additional studies carried out at the same time. While carrying out the course working assigments are compared to already completed studies.
Recommended or required reading:
No required material.
Assessment methods and criteria:
Course is carried out by working minimum of two months in a work accepted by study program responsible person. Before starting the actual work the student needs to make a plan for the working period and return it to the responsible person. A weekly report is required from every working week. These reports have to turned in

before the working period ends. After the working period is over the student writes a final report and returns it to the responsible person. Signed testimonial from the employer is also required with the final report.
Grading:
The course is graded as ”pass/fail”
Person responsible:
Jukka Kontinen
Hannu Rautio
Working life cooperation:
The course is carried out as practical training.
Other information:
This course is alternative to 521016A Advanced Practical Training, 3 ECTS.

521299S: Competence demonstration in electronics and telecommunication technology, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Katz, Marcos Daniel, Juha Häkkinen

Opintokohteen kielet: Finnish, English

ECTS Credits:
5 ECTS credits / 135 hours of student work.
Language of instruction:
Finnish / English
Timing:
The course is held in the autumn semester, during periods 1 and 2.
Learning outcomes:
Upon completion of the course, the student:
• explain how a particular M.Sc. level course topic is important in designing an electrical device.
• apply a curriculum provided skill to realise a device functionality defined in a specification/standard.
• organise his or hers work as part of a larger device design project.
• develop a working prototype of a product concept or its parts.
Contents:
The goal of this M.SC.-level course is to offer students a possibility to apply skills and knowledge accumulated during studies in a practical work producing a prototype device highlighting the character of the degree programme and the skills it provides. The device is linked to the Digital solutions in sensing and interactions focus area of the faculty.
Contents of the course changes year-by-year, therefore, current information is given in Moodle page of the course.
Mode of delivery:
Contact teaching, project work in teams/pairs.
Learning activities and teaching methods:
Lectures 12h, self study/project work 123h. Project-specific guidance will be available from experts and teachers at times agreed upon during the course.
Target group:
The course can be taken by students of the Degree Programme in Electronics and Communications Engineering at final stages of studies.
Prerequisites and co-requisites:
Courses of the Degree Programme in Electronics and Communications Engineering related to the project work.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Study materials of the courses of the Degree Programme in Electronics and Communications Engineering, which are related to the project work. Current material is specified in the Moodle page of the course.
Assessment methods and criteria:
The course will be evaluated on the basis of the project report/documentation delivered at the end of the course, unless specified otherwise in the Moodle page to the course.
Grading:
The course is evaluated passed with honors/pass/fail.

Person responsible:
Juha Häkkinen and Marcos Katz
Working life cooperation:
See Moodle page of the course.
Other information:
See Moodle page of the course.

521907S: Fab Lab Digital Fabrication, 5 op

Voimassaolo: 01.01.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Faculty of Information Technology and Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jani Ylioja

Opintokohteen kielet: English

ECTS Credits:
5 ECTS
Language of instruction:
English
Timing:
Spring, periods 3-4.
Learning outcomes:
The student can:
1. demonstrate 2D design development for CNC production
2. describe workflows for CNC production
3. design appropriate objects within the limitations of 3 axis machining
4. demonstrate workflows used in mould design, construction and casting
5. identify the advantages and limitations of 3D printing and scanning technology
6. apply design methods and production processes to show one's understanding of 3D techniques
7. demonstrate workflows used in the chosen, changing process
8. select and apply suitable materials and processes to create one's project with selected process

Contents:
The student learns, theory and hands-on, small-scale digital fabrication techniques and prototyping for 2D, 2.5D and 3D: 3D-scanning and printing, CNC-machining, casting and moulds and one elective digital technique (embroidery, composites, etc.).
Mode of delivery:
Online lectures, exercises and practice work at Fab Lab (information on restrictions for accessing Fab Lab will be given during lectures).
Learning activities and teaching methods:
Lectures 30 h / excercises 80 h, self study the rest.
Target group:
M.Sc. students and other students.
Prerequisites and co-requisites:
Fab Lab Project Management.
Recommended optional programme components:
-
Recommended or required reading:
http://fabacademy.org/
Assessment methods and criteria:
The course is passed with approved exercise reports.
Grading:
Pass / fail
Person responsible:
Jani Ylioja
Working life cooperation:
-
Other information:
Course instructions can be found from Moodlehttps://moodle.oulu.fi/course/view.php?id=6036

521905A: Fab Lab Electronics, 5 op

Voimassaolo: 01.01.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Faculty of Information Technology and Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jani Ylioja

Opintokohteen kielet: English

ECTS Credits:
5 ECTS
Language of instruction:
English
Timing:
Spring, periods 3-4.
Learning outcomes:
The student can
1. describe the process of milling, stuffing, de-bugging and programming of self made printed circuit board with microcontroller
2. demonstrate correct workflows and identify areas for improvement if required
3. select and use software for circuit board design
4. demonstrate workflows used in circuit board design and fabrication
5. implement and interpret programming protocols
Contents:
The course gives basic knowledge of small scale digital fabrication and prototyping of printed circuit boards including design, fabrication and testing and gives examples of fabricating and using sensors and signaling devices or actuators with an embedded device.
Mode of delivery:
Online lectures, exercises and practice work at Fab Lab (information on restrictions for accessing Fab Lab will be given during lectures).
Learning activities and teaching methods:
Lectures 30 h / excercises 80 h, self study the rest.
Target group:
M.Sc. students and other students.
Prerequisites and co-requisites:
Fab Lab Project Management, Johdatus elektroniikkaan, Elektroniikkasuunnittelun perusteet.
Recommended optional programme components:
-
Recommended or required reading:
http://fabacademy.org/
Assessment methods and criteria:
The course is passed with approved exercise reports.
Grading:
Pass / fail
Person responsible:
Jani Ylioja
Working life cooperation:
-
Other information:
Course instructions can be found from Moodlehttps://moodle.oulu.fi/course/view.php?id=6034

521906A: Fab Lab Programming, 5 op

Voimassaolo: 01.01.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Faculty of Information Technology and Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jani Ylioja

Opintokohteen kielet: English

ECTS Credits:
5 ECTS
Language of instruction:
English
Timing:
Spring, periods 3-4.
Learning outcomes:
The student can:
1. identify relevant information in a microcontroller data sheet
2. implement programming protocols
3. define the scope of a project and develop a project plan
4. demonstrate workflows used in network design
5. implement and interpret networking protocols
6. interpret and implement design and programming protocols to create a Graphic User Interface (GUI)
Contents:
Student learns to build machine-to-machine networks using self fabricaded embedded devices. Student also learns networking between embedded and commercial devices such as personal computers or mobile phones. Student learns to program graphical interfaces for such systems.
Mode of delivery:
Online lectures, exercises and practice work at Fab Lab (information on restrictions for accessing Fab Lab will be given during lectures).
Learning activities and teaching methods:
Lectures 30 h / excercises 80 h, self study the rest.
Target group:
M.Sc. students and other students.
Prerequisites and co-requisites:
Fab Lab Project Management , Fab Lab Electronics , Ohjelmoinnin perusteet, Johdatus tietokonejärjestelmiin.
Recommended optional programme components:
-
Recommended or required reading:
http://fabacademy.org/
Assessment methods and criteria:
The course is passed with approved exercise reports.
Grading:
Pass / fail
Person responsible:
Jani Ylioja
Working life cooperation:
-
Other information:
Course instructions can be found from Moodlehttps://moodle.oulu.fi/course/view.php?id=6035

521904A: Fab Lab Project Management, 5 op

Voimassaolo: 01.01.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Faculty of Information Technology and Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jani Ylioja

Opintokohteen kielet: English

ECTS Credits:
5 ECTS
Language of instruction:

English
Timing:
Spring, periods 3-4.
Learning outcomes:
The student can:
1. communicate an initial project proposal
2. Explore and use website development tools
3. identify and utilise version control protocols
4. evaluate and select 2D and 3D software
5. demonstrate and describe processes used in modelling with 2D and 3D software
6. demonstrate and describe parametric 2D modelling processes
7. identify and explain processes involved in using the laser cutter
8. develop, evaluate and construct the final prototype of parametric design
9. identify and explain processes involved in using vinyl cutter
10. design and create the final object using vinyl cutter

Contents:
The course gives basic knowledge of managing digital fabrication processes. Subjects, from point of view of digital fabrication include version control, project management, computer aided design, computer controlled cutting using parametric design methods, intellectual property, inventions and income.
Mode of delivery:
Online lectures, exercises and practice work at Fab Lab (information on restrictions for accessing Fab Lab will be given during lectures).
Learning activities and teaching methods:
Online lectures, exercises and practice work at Fab Lab (information on restrictions for accessing Fab Lab will be given during lectures). Lectures 30 h / excercises 80 h, self study the rest.
Target group:
M.Sc. students and other students.
Prerequisites and co-requisites:
Principles of Digital Fabrication.
Recommended optional programme components:
-
Recommended or required reading:
http://fabacademy.org/
Assessment methods and criteria:
The course is passed with approved exercise reports.
Grading:
Pass / fail
Person responsible:
Jani Ylioja
Working life cooperation:
-
Other information:
Course instructions can be found from Moodle: https://moodle.oulu.fi/course/view.php?id=6033

521908S: Fab Lab Project Work, 5 op

Voimassaolo: 01.01.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Faculty of Information Technology and Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jani Ylioja

Opintokohteen kielet: English

ECTS Credits:
5 ECTS
Language of instruction:
English
Timing:
Spring, periods 3-4.
Learning outcomes:

The student can:
1. work and communicate effectively in a team and independently
2. design, plan and build a system
3. analyse and solve technical problems
4. recognise opportunities for improvements in the design
5. implement project plan
6. apply time management techniques
7. summarise and communicate the essence of one’s project development
8. create one’s own integrated design
9. demonstrate 2D & 3D modelling capabilities applied to one’s own designs
10. select and apply appropriate additive and subtractive techniques
11. demonstrate competence in design, fabrication and programming of your own fabbed microcontroller PCB, including an input & output device

Contents:

The student learns to work in a team to digital fabrication. The group learns to make moc-up of a robot or a machine. The student also learns to apply suitable time management techniques for one’s project and to integrate different skills to one functional product.

Mode of delivery:

Distributed and local lectures and exercises in three of one week long workshops and final project to integrate digital fabrication skills.

Learning activities and teaching methods:

Lectures 21 h / excercises 64 h, self study the rest.

Target group:

M.Sc. students and other students.

Prerequisites and co-requisites:

Fab Lab Project Management, Fab Lab Electronics, Fab Lab Programming, Fab Lab Digital Fabrication.

Recommended optional programme components:

-

Recommended or required reading:

http://fabacademy.org/

Assessment methods and criteria:

The course is passed with approved exercise reports.

Grading:

Pass / fail

Person responsible:

Jani Ylioja

Working life cooperation:

-

Other information:

-

521006P: Glimpse into ICT, 2 op

Voimassaolo: 01.01.2020 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Fanny Vainionpää, Antti Mäntyniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521006P	Glimpse into ICT (OPEN UNIV)	2.0 op

521018A: Practical training, 5 op

Voimassaolo: 01.01.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits
Language of instruction:
Finnish or English
Timing:
This course can be taken in periods I-IV. The recommended time to take this course is during summer of the second year.
Learning outcomes:
Student can apply knowledge and skills learned during university studies to complete work assignments in his/her own field.
Student can evaluate and develop himself/herself as a learner and worker.
Student can plan and evaluate his/her time management and working methods.
Student is capable of working in systematic and goal-oriented manner in group as well as independently.
Student can name important factors that direct the actions of work community and the employer.
Student can name duties where he/she can work after graduating from university.
Contents:
Planning and preparation, introduction to work assignments related to students field of study, carrying out work assignments, documentation of own accomplishments, writing report and reflection.
Mode of delivery:
Independent work.
Learning activities and teaching methods:
Student independently finds a place to work to complete the course. To pass the course, minimum of two months of full time work is required. Work can also be carried out in multiple periods. The required elements are a) Making a practice plan for the working period 4 h, b) Documentation of progress during working 20 h, c) Learning while working 108 h, d) Final raport and reflection 8 h
Target group:
Bachelor level students in electrical engineering
Prerequisites and co-requisites:
-
Recommended optional programme components:
The course does not require additional studies carried out at the same time. While carrying out the course working assigments are compared to already completed studies.
Recommended or required reading:
No required material.
Assessment methods and criteria:
Course is carried out by working minimum of two months in a work accepted by study program responsible person. Before starting the actual work the student needs to make a plan for the working period and return it to the responsible person. A weekly report is required from every working week. These reports have to turned in before the working period ends. After the working period is over the student writes a final report and returns it to the responsible person. Signed testimonial from the employer is also required with the final report.
Grading:
The course is graded as ”pass/fail”.
Read more about assessment criteria at the University of Oulu webpage.
Person responsible:
Jari Hannu
Working life cooperation:
The course is carried out as practical trainingThe course is carried out as practical training.
Other information:
The BSc in electrical engineering degree can include optional practical training. This course is alternative to 521012A Practical Training, 3 ECTS.

521229A: Principles of repurposing of electronics, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits / 135 h student work
Language of instruction:
Finnish / English
Timing:
The course is held in the autumn semester, during periods I and II. Recommended time: BSc second year.
Learning outcomes:
Upon completion of the course, the student:

- is able to repurpose old electronics to create new applications and devices
- is able to create simple Arduino-based embedded programs
- is able to implement communication between two electrical devices/equipment
- is able to build own measurement instruments to enable hardware repurposing, such as a simple logic analyzer
- is able to create simple Android programs
- is able to deconstruct and take apart old electronics safely
- is able to recognize and repurpose old components removed from used electronics
- is able to safely solder and desolder electrical components
- is able to define and implement simple electrical systems and applications

Contents:
The course teaches students to use common methods to hack hardware in order to repurpose old electronic devices to new applications. These techniques include (a) patching into I/O, (b) replacing a component, (c) signal hacking using a logic analyzer, (d) firmware hacking using hex dump and (e) repurposing circuit boards and components removed from old electronics. Major part of the course is dedicated to students own projects in groups to create devices and system using repurposed electronics such as old cell phones, PCs, printers etc.
Mode of delivery:
Contact teaching, project work in teams/pairs
Learning activities and teaching methods:
Lectures 12h, self study/project work 123h. Guidance for the self studi will be available weekly or at times agreed upon during the course.
Target group:
The course can be taken by students from any degree program, BSc or MSc level.
Prerequisites and co-requisites:
None
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time. Any prior knowledge about Arduinoa and Android programming are beneficial. Principles of Digital Fabrication (521159P) is recommended,but not required
Recommended or required reading:
There is no recommended or required reading, since most of the basic ideas and examples can best be found from the internet. However, some of the key concepts can be found in Anderew Huang, ***The Hardware Hacker – Adventures in Making and Breaking Hardware***, March 2017, 416 pp., ISBN-13: 978-1-59327-758-1 and Joe Grand, Kevin Mitnick and Ryan Russell, ***Hardware Hacking - Have Fun while Voiding your Warranty***, 1st Edition, January 2004, 448 pp., eBook ISBN: 9780080478258, Paperback ISBN: 9781932266832
Assessment methods and criteria:
The course will be evaluated on the basis of the project delivered by the teams of students. Essential part of this reporting is the documentation of the project.
Read more about assessment criteria at the University of Oulu web page.
Grading:
The course is evaluated passed with honors/pass/fail
Person responsible:
Juha Häkkinen
Working life cooperation:
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Other information:
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