Opasraportti

ITEE - Electronics and Communications Engineering (2018 - 2019)

Degree Programme in Electronics and Communications

International Master's program in Wireless Communications Engineering, course structure diagram: http://www.oulu.fi/sites/default/files/content/Wireless%20Communications%20Engineering%20Course%20Structure%20Diagram%202018_2020.pdf

Finnish language programs:

BSc: http://www.oulu.fi/sites/default/files/content/ElTelecomBSc_2018_2019.pdf

MSc: http://www.oulu.fi/sites/default/files/content/ElTelecomMSc_2018_2019.pdf

Tutkintorakenteet

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

Tutkintorakenteen tila: published

Lukuvuosi: 2018-19

Lukuvuoden alkamispäivämäärä: 01.08.2018

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 124 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

521004P: Orientation to Electronics and Communications Engineering, 1 op
031010P: Calculus I, 5 op
521077P: Introduction to Electronics, 5 op
521141P: Elementary Programming, 5 op
031078P: Matrix Algebra, 5 op
521109A: Electrical Measurement Principles, 5 op
031075P: Calculus II, 5 op
031021P: Probability and Mathematical Statistics, 5 op
031076P: Differential Equations, 5 op
521302A: Circuit Theory 1, 5 op
761310A: Wave motion and optics, 5 op
Compulsory
761310A-01: Wave motion and optics, lectures and exam, 0 op
761310A-02: Wave motion and optics, lab. exercises, 0 op
521301A: Digital Techniques 1, 8 op
031077P: Complex analysis, 5 op
521104P: Introduction to Material Physics, 5 op
031080A: Signal Analysis, 5 op
521303A: Circuit Theory 2, 5 op
521287A: Introduction to Computer Systems, 5 op
521337A: Digital Filters, 5 op
521071A: Principles of Semiconductor Devices, 5 op
521431A: Principles of Electronics Design, 5 op
761312A: Electromagnetism 2, 5 op
521330A: Telecommunication Engineering, 5 op
521432A: Electronics Design I, 5 op
521329A: Hands-on Course in Wireless Communication, 5 op
521384A: Basics in Radio Engineering, 5 op
521241A: Optical systems, 5 op
521404A: Digital Techniques 2, 5 op
521070A: Introduction to Microfabrication Techniques, 5 op
521307A: Laboratory Exercises on Analogue Electronics, 5 op
521304A: Filters, 5 op
521092A: Electronic Measurement Techniques, 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

Optional studies

Optional courses to complete the 180 credit degree can be selected e.g. from other engineering branches, natural sciences and business studies. Practical training, 3 credits, can also be included. Each student's optional studies are approved by programme administration. Some recommended courses in the Finnish language study guide. In more detail: http://www.oulu.fi/ee/opiskelu/valinnaiset

Master's Programme in Wireless Communications Engineering

Tutkintorakenteen tila: published

Lukuvuosi: 2018-19

Lukuvuoden alkamispäivämäärä: 01.08.2018

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*
  - 031025A: Introduction to Optimization, 5 op
  - 521348S: Statistical Signal Processing 1, 5 op
  - 521316S: Broadband Communications Systems, 5 op
  - 521340S: Communications Networks I, 5 op
  - 521321S: Elements of Information Theory and Coding, 5 op
  - 521323S: Wireless Communications I, 5 op
  - 521324S: Statistical Signal Processing II, 5 op
  - 521385S: Mobile Telecommunication Systems, 5 op
  - 521317S: Wireless Communications II, 8 op
  - 521377S: Communications Networks II, 7 op
  - 521325S: Communication Signal Processing II, 5 op
  - 521326S: Radio Engineering 1, 5 op

A451226: Module of the option, RF Engineering, 36 - 71 op
- *obligatory studies of the RF study option*
  - 521316S: Broadband Communications Systems, 5 op
  - 521401S: Electronics Design II, 6 op
  - 521323S: Wireless Communications I, 5 op
  - 521326S: Radio Engineering 1, 5 op
  - 521348S: Statistical Signal Processing 1, 5 op
  - 521225S: RF Components and Measurements, 5 op
  - 521324S: Statistical Signal Processing II, 5 op
  - 521405A: Electronic System Design, 5 op
  - 521435S: Electronics Design III, 6 op
  - 521327S: Radio Engineering II, 6 op
  - 521402S: Telecommunications Circuit Design, 6 op
- *Include in the advanced module EITHER 521388S OR 521386S AND 521322S OR 521300S.*
  - 521388S: Antennas, 5 op
  - 521386S: Radio Channels, 5 op
  - 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
- *Alternative*
  - 900017Y: Survival Finnish, 2 op
  - 900013Y: Beginners' Finnish Course 1, 3 op
  - 900053Y: Beginners' Finnish Course 2, 5 op
  - 521386S: Radio Channels, 5 op
  - 521388S: Antennas, 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
  - 521225S: RF Components and Measurements, 5 op
  - 521097S: Wireless Measurements, 5 op
  - 521327S: Radio Engineering II, 6 op
  - 521405A: Electronic System Design, 5 op
  - 521402S: Telecommunications Circuit Design, 6 op
  - 521401S: Electronics Design II, 6 op
  - 521435S: Electronics Design III, 6 op
  - 813621S: Research Methods, 5 op
  - 521273S: Biosignal Processing I, 5 op

521385S: Mobile Telecommunication Systems, 5 op
521340S: Communications Networks I, 5 op
521377S: Communications Networks II, 7 op
521317S: Wireless Communications II, 8 op
521325S: Communication Signal Processing II, 5 op
521145A: Human-Computer Interaction, 5 op
521279S: Signal Processing Systems, 5 op
521148S: Ubiquitous Computing Fundamentals, 5 op
521281S: Application Specific Signal Processors, 5 op
521493S: Computer Graphics, 7 op
521290S: Distributed Systems, 5 op
521466S: Machine Vision, 5 op
521045S: Mobile Computing, 5 op
521044A: Social Computing, 5 op
521260S: Programmable Web Project, 5 op
521479S: Software Project, 7 op
521321S: Elements of Information Theory and Coding, 5 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.

Master's Thesis / Wirelless Communication

522991S: Master's Thesis in Radio Engineering, 30 op
521011S: Maturity Test for Master's Degree, Electronics and Communications Engineering, 0 op

Master's Thesis / Telecommunication Engineering

521998S: Master's Thesis in Telecommunication Engineering, 30 op
521011S: Maturity Test for Master's Degree, Electronics and Communications Engineering, 0 op

MSc. Engineering, Electronics and Communications Engineering

Tutkintorakenteen tila: published

Lukuvuosi: 2018-19

Lukuvuoden alkamispäivämäärä: 01.08.2018

Option (60 - 80 op)

Compulsory, choose one of the options and one of the related advanced modules.

Apart from the below courses, the advanced module can contain also courses from other options as well as e.g. natural sciences or economics courses that support your degree. The minimum extent of the degree is 120 ECTS credits. Please observe this when selecting your optionals.

Please note: there may be mistakes in module size limits which will not affect your choices.

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
521326S: Radio Engineering 1, 5 op
521088S: Optoelectronics, 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 two courses.
521435S: Electronics Design III, 6 op
521453A: Operating Systems, 5 op
521457A: Software Engineering, 5 op
521025S: Power Electronics, 5 op
521300S: Electronics Design and Construction Exercise, 6 op
521402S: Telecommunications Circuit Design, 6 op
Optional Studies: Electronics
521410S: Special Course in Electronic Design, 4 - 7 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
521401S: Electronics Design II, 6 op
521124S: Sensors and Measuring Techniques, 5 op
521326S: Radio Engineering 1, 5 op
521073S: Electroceramics and Intelligent Materials, 5 op
521075S: Microelectronics Packaging Technologies, 5 op
521074S: Microelectronics and Micromechanics, 5 op
521225S: RF Components and Measurements, 5 op
521215S: Microelectronics project, 5 op
A451291: Advanced Module, Electronics Materials and Components, 10 - 52 op
Advanced module, Obligatory courses (min. 2 courses) min. 10 ECTS cr
521080S: X-ray Diffraction, 5 op
521072S: Microsensors, 5 op
521079S: Introduction to Nanotechnology, 5 op
521089S: Printed Electronics, 5 op
Recommended optional studies, see http://www.oulu.fi/ee/opiskelu/oppaat
521435S: Electronics Design III, 6 op
521405A: Electronic System Design, 5 op
521423S: Embedded System Project, 5 op
521406S: Digital Techniques 3, 7 op
521300S: Electronics Design and Construction Exercise, 6 op
521388S: Antennas, 5 op
521386S: Radio Channels, 5 op
521327S: Radio Engineering II, 6 op
521402S: Telecommunications Circuit Design, 6 op
521096S: Measurement Systems, 5 op
521088S: Optoelectronics, 5 op
521094S: Optoelectronic Sensors of Future, 5 op
521098S: Testing techniques of Electronics, 5 op
521115S: EMC Design, 5 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
031025A: Introduction to Optimization, 5 op
521321S: Elements of Information Theory and Coding, 5 op
521316S: Broadband Communications Systems, 5 op
521323S: Wireless Communications I, 5 op
521340S: Communications Networks I, 5 op
521348S: Statistical Signal Processing 1, 5 op
521324S: Statistical Signal Processing II, 5 op
521385S: Mobile Telecommunication Systems, 5 op
Advanced module, obligatory courses, 25 ECTS cr
A453273: Advanced module, Telecommunication Engineering, 10 - 47 op
Advanced module mandatory courses, 25 ECTS cr
521377S: Communications Networks II, 7 op
521317S: Wireless Communications II, 8 op
521325S: Communication Signal Processing II, 5 op
521326S: Radio Engineering 1, 5 op
Advanced Module, Telecommunication Engineering (optional studies)
A453295: Advanced Module, Telecommunication Engineering (optional studies), 11 - 37 op
Advanced module, optional studie s
521435S: Electronics Design III, 6 op
521388S: Antennas, 5 op
521386S: Radio Channels, 5 op
521327S: Radio Engineering II, 6 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521322S: Telecommunication Engineering Project, 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 of the RF study option
521316S: Broadband Communications Systems, 5 op
521401S: Electronics Design II, 6 op
521323S: Wireless Communications I, 5 op
521326S: Radio Engineering 1, 5 op
521348S: Statistical Signal Processing 1, 5 op
521225S: RF Components and Measurements, 5 op
521324S: Statistical Signal Processing II, 5 op
521405A: Electronic System Design, 5 op
521435S: Electronics Design III, 6 op
521327S: Radio Engineering II, 6 op
521402S: Telecommunications Circuit Design, 6 op
Include in the advanced module EITHER 521388S OR 521386S AND 521322S OR 521300S.
521388S: Antennas, 5 op
521386S: Radio Channels, 5 op
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.
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521410S: Special Course in Electronic Design, 4 - 7 op

Photonics and Measurement Techniques

H451227: Module of the Option, Photonics and Measurement Technology, 60 - 80 op
Module of the option, compulsory studies, 31 ECTS cr
A451223: Module of the Option, Photonics and Measurement Techniques, 30 - 41 op
Compulsory courses, 30 ECTS cr
521091S: Technical Optics, 5 op
521096S: Measurement Systems, 5 op
521443S: Electronics Design II, 5 op
521088S: Optoelectronics, 5 op

521124S: Sensors and Measuring Techniques, 5 op
521097S: Wireless Measurements, 5 op

Advanced Modules, Optical and Electrical Measurement Techniques, 15 ECTS cr

A451292: Advanced Module, Optical and Electrical Measurement Techniques, 15 - 57 op

Advanced module, Compulsory Studies 15 ECTS cr (Choose) and select optional studies to make total 120 ECTS cr

521242A: Introduction to Biomedical Engineering, 5 op
521240S: Biophotonics and Biomedical Optics, 5 op
521093S: Biomedical Instrumentation, 5 op
521094S: Optoelectronic Sensors of Future, 5 op

A451293: Advanced Module,Testing Techniques and Printed Electronics, 10 - 57 op

Advanced module, below compulsory studies 15 ECTS cr and select optional studies to make total 120 ECTS cr

521089S: Printed Electronics, 5 op
521098S: Testing techniques of Electronics, 5 op
521079S: Introduction to Nanotechnology, 5 op

Advanced practical training (3 op)

521016A: Advanced Practical Training, 3 op

Master's Thesis (30 op)

Choose your Thesis category among the following.

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

MSc Thesis Electronics design

523991S: Master's Thesis in Electronics Design, 30 op

MSc Thesis Electronics materials and components

523992S: Master's Thesis in Electronics Materials and Components, 30 op

MSc Thesis Telecommunication

521998S: Master's Thesis in Telecommunication Engineering, 30 op

MSc Thesis Radio engineering

522991S: Master's Thesis in Radio Engineering, 30 op

MSc Thesis Photonics and measurement techniques

523993S: Master's Thesis in Photonics and Measurement Technology, 30 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuuluvien opintokohteiden kuvaukset

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 124 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

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

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

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,
- formulate strategies for developing your English-language communication skills based on an evaluation of your own strengths and weaknesses.

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 fown 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 / team work 22 hours / independent work 7 hours. Lessons include regular pair and group work in class. Team work includes the preparation of four short presentations (22 hours). Independent homework activities include an online vocabulary test (3 hours) and other small assignments (5 hours). Active participation is essential.

Target group:

Students in the engineering programmes: TTK (PO1, YMP1, KO1, TuTa1, KaiRik1), 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. Students must achieve a grade of 75% in the online vocabulary test.
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.

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 Optima 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 course Optima 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, TST and OMS).

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:

See contact teachers

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 (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.

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 4 basic areas:
i) business communication (e.g. telephoning skills and correspondence),
ii) social 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:

See contact teachers

Working life cooperation:

-

Other information:

-

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.

Learning outcomes:

By the end of the course, you are expected to be able to
1) define what you need to know about a word or a lexical phrase in order to learn vocabulary,
2) give examples of how words are built from meaningful parts,
3) apply vocabulary learning techniques,
4) explain and apply general academic / scientific vocabulary (AWL),
5) outline the characteristics of informal vs. formal / academic vocabulary,
6) demonstrate basic academic writing and communication skills.

Contents:

The general aim of this module is 1) to help you become aware of the strategies which best promote your skills to learn and memorise vocabulary, and 2) 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 (*the Academic Word List*).
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 be given many varied 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 an essay (6 hours); two exams (10), one around the midpoint of the course and the other towards the end; presentations (6), which will be given in class to small groups of students; and other homework assignments (5 hours). 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. In addition to this, satisfactory completion of the in-class/ homework assignments and the two vocabulary tests is required.
Lue lisää opintosuoritusten arvostelusta yliopiston verkkosivulta.

Grading:

Pass/Fail

Person responsible:

See contact teachers

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, students work independently, studying online handouts and consolidating their 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) in a classroom on the Linnanmaa campus.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Pass/Fail

Person responsible:

See contact teachers

Working life cooperation:

-

Other information:

-

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 of all faculties

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:

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 course unit is held every semester. There are two teaching groups in the autumn semester and three in the spring. 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 of all faculties

Prerequisites and co-requisites:

See Required Proficiency Level

Recommended optional programme components:

-

Recommended or required reading:

Freut mich 1 (Otava). Authors: Anja Blanco and Pauli Kudel.
Fahrplan. Authors: Kauppi, Eva ja Simon, Heli. Chapters 8 - 14. A additional study material prepared by the teacher.

Assessment methods and criteria:

Continuous assesment, 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:

Registration in WebOodi. If the registration has closed the student can sign up by contacting the teacher by e-mail.

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 of all faculties and exchange students

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:

Registration in WebOodi. 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

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 of all faculties and exchange students.

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:

Registration in WebOodi. If the registration has closed the student can sign up by contacting the teacher by e-mail.

Compulsory to all

521004P: Orientation to Electronics and Communications Engineering, 1 op

Voimassaolo: 01.08.2013 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

1 ECTS

Language of instruction:

Finnish, English when needed.

Timing:

Autumn, periods 1-2.

Learning outcomes:

1. After completing this course, students are familiar with academic studies and study-related services.

2. Students know how to plan and schedule their studies based on their program curriculum.

3. Students can use the necessary information and computer systems.

Contents:

Issues related to starting the studies. Education in electrical and telecommunications engineering.The student organizations, social services offered to students (such as financial aid, sports and health services). University of Oulu and its administration.

Mode of delivery:

Contact teaching.

Learning activities and teaching methods:

Student tutoring, teacher tutoring, information sessions offered by the University, Faculty and degree program, independent work; total of 30 hours.

Target group:

1st year Electronics and Communications Engineering BSc students

Prerequisites and co-requisites:

None.

Recommended optional programme components:

None.

Recommended or required reading:

Study guide, websites, new students' folder.

Assessment methods and criteria:

Participation in information sessions as well as student and teacher tutoring. Each student is required to submit a PSP for passing the course. 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:

Maritta Juvani

Working life cooperation:

None.

Other information:

-

031010P: Calculus I, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Applied Mathematics and Computational Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Lusikka
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 can be completed in English by intermediate exams or by a final exam.

Timing:

Autumn semester, period 1

Learning outcomes:

Upon completion of the course, the student identifies concepts of vector algebra, can use vector algebra for solving problems of analytic geometry, can explain basic characteristics of elementary functions, is able to analyse the limit and the continuity of real valued functions of one variable, can solve problems associated with differential and integral calculus of real valued functions of one variable.

Contents:

Vector algebra and analytic geometry. Limit, continuity, differential and integral calculus and applications of real valued functions of one variable. Complex numbers.

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:

-

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:

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:

Ilkka Lusikka

Working life 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:

-

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:

-

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:

-

521109A: Electrical Measurement Principles, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Saarela
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:

Juha Saarela

Working life cooperation:

None.

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: Ilkka Lusikka
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:

Face-to-face 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.
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:

Ilkka Lusikka

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:

Face-to-face 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.
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:

-

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:

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:

The recommended prerequisite is the completion of the course Calculus I.

Recommended optional programme components:

-

Recommended or required reading:

Recommented 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:

-

Other information:

-

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:

-

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
Opettajat: Seppo Alanko
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

Compulsory

761310A-01: Wave motion and optics, lectures and exam, 0 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opettajat: Seppo Alanko
Opintokohteen kielet: Finnish
Leikkaavuudet:

766349A	Wave motion and optics	7.0 op
761114P	Wave motion and optics	5.0 op
761114P-01	Wave motion and optics, lectures and exam	0.0 op
761114P-02	Wave motion and optics, lab. exercises	0.0 op
766329A	Wave motion and optics	6.0 op

761104P Wave Motion 3.0 op

Language of instruction:

Finnish. The course material and exercises are available in English.

Timing:

Firts 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

761310A-02: Wave motion and optics, lab. exercises, 0 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Partial credit

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-01 Wave motion and optics, lectures and exam 0.0 op

761114P-02 Wave motion and optics, lab. exercises 0.0 op

766329A Wave motion and optics 6.0 op
761104P Wave Motion 3.0 op

Ei opintojaksokuvauksia.

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: Antti Mäntyniemi
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:

-

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:

-

Other information:

-

521104P: Introduction to Material Physics, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Jani Peräntie, Juha Hagberg
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 132,5 hours of work

Language of instruction:

Finnish.

Timing:

Autumn semester period 1

Learning outcomes:

1. is able to explain the principal solid state crystal structures

2. can explain how propagating waves and electrons in a crystal lattice can be presented

3. can explain the free electron model of metals and the formation of the energy band structure in crystals and their significance to the electrical properties of materials

4. is able to explain the basic phenomena related to semiconductors and is able to calculate the charge carrier concentrations in them

Contents:

Crystal structures, cohesion and defects. Reciprocal lattice and waves in crystals. Statistical mechanics and thermal vibration. Free electron model of metals. Energy bands in crystal. Basic phenomena of semiconductors.

Mode of delivery:

Will be notified in the beginning of lectures

Learning activities and teaching methods:

Will be notified in the beginning of lectures

Target group:

Second year electrical engineering students

Prerequisites and co-requisites:

Basic physics and mathematics.

Recommended optional programme components:

Basic course for 521071A Principles of Semiconductor Devices.

Recommended or required reading:

Lecture notes (in Finnish). English material for instance parts from books: H.M. Rosenberg: The Solid State, Clarendon Press, Oxford, 1988 and B. Streetman: Solid State Electronic Devices, Prentice Hall, New Jersey, 1995.

Assessment methods and criteria:

Will be notified in the beginning of lectures.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Will be notified in the beginning of lectures. Read more about assessment criteria at the University of Oulu webpage.

Person responsible:

Juha Hagberg

Working life cooperation:

No

Other information:

-

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 or a retake 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 calculate the spectrum of a sampled 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:

Blended teaching.

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 Pro-cessing. Shanmugan, K.S., Breipohl, A.M.: Random Signals, Detection, Estimation and Data Analysis.

Assessment methods and criteria:

The course is completed with a final exam or a retake exam. In addition to the final exam, STACK-assignments given during the course are part of the 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 1-5. In the numerical scale zero stands for a fail.

Person responsible:

Vesa Kotila

Working life cooperation:

-

Other information:

-

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:

-

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 ECTS cr

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 (16h), 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.

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.
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:

Teemu Leppänen

Working life cooperation:

Visiting lectures with experts from local industry are possible.

Other information:

This course replaces the course 521142A Embedded systems programming.

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:

Face-to-face teaching (Lectures), independent work, group work

Learning activities and teaching methods:

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.

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: Juha Hagberg, Jani Peräntie

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:

Will be notified in the beginning of lectures.

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:

-

521431A: Principles of Electronics Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Kostamovaara

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:

Face-to-face teaching

Learning activities and teaching methods:

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:

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:

Juha Kostamovaara

Working life cooperation:

-

761312A: Electromagnetism 2, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Anita Aikio

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

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	Telecommunication Engineering II	3.0 op

ECTS Credits:

5

Language of instruction:

Finnish. The course can be completed in other languages e.g. in English as a book examination.

Timing:

The course is held in period 4.

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 (amplitudemodulation) and non-linear (anglemodulation) 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. Characteristics and modelling of radio channels. Influence of band-limiting and multi-path propagation (inter-symbol interference ISI & fading) on system performance. Diversity, channel equalizing and MCM/OFDM methods for reducing channel interference. Spread-spectrum technique, and benefits & limitations & applications of that principle. Cellular system idea. Basics of information theory, source coding and error-control coding methods.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Face-to-face teaching 52 h. No separate times for class-ecercises. Exercises are integrated as part of face-to-face teaching event. Self-study 73 h. Total 125 h.

Target group:

Second year B.Sc.(Tech.) students in electrical engineering and computer engineering degree programmes.

Prerequisites and co-requisites:

031080A Signal analysis course.

Recommended optional programme components:

No connections to other courses.

Recommended or required reading:

Lecture slides in Finnsih are stored into the TTK-OPTIMA environment. 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 several mini-exams during course, or with final exam.

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).

521432A: Electronics Design I, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

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:

Differential amplifier, frequency response of a transistor amplifier, feedback, stability and nonidealities of a feedback amplifier, terminals and power amplifiers, oscillators and tuned amplifiers, non-adventional operations amplifier, applications of operational amplifier, comparator

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 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:

Juha Kostamovaara

Working life cooperation:

-

Other information:

-

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 credits

Language of instruction:

Finnish

Timing:

The course is organized in the autumn semester during 1. 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. That is obtained with the aid of small laboratory exercise work tasks which require understanding theories of basic analog and digital carrier modulation methods.
2. understands the idea of complex-valued I&Q vecor-signals, which exist behind software radios and measurement techniques.
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.
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 transceiver

Mode of delivery:

Face-to-face teaching and guided laboratory exercises in a class. Self-studying at home between work themes. Writing of exercise work reports.

Learning activities and teaching methods:

Course consist of small wireless communication tasks using various analog and digital carrier modulations. Number of exercises is 7. The course utilizes National Instruments USRP-2900 universal software radio peripheral transceiver 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 license. If necessary, students have to participate in short briefing lectures to get instructions for each exercise work. Exercises 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 retun report two weeks after each work session.
Course contains 7 hours lectures for work instructions and 28 hours of measurement work. In addition, students perform self-study and reporting at home.

Target group:

Third year bachelor level electrical engineering students

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 TTK-Optima environment. In addition, some NI USRP-2900 related material will be placed into Optima. Some materials and links can be found also from the Noppa page: https://noppa.oulu.fi/noppa/kurssi/521329a/etusivu

Assessment methods and criteria:

All students of a group have to participate in introductory face-to-face teaching 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:

For each exercise work grading is done with the numbers 0…5. Grade 0 is interpreted as failed. Each work must have at least grade 1. Final grade is an average of sub-tasks with standard rounding technique.

Person responsible:

Kari Kärkkäinen

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: Aarno Pärssinen, Risto Vuohtoniemi

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. 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. 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. Additional reading in Finnish: Jyrki Louhi & Arto Lehto: Radiotekniikan harjoituksia. Otatieto, 1995.

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:

-

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:

-

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:

-

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: Teirikangas, Merja Elina
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

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:

Parallel to Electronics Design I.

Recommended or required reading:

Lecture notes of Principles of Ekectronic 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:

-

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:

-

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: Juha Saarela
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 / 136 h

Language of instruction:

Course is lectured in Finnish. Lecture notes are available in English. Calculation exercises, laboratory exercises and the exam can be done in English.

Timing:

Period 4

Learning outcomes:

1. can name the electrical measurement technique terminology associated to measurement systems, sensors and buses to candidate level.

2. can plan and implement complicated measurements with oscilloscopes

3. can plan and implement basic measurements with spectrum analyzers

4. can plan and implement basic measurements with light detectors

5. can name common sources of noise and interference

6. name means to control noise and interference

7. 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 and calculation exercises 30h, laboratory exercises 16 h and self-study 90h

Target group:

Course is compulsory for most electrical engineering students. Course is open for all students in University of Oulu.

Prerequisites and co-requisites:

Courses of Electrical Measurement Principles and Analogue Electronics I are recommended.

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 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:

Juha Saarela

Working life cooperation:

None.

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 credits / 27 hours of work

Language of instruction:

Finnish

Timing:

Architecture 3. spring semester, period I; Biochemistry 3. autumn semester; Biology 3. autumn semester, period I; Chemistry 3. autumn semester, period II; Computer Science and Engineering 2. spring semester, period IV; Electronics and Communications Engineering 3. spring semester; Geosciences 2. spring semester, period IV; Geography 1. and 3. spring semester, period III, Industrial Engineering and Management 3. year (Master's degree students in Industrial Engineering and Management 1st year.); Information Processing Sciences 1. 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.

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 RefWorks 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.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Web learning material Tieteellisen tiedonhankinnan opas http://libguides.oulu.fi/tieteellinentiedonhankinta (in Finnish)

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
Working life cooperation:
-
Other information:
-

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
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

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

Ei opintojaksokuvauksia.

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

Ei opintojaksokuvauksia.

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:
-
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 Optima 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
Toropainen, Outi
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.

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

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.

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:

-

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:

Fall, during period 1

Learning outcomes:

Upon completion the student will

1. understand the key concepts in estimation theory such as the classical and Bayesian framework.
2. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
3. can derive an estimator for a given criterion and basic data models.
4. can use the methodology of estimation theory to analyze the performance of estimators
5. can choose a proper estimator for a given purpose
6. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), matched filtering

Contents:

Estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, leas squares estimation, Bayesian estimation, linear Bayesian estimation, Kalman filters, statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching, lectures and exercises 50 h and compulsory Matlab assignments 30 h, independent work 50 h. Some lectures may be replaced with video lectures.

Target group:

Electrical, communications, computer and system engineering as well as mathematics, physics and computer science students with knowledge of statistics in master or senior undergraduate level.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra

Recommended optional programme components:

-

Recommended or required reading:

Parts from books Kay, Steven M. "Fundamentals of statistical signal processing, volume I: estimation theory." (1993), Kay, Steven M. "Fundamentals of statistical signal processing: Detection theory, vol. 2." (1998).

Assessment methods and criteria:

The course is passed with two midterms exams (there will also be arranged a University Exam covering whole course around 5-6 weeks after the course) and accepted MATLAB assignments (programs + reports). In the final grade of the course, the weight for the examination is 0.7 and that for the MATLAB assignments is 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:

Markku Juntti
Janne Lehtomäki

Working life cooperation:

-

Other information:

-

521316S: Broadband Communications Systems, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Rajatheva Rajatheva, Satya Joshi
Opintokohteen kielet: English
Leikkaavuudet:

521316A	Broadband Communications Systems	4.0 op
521316A-01	Introduction to Broadband Transmission Techniques, exam	0.0 op
521316A-02	Introduction to Broadband Transmission Techniques, exercise work	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

1. Student can distinguish the basic transmission technologies used in the most important commercial wireless communication systems.

2. The student can differentiate and compare the key points behind these technologies, why they are used and what are their advantages and disadvantages.

3. Student can explain how the wireless channel impacts the design of the overall system.

4. The most relevant standards are introduced and explained, so that student can attain information from past and especially the forthcoming wireless standards.

5. Observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise.

Contents:

Introduction to Detection and Estimation Theory, Performance in AWGN and flat fading channels, Fading Multipath Channels, Mobility, Propagation, Path Loss Models, Orthogonal Frequency Division Multiplexing, Wireless Systems and Standards: 3G, LTE, 5G

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h.

Target group:

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

Prerequisites and co-requisites:

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

Recommended optional programme components:

Statistical signal processing and the course support each other.

Recommended or required reading:

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

Assessment methods and criteria:

The course is passed with mid term exams (first one during lecture periods) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Nandana Rajatheva

Working life cooperation:

-

Other information:

-

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. Upon completing the required coursework, the student is able to list and understand the functionalities of different layers of OSI and TCP/IP protocol models
2. The course gives the skills for the student to explain the mobile network evolution through previous and existing generations of mobile networks (1G, 2G, 3G, and 4G) towards 5G.

3. The student is able to describe the basic system architecture of GSM, GPRS, EDGE, UMTS and LTE, understands the significance of emerging technologies such as Network Function Virtualization (NVF), Software Defined Networking (SDN), Multi-Access Edge Computing (MEC), Cloud Radio Access Networks (CRAN), and core network functionalities such as Evolved Packet Core (EPC).
4. The student knows the basic properties of routing protocols in fixed, wireless and ad hoc networks, and can use graph theory to solve network routing problems
5. Students can describe the main principles of network programmability, mobility control, and network security, and can apply and solve related engineering problems.
6. The student is able to simulate different types of networks in simulation environments.

Contents:

Communications architecture and protocols, mobility management, network security, network management and ad hoc, wireless local area and mobile networks. Introduction to cloud computing, edge computing, network function virtualization and software defined networking. The goal is to present the fundamentals of the new communication architectures, trends and technologies accepted by academia and industry. Technical implementation and application of the common data and local networks are also discussed.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work with a simulation program (15 h).

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:

S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies (2nd ed.), 2009; Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015.

Assessment methods and criteria:

The course is passed with a final examination and the accepted 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:

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521321S: Elements of Information Theory and Coding, 5 op

Voimassaolo: 14.11.2005 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Rajatheva Rajatheva, Timo Kokkonen
Opintokohteen kielet: English
Leikkaavuudet:

521323S	Wireless Communications 2	5.0 op

ECTS Credits:

5

Language of instruction:

English.

Timing:

Fall, period 2

Learning outcomes:

1. can use basic methodology of information theory to calculate the capacity bounds of communication and data compression systems.

2. can estimate the feasibility of given design tasks before the execution of the detailed design.

3. understands the operating principles of block codes, cyclic codes and convolutional codes.

4. can form an encoder and decoder for common binary block codes, and is capable of using tables of the codes and shift register when solving problems.

5. can represent the operating idea of a convolutional encoder as a state machine.

6. is able to apply the Viterbi algorithm to decoding of convolutional codes.

7. is capable of specifying principles of Turbo, LDPC and Polar coding and coded modulation.

8. can evaluate error probability of codes and knows practical solutions of codes by name.

Contents:

Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, block codes, cyclic codes, burst error correcting codes, error correcting capability of block codes, convolutional codes, Viterbi algorithm, concatenated codes, and introduction to Turbo, LDPC and Polar coding and to coded modulation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h and group working.

Target group:

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

Prerequisites and co-requisites:

Signal Analysis, Telecommunication Engineering

Recommended optional programme components:

Wireless Communications I and the course support each other. Their simultaneous studying is recommended.

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, David J. C. Makay: Information Theory, Inference and Learning Algorithms, ISBN, ISBN-13: 978-0521642989, ISBN-10: 0521642981, and S. Benedetto and E. Biglieri: Principles of Digital Transmission with Wireless Applications, 1999, Chapters 3, 10 and in part 11 and 12. Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with continuous evaluation (only during lecture period) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Timo Kokkonen (Coding) / Nandana Rajatheva (Information theory)

Working life cooperation:

No

Other information:

-

521323S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S	Wireless Communications I	5.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 1	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

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 the suitable diversity methods for fading channel and related combining methods
4. can define the basic carrier and symbol synchronization methods and is able to make the performance comparison of them
5. can explain design methods signals for band-limited channels
6. can classify different channel equalizers, and perform the performance analysis

Contents:

Digital modulation methods and their performance in AWGN-channel, radio channel models, performance of digital modulation in fading channel, diversity techniques, channel equalizers in wireless communication channel, carrier and symbol synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 44 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 EE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering 521316S Broadband Communications Systems

Recommended optional programme components:

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Recommended or required reading:

Parts of book: Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005. Parts of book: J.G. Proakis: Digital Communications, 4th ed, McGraw Hill, 2001.

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

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 design of baseband parts of a communications transceiver.
2. have the skills to apply estimation, detection and other statistical signal processing methods to communications transceiver and system design.
3. can use linear algebra, basics of optimization and statistical signal processing to derive receiver algorithms, in particular for soft output equalization/detection and receiver synchronization.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including (un) supervised 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.

Contents:

Review of linear algebra, matrix computations and basics of constrained optimization; transceiver baseband design targets, filter optimization, adaptive filters and algorithms, iterative algorithms, algorithm convergence, equalization and detection algorithms, channel estimation, receiver carrier and timing synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing. The recommended prerequisite is the completition of 521323S Wireless communications I.

Recommended optional programme components:

-

Recommended or required reading:

Parts from books:
1. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
2. K. Vasudevan, Digital Communications and Signal Processing, Universities Press (India) 2017.
3. S. Haykin, Adaptive Filter Theory, 3rd ed. or newer, Prentice Hall 1996.
4. T. Kailath, A. H. Sayed & G. Hassibi, “Linear Estimation”, Prentice Hall 2000.
5. G. H. Golub & C. F. Van Loan, Matrix computations, 3rd ed. or newer, Johns Hopkins University Press 1996.
6. H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
7. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems. Completing the simulation project tasks, and a mid-term exams during the course. The mid-term exams can be retaken by a final exam later.
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:

-

521385S: Mobile Telecommunication Systems, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Katz, Marcos Daniel
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. Upon completing the required coursework, the student will be able to determine and fit the values of the main parameters for modern mobile telecommunication systems network planning. The course gives skills to describe mobility management, adaptive resource control and dynamic resource allocation in mobile networks.
The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

Contents:

Concept and structures of modern mobile communications systems. Basics of radio network planning and capacity. Distributed transmission power control and mobility management. Resource allocation techniques: adaptive resource control, dynamic resource allocation. Cooperative communications. Examples of digital mobile telecommunication systems in practice.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 16 h and the compulsory laboratory work (16 h)

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Telecommunication Engineering, Broadband Communications Systems and Wireless Communications 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:

The course material will be defined at the beginning of the course.

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 unit utilizes a numerical grading scale 1-5.

Person responsible:

Marcos Katz

Working life cooperation:

-

Other information:

Objective: The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

521317S: Wireless Communications II, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti-Heikki Tölli, Jarkko Kaleva

Opintokohteen kielet: English

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 3-4

Learning outcomes:

1. Upon completing the required coursework, the student is familiarised with the channel capacity as the basic performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna se

2. After learning the basics in a single-user multiple-input multiple-output (MIMO) communications, the student is acquainted with the capacity optimal multi-antenna transmission and reception schemes in both multiple access and broadcast channels.

3. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios.

4. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

5. Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

Contents:

Capacity of point-to-point and multiuser wireless channels, point-to-point MIMO communications, multiuser multiple antenna communications in uplink and downlink, opportunistic communications, scheduling and interference management, coordinated multi-cell transmission.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 45 h, exercises 25 h and the compulsory design work with a simulation program (25 h)

Target group:

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

Prerequisites and co-requisites:

In addition to the course Wireless Communications I, a working knowledge in digital communications, random processes, linear algebra, and detection theory is required. Also, students are asked to read chapters 1-4 from the textbook before attending the course.

Recommended optional programme components:

Prior knowledge of information theory and 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 5-10, as well as, a few recent journal publications related to multiuser MIMO downlink. 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%).
Read more about assessment criteria at the University of Oulu webpage.

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 III.

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 student is able to understand programmable networking, their benefits, and the openness of networks for innovations through programmable networks. The aim is to help the student to understand the basic principles of networking by providing a balance between the description of existing networks and the future trends in communication networks.
2. The student learns the benefits of network function virtualization (NFV), multi-access edge computing (MEC), network slicing and software defined networking (SDN). Students will understand the importance of these in future networks, MEC their use-cases, and leverage using them in designing and deploying them in modern communication networks.
3. The student understands 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.
4. Student achieves skill to design and implement simple SDNs and test for performance in both network simulators and real-life network environment. The descriptive material is used to illustrate the underlying concepts, and the practical material is used to generate a deeper interest of students in communication networks by giving them the chance to innovate themselves.

Contents:

The course will also give idea of how NFV, SDN and MEC can enable innovation in networking by providing the students with basics on to explore the networking field and perform experiments, write novel protocols and use their innovative capabilities. The course will also present interesting research areas such as network management, network security, and network load-balancing. Furthermore, the course will give hands-on experience on enabling programmable networks in a Lab environment or personal PCs/laptops using the SDN prototyping environment i.e. Mininet. For MEC and NFVs, 5G test network may be used for demonstrations, experiments and exercise work.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 15 h and the compulsory design work either with a simulation program or testbed implementation (30 h).

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. Additional reading materials related to NFV, SDN and MEC are provided in OPTIMA.

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:

-

521325S: Communication 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:

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

ECTS Credits:

5 ECTS cr / 130 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 1st 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, multiantenna processing and connection establishment.
3. understands the requirements of the curren wireless communications standards and related orthogonal frequency division 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.
6. knows how to interface the software models to the common implementation architectures.

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching (lectures and exercises) 25h, Simulation and design exercises in groups 80 h, independent work & passed assignment 35 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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing, 521324S Communications signal processing I. The recommended prerequisite is the completition of 521323S Wireless communications I.

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. T.-D. Chiueh, P.-Y. Tsai, I.-W. Lai, Baseband Receiver Design for Wireless MIMO-OFDM Communications, 2nd ed. IEEE Wiley 2012.
3. .H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
4. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems and completing the simulation projects, and 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 (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.

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 Exam, Radio engineering 1 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.

2. can also explain factors, which are limiting the bandwidth of impedance matching networks.

3. will be able to design the impedance matching for a low noise amplifier.

4. In the impedance matching the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

5. . will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.

6. will be able to design a power divider and a directional coupler.

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, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Mode of delivery:

Face-to-face teaching

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 of the RF study option

521316S: Broadband Communications Systems, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Rajatheva Rajatheva, Satya Joshi
Opintokohteen kielet: English
Leikkaavuudet:

521316A	Broadband Communications Systems	4.0 op
521316A-01	Introduction to Broadband Transmission Techniques, exam	0.0 op
521316A-02	Introduction to Broadband Transmission Techniques, exercise work	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

1. Student can distinguish the basic transmission technologies used in the most important commercial wireless communication systems.

2. The student can differentiate and compare the key points behind these technologies, why they are used and what are their advantages and disadvantages.

3. Student can explain how the wireless channel impacts the design of the overall system.

4. The most relevant standards are introduced and explained, so that student can attain information from past and especially the forthcoming wireless standards.

5. Observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise.

Contents:

Introduction to Detection and Estimation Theory, Performance in AWGN and flat fading channels, Fading Multipath Channels, Mobility, Propagation, Path Loss Models, Orthogonal Frequency Division Multiplexing, Wireless Systems and Standards: 3G, LTE, 5G

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h.

Target group:

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

Prerequisites and co-requisites:

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

Recommended optional programme components:

Statistical signal processing and the course support each other.

Recommended or required reading:

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

Assessment methods and criteria:

The course is passed with mid term exams (first one during lecture periods) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Nandana Rajatheva

Working life cooperation:

-

Other information:

-

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: Juha Kostamovaara
Opintokohteen kielet: English

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:

Juha Kostamovaara

Working life cooperation:

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Other information:

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521323S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01 Wireless Communications I, Exam 0.0 op
521395S Wireless Communications I 5.0 op
521320S Wireless Communications 2 8.0 op
521320S-01 Intermediate exam or final exam, Wireless Communications 1 0.0 op
521320S-02 Exercisework, Wireless Communications 2 0.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

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 the suitable diversity methods for fading channel and related combining methods
4. can define the basic carrier and symbol synchronization methods and is able to make the performance comparison of them
5. can explain design methods signals for band-limited channels
6. can classify different channel equalizers, and perform the performance analysis

Contents:

Digital modulation methods and their performance in AWGN-channel, radio channel models, performance of digital modulation in fading channel, diversity techniques, channel equalizers in wireless communication channel, carrier and symbol synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 44 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 EE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering 521316S Broadband Communications Systems

Recommended optional programme components:

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Recommended or required reading:

Parts of book: Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005. Parts of book: J.G. Proakis: Digital Communications, 4th ed, McGraw Hill, 2001.

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

Working life cooperation:

No

Other information:

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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 Exam, Radio engineering 1 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.

2. can also explain factors, which are limiting the bandwidth of impedance matching networks.

3. will be able to design the impedance matching for a low noise amplifier.

4. In the impedance matching the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

5. . will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.

6. will be able to design a power divider and a directional coupler.

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, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Mode of delivery:

Face-to-face teaching

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:

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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:

Fall, during period 1

Learning outcomes:

Upon completion the student will

1. understand the key concepts in estimation theory such as the classical and Bayesian framework.
2. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
3. can derive an estimator for a given criterion and basic data models.
4. can use the methodology of estimation theory to analyze the performance of estimators
5. can choose a proper estimator for a given purpose
6. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), matched filtering

Contents:

Estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, leas squares estimation, Bayesian estimation, linear Bayesian estimation, Kalman filters, statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching, lectures and exercises 50 h and compulsory Matlab assignments 30 h, independent work 50 h. Some lectures may be replaced with video lectures.

Target group:

Electrical, communications, computer and system engineering as well as mathematics, physics and computer science students with knowledge of statistics in master or senior undergraduate level.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra

Recommended optional programme components:

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Recommended or required reading:

Parts from books Kay, Steven M. "Fundamentals of statistical signal processing, volume I: estimation theory." (1993), Kay, Steven M. "Fundamentals of statistical signal processing: Detection theory, vol. 2." (1998).

Assessment methods and criteria:

The course is passed with two midterms exams (there will also be arranged a University Exam covering whole course around 5-6 weeks after the course) and accepted MATLAB assignments (programs + reports). In the final grade of the course, the weight for the examination is 0.7 and that for the MATLAB assignments is 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:

Markku Juntti
Janne Lehtomäki

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
Opettajat: Teirikangas, Merja Elina
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:

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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 design of baseband parts of a communications transceiver.
2. have the skills to apply estimation, detection and other statistical signal processing methods to communications transceiver and system design.
3. can use linear algebra, basics of optimization and statistical signal processing to derive receiver algorithms, in particular for soft output equalization/detection and receiver synchronization.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including (un) supervised 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.

Contents:

Review of linear algebra, matrix computations and basics of constrained optimization; transceiver baseband design targets, filter optimization, adaptive filters and algorithms, iterative algorithms, algorithm convergence, equalization and detection algorithms, channel estimation, receiver carrier and timing synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing. The recommended prerequisite is the completition of 521323S Wireless communications I.

Recommended optional programme components:

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Recommended or required reading:

Parts from books:

1. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
2. K. Vasudevan, Digital Communications and Signal Processing, Universities Press (India) 2017.
3. S. Haykin, Adaptive Filter Theory, 3rd ed. or newer, Prentice Hall 1996.
4. T. Kailath, A. H. Sayed & G. Hassibi, “Linear Estimation”, Prentice Hall 2000.
5. G. H. Golub & C. F. Van Loan, Matrix computations, 3rd ed. or newer, Johns Hopkins University Press 1996.

6. H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
7. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems. Completing the simulation project tasks, and a mid-term exams during the course. The mid-term exams can be retaken by a final exam later.
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:

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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, reliability of electronics.

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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521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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.

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:

Juha Kostamovaara

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	Radio Engineering II	5.0 op
521375S-01	Exam, Radio Engineering II	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:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (40 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:

-

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.

Include in the advanced module EITHER 521388S OR 521386S AND 521322S OR 521300S.

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:

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:

Face-to-face 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 (Third Edition). John Wiley & Sons, 2005. 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:

Course will be given every second year in even years. Will be held next time in the spring of 2020.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

The course is held in the spring semester, during period IV.

Learning outcomes:

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. 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. Ultra wideband radio channels. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h / Exercises 12 h / compulsory laboratory work 14 h / Self-study 80 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:

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

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2019.

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 1-2

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.

Alternative

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 of Oulu University.

Required proficiency level:

No previous Finnish studies.

ECTS Credits:

2 ECTS credits

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:

Multi-modal teaching (Contact teaching, on-line teaching and independent work)

Learning activities and teaching methods:

Lessons 1–2 times a week (14 h, including the final exam) and guided self study (40 h)

Target group:

International degree and post-graduate degree students and exchange students 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 0-5.

Person responsible:

Anne Koskela

Working life cooperation:

-

Other information:

Sign-up in WebOodi.

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:

A1.2

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, describing people and things, talking about weather and seasons, the names of the months and colours.

The structures studied are: verb types, basics of the change of the consonants k, p and t in verbs and nouns, the genitive and partitive 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 and exchange students of the University

Prerequisites and co-requisites:

Completion of the Survival Finnish Course

Recommended optional programme components:

-

Recommended or required reading:

Gehring, S. & Heinzmann, S. Suomen mestari 1 (chapters 3 - 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. 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:

The course is intended for the international students in every faculty of Oulu University.

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: asking for and giving directions, asking for help/favours, carrying out transactions in shops and restaurants, talking about the past, asking for and expressing opinions and feelings, accommodation, travelling, vehicles, work, professions, food, drink and parties.

The structures studied are: the local cases, nominative plural (basic form plural), imperfect (past tense of verbs), part of the imperative, more declension types for nouns (word types), more about the change of the consonants k, p and t in verbs and nouns, declension of the demonstrative pronouns and personal pronouns, more about the partitive case, basics of the object cases, postpositions and some sentence types in Finnish.

Mode of delivery:

Contact teaching and guided 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 and exchange students of the University

Prerequisites and co-requisites:

Completion of the Beginners' Finnish Course 1

Recommended optional programme components:

-

Recommended or required reading:

Gehring, S. & Heinzmann, S.: **Suomen mestari 1** (kappaleet 6-9)

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:

Anne Koskela

Working life cooperation:

-

Other information:

Sign-up in WebOodi. The lessons will be held **twice a week** during a 13-week period.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

The course is held in the spring semester, during period IV.

Learning outcomes:

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. 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. Ultra wideband radio channels. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h / Exercises 12 h / compulsory laboratory work 14 h / Self-study 80 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:

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

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2019.

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:

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:

Face-to-face 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 (Third Edition). John Wiley & Sons, 2005. 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:

Course will be given every second year in even years. Will be held next time in the spring of 2020.

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Opettajat: Matti Latva-aho, 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:

Matti Latva-aho, 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 1-2

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

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Teirikangas, Merja Elina
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:

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521097S: Wireless Measurements, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Saarela
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 Finnish or in English if two or more foreign students participate.

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:

Juha Saarela

Working life cooperation:

No.

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	Radio Engineering II	5.0 op
521375S-01	Exam, Radio Engineering II	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:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (40 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:

-

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, reliability of electronics.

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:

-

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.

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: Juha Kostamovaara
Opintokohteen kielet: English

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:

Juha Kostamovaara

Working life cooperation:

-

Other information:

-

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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.

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:

Juha Kostamovaara

Working life cooperation:

-

Other information:

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813621S: Research Methods, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Arto Lanamäki

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 autumn semester, during periods 1 and 2. It is recommended to complete the course in the 1st autumn semester.

Learning outcomes:

Having completed the course, the student is able to explain the general principles of scientific research and the practices of scientific methodology. The student is also able to generate research problems in information processing sciences. The student is able to identify and describe the main research approaches and methods in information processing sciences, and choose the appropriate approach and method for a research problem. The student is also able to evaluate the methodological quality of a research publication. After the course the student is able to 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:

Face-to-face teaching, lecture videos.

Learning activities and teaching methods:

Lectures 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:

Completion of Bachelor's studies.

Recommended or required reading:

Lecture slides and specified literature.

Assessment methods and criteria:

Accepted learning diary.

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: Tapio Seppänen

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 50 hours of work

Language of instruction:

English. Examination can be taken in English or Finnish.

Timing:

The course unit is held in the autumn semester, during period 2. It is recommended to complete the course at the end of studies.

Learning outcomes:

After completing the course, student
1. knows special characteristics of the biosignals and typical signal processing methods
2. can solve small-scale problems related to biosignal analysis
3. implement small-scale 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.

Learning activities and teaching methods:

Lectures 10h, Laboratory work 20h, Self-study 20h, written examination.

Target group:

Students interested in biomedical engineering, at their master's level studies.
Students of the University of Oulu.

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:

Laboratory work is supervised by assistants who also check that the task assignments are completed properly. All task assignments are compulsory. The course ends with a written exam.
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.

521385S: Mobile Telecommunication Systems, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Katz, Marcos Daniel

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. Upon completing the required coursework, the student will be able to determine and fit the values of the main parameters for modern mobile telecommunication systems network planning. The course gives skills to describe mobility management, adaptive resource control and dynamic resource allocation in mobile networks.
The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

Contents:

Concept and structures of modern mobile communications systems. Basics of radio network planning and capacity. Distributed transmission power control and mobility management. Resource allocation techniques: adaptive resource control, dynamic resource allocation. Cooperative communications. Examples of digital mobile telecommunication systems in practice.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 16 h and the compulsory laboratory work (16 h)

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Telecommunication Engineering, Broadband Communications Systems and Wireless Communications 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:

The course material will be defined at the beginning of the course.

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 unit utilizes a numerical grading scale 1-5.

Person responsible:

Marcos Katz

Working life cooperation:

-

Other information:

Objective: The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

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. Upon completing the required coursework, the student is able to list and understand the functionalities of different layers of OSI and TCP/IP protocol models
2. The course gives the skills for the student to explain the mobile network evolution through previous and existing generations of mobile networks (1G, 2G, 3G, and 4G) towards 5G.
3. The student is able to describe the basic system architecture of GSM, GPRS, EDGE, UMTS and LTE, understands the significance of emerging technologies such as Network Function Virtualization (NVF), Software Defined Networking (SDN), Multi-Access Edge Computing (MEC), Cloud Radio Access Networks (CRAN), and core network functionalities such as Evolved Packet Core (EPC).
4. The student knows the basic properties of routing protocols in fixed, wireless and ad hoc networks, and can use graph theory to solve network routing problems
5. Students can describe the main principles of network programmability, mobility control, and network security, and can apply and solve related engineering problems.
6. The student is able to simulate different types of networks in simulation environments.

Contents:

Communications architecture and protocols, mobility management, network security, network management and ad hoc, wireless local area and mobile networks. Introduction to cloud computing, edge computing, network function virtualization and software defined networking. The goal is to present the fundamentals of the new communication architectures, trends and technologies accepted by academia and industry. Technical implementation and application of the common data and local networks are also discussed.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work with a simulation program (15 h).

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:

S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies (2nd ed.), 2009; Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015.

Assessment methods and criteria:

The course is passed with a final examination and the accepted 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:

-

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 student is able to understand programmable networking, their benefits, and the openness of networks for innovations through programmable networks. The aim is to help the student to understand the basic principles of networking by providing a balance between the description of existing networks and the future trends in communication networks.
2. The student learns the benefits of network function virtualization (NFV), multi-access edge computing (MEC), network slicing and software defined networking (SDN). Students will understand the importance of these in future networks, MEC their use-cases, and leverage using them in designing and deploying them in modern communication networks.
3. The student understands 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.
4. Student achieves skill to design and implement simple SDNs and test for performance in both network simulators and real-life network environment. The descriptive material is used to illustrate the underlying concepts, and the practical material is used to generate a deeper interest of students in communication networks by giving them the chance to innovate themselves.

Contents:

The course will also give idea of how NFV, SDN and MEC can enable innovation in networking by providing the students with basics on to explore the networking field and perform experiments, write novel protocols and use their innovative capabilities. The course will also present interesting research areas such as network management, network security, and network load-balancing. Furthermore, the course will give hands-on experience on enabling programmable networks in a Lab environment or personal PCs/laptops using the SDN prototyping environment i.e. Mininet. For MEC and NFVs, 5G test network may be used for demonstrations, experiments and exercise work.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 15 h and the compulsory design work either with a simulation program or testbed implementation (30 h).

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. Additional reading materials related to NFV, SDN and MEC are provided in OPTIMA.

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:

-

521317S: Wireless Communications II, 8 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Antti-Heikki Tölli, Jarkko Kaleva
Opintokohteen kielet: English

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 3-4

Learning outcomes:

1. Upon completing the required coursework, the student is familiarised with the channel capacity as the basic performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna se

2. After learning the basics in a single-user multiple-input multiple-output (MIMO) communications, the student is acquainted with the capacity optimal multi-antenna transmission and reception schemes in both multiple access and broadcast channels.

3. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios.

4. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

5. Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

Contents:

Capacity of point-to-point and multiuser wireless channels, point-to-point MIMO communications, multiuser multiple antenna communications in uplink and downlink, opportunistic communications, scheduling and interference management, coordinated multi-cell transmission.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 45 h, exercises 25 h and the compulsory design work with a simulation program (25 h)

Target group:

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

Prerequisites and co-requisites:

In addition to the course Wireless Communications I, a working knowledge in digital communications, random processes, linear algebra, and detection theory is required. Also, students are asked to read chapters 1-4 from the textbook before attending the course.

Recommended optional programme components:

Prior knowledge of information theory and 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 5-10, as well as, a few recent journal publications related to multiuser MIMO downlink. 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%).
Read more about assessment criteria at the University of Oulu webpage.

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 III.

521325S: Communication 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:

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

ECTS Credits:

5 ECTS cr / 130 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 1st 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, multiantenna processing and connection establishment.
3. understands the requirements of the curren wireless communications standards and related orthogonal frequency division 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.
6. knows how to interface the software models to the common implementation architectures.

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching (lectures and exercises) 25h, Simulation and design exercises in groups 80 h, independent work & passed assignment 35 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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing, 521324S Communications signal processing I. The recommended prerequisite is the completition of 521323S Wireless communications I.

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. T.-D. Chiueh, P.-Y. Tsai, I.-W. Lai, Baseband Receiver Design for Wireless MIMO-OFDM Communications, 2nd ed. IEEE Wiley 2012.
3. .H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
4. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems and completing the simulation projects, and 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 (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.

Other information:

-

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:

In English.

Timing:

Autumn, period 2

Learning outcomes:

1. Knowledge of the Human Computer Interaction (HCI) fundamentals
2. Knowledge of evaluation techniques
3. Knowledge of prototyping techniques
4. Knowledge of how HCI can be incorporated in the software development process

Contents:

Human and computer fundamentals, design and prototyping, evaluation techniques, data collection and analysis.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures (12 h), exercises (16 h), and practical work (105 h). The course is passed with an approved practical work (several assignments). The implementation is fully 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 programming and design skills are desired.

Recommended optional programme components:

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

Recommended or required reading:

All necessary material will be provided by the instructor.

Assessment methods and criteria:

The assessment is project-based. Students have to complete several individual exercises throughout the semester: 1: Using questionnaires; 2: Fitts law; 3: Advanced, team-based design exercise and essay. Passing criteria: all exercises must be completed, each receiving more than 50% of the available points. 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:

Simo Hosio (Dr. Tech.)

Working life cooperation:

If relevant, guest lectures may be organized (optional).

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
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Autumn, period 2

Learning outcomes:

1. Student can explain the challenges of signal processing hardware, software, and design methodologies.

2. Student is able to transform a digital filter designed with floating point arithmetic into a fixed point precision implementation, optimizing the word lengths to achieve the performance specifications.

3. Student is able to explain the most important algorithm implementation structures and can identify their usage contexts.

4. Student has rudimentary practical skills in modeling, designing, and judging finite word length signal processing algorithms with Matlab and Simulink software tools.

Contents:

Binary and floating point arithmetic, DSP programming models and co-design, digital signal processors, algorithms and implementations, including CORDIC, transforms (FFT and DCT), multi-rate signal processing, polyphase filters, filter banks, adaptive algorithms and applications. The software environments of the course are Matlab with the Fixed Point Toolbox extension and Simulink with the DSP Blockset extension.

Mode of delivery:

Lectures, independent work, group work.

Learning activities and teaching methods:

The course consists of lectures (30 h) and design exercises (6-12 h). the rest as independent work (33h).

Target group:

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

Prerequisites and co-requisites:

521337A Digital Filters, 521267A Computer Engineering or 521286A Computer Systems, 8 ECTS cr or 521287A Introduction to Computer Systems, 5 ECTS cr

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 English.

Assessment methods and criteria:

Grading is based on the evaluation of the design exercises, which are done during the course, and exams, which are arranged during the lectures.
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.

521148S: Ubiquitous Computing Fundamentals, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Ojala, Timo Kullervo
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

English

Timing:

Autumn, periods 1-2.

Learning outcomes:

Upon completing the course the student:
1. understands the history and current state of ubiquitous computing.
2. is able to design, implement, and evaluate a ubiquitous computing system.
3. is able to carry out a research project from initial research problem statement to prototype implementation, empirical evaluation in-the-wild, and reporting in form of a research paper.

Contents:

Ubiquitous computing systems, privacy, field studies, ethnography, interfaces, location, context-aware computing, processing sequential sensor data.

Mode of delivery:

Face-to-face

Learning activities and teaching methods:

Lectures 20 h / exercises 20 h / project work 50 h / self-study 43 h. Exercises and project work are completed as a group work.

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:

None.

Recommended or required reading:

Required literature: John Krumm (editor) Ubiquitous Computing Fundamentals, Chapman & Hall, 2010, ISBN 978-1-4200-9360-5, 328 pages; selected scientific publications.

Assessment methods and criteria:

The course is passed with approved exercise reports and an approved project work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course uses numerical scale 1-5.

Person responsible:

Professor Timo Ojala

Working life cooperation:

None.

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: Olli Silven
Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

Language of instruction:

In 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, 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 project work.
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.

521493S: Computer Graphics, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Xiaopeng Hong, Yingyue Xu, Guoying Zhao

Opintokohteen kielet: English

Leikkaavuudet:

521140S	Computer Graphics	5.0 op

ECTS Credits:

7 ECTS credits

Language of instruction:

In English.

Timing:

Spring, period 4.

Learning outcomes:

Upon completion of the course, the student:
1. is able to specify and design 2D graphics algorithms including: line and circle drawing, polygon filling and clipping
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 OpenGL

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 (OpenGL) for implementation.

Mode of delivery:

Face to face teaching.

Learning activities and teaching methods:

Lectures 30 h / Self-study and programming assignments 104h.

Target group:

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

Prerequisites and co-requisites:

Programming skills using C++; basic data structures; simple linear algebra. Additionally recommended prerequisite is the completion of the following course prior to enrolling for course unit: 521267A Computer Engineering or 521286A Computer Systems or 521287A Introduction to Computer Systems

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) Materials in the internet (e.g. OpenGL redbook) OpenGL Programming Guide or 'The Red Book': http://unreal.srk.fer.hr/theredbook/ OpenGL Video Tutorial: target=_blank>http://www.videotutorialsrock.com /opengl_tutorial/what_is_opengl/text.php

Assessment methods and criteria:

The assessment of the course is based on the exam (50%) and returned course work (50%).
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, Xiaopeng Hong, Yingyue Xu

Working life cooperation:

No

Other information:

-

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: Xiang Su
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:

Face-to-face.

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:

Xiang Su

Working life cooperation:

None.

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 representation, 3. Color and shading, 4. Image features, 5. Recognition, 6. Texture, 7. Motion from 2D image sequences, 8. 2D models and transformations, 9. Perceiving 3D from 2D images, 10. 3D transformations and reconstruction.

Mode of delivery:

Face-to-face teaching, homework assignments.

Learning activities and teaching methods:

Lectures (20 h), exercises (16 h) and Matlab homework assignments (30 h), self-studying (67 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

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.

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: Denzil Teixeira Ferreira
Opintokohteen kielet: English
Leikkaavuudet:

521046A	Mobile Computing	5.0 op
521147S	Mobile and Social Computing	5.0 op

ECTS Credits:

5ECTS / 138 hours of work

Language of instruction:

English

Timing:

Spring, periods 3 and 4

Learning outcomes:

This course focuses on one of the core demands of industry today: deep understanding of mobile interaction, mobile computing constrains and mobile development. After this class, students will possess

the:
- ability to design and prototype a mobile user interface taking into account usability aspects of interaction on smaller displays
- ability to explain and leverage the fundamental concepts of context awareness using smartphone hardware, software and human sensors
- ability to understand and implement from scratch a mobile application that leverages both usability and context to create engaging mobile experiences

Contents:

The basic concepts of mobile interface design, implementation, mobile sensor acquisition, context awareness.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

5 ECTS cr = 138h of course work. Lectures (14h), in-class exercises (14h) and practical work (107h) (project, assignments).

Target group:

Computer Science and Engineering students and other students.

Prerequisites and co-requisites:

Recommended to have experience with object-oriented programming (Java, C#).

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 necessary material will be provided by the instructor.

Assessment methods and criteria:

The assessment depends on whether the student attends or not the class. For attending students, the assessment is based on 5 laboratory exercises (which the student needs a passing grade). For non-attending students, 5 individual assignments are assigned instead of the laboratory exercises (which the student needs a passing grade). For non-attending students, there is an intermediate exam at the end of period 3 and another at the end of period 4. All students, attending or not, are peer-assessed in a team project during period 4.

Grading:

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

Person responsible:

Denzil Socrates Teixeira Ferreira

Working life cooperation:

-

521044A: Social Computing, 5 op

Voimassaolo: 01.08.2018 -

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 / 135 hours of work

Language of instruction:

Finnish; course can also be completed in English.

Timing:

The course is organsed during the spring semester, during period III. It is recommended to complete the course at the 3rd spring semester.

Learning outcomes:

By the end of the course, students:
-- possess the skills for analysing and designing socially intelligent applications that consist of individuals and computing devices in a variety of contexts.
-- apply the best practices and avoid major pitfalls in designing social services and applications
-- have advanced understanding of both the positive and negative real-world consequences/aspects of social computing systems
-- aree able to explain human behaviour with social computing systems by using theories from such as sociology or psychology.

Contents:

Basics of social computing, computer-mediated human communication, designing social software, analysing social computing projects, crowdsourcing

Mode of delivery:

The course consists of lectures, exercises and individual / group-based assignments.

Learning activities and teaching methods:

The course consists of lectures (12h), exercises (16h), assignments and self-study (102h).

Target group:

M.Sc. and B.Sc. students. The course recommended for anyone who wishes to strengthen their expertise on human-computer interaction regards the social component.

Prerequisites and co-requisites:

Recommended: 521145A - Human-Computer Interaction

Recommended optional programme components:

The course is an independent entity, and does not require other courses from the student.

Recommended or required reading:

Selected academic publications, delivered upon starting the course.

Assessment methods and criteria:

The students are assessed based on the quality of the assignments. Some of the assignments are peer-evaluated and some are assessed by the course staff.
All the assessment criteria are based on the learning goals of the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical (1-5)

Person responsible:

Simo Hosio

Working life cooperation:

When possible, guest lectures by local companies are organized, to explain further how social computing drives business.

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, transactional/non-transactional databases , RESTful clients (HTML5 and Javascript).

Mode of delivery:

Web-based teaching and face-to-face teaching.

Learning activities and teaching methods:

Lectures 4 h, guided laboratory work 15 h, the rest as self-study and group work. Each group implements programs and writes a report.

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:

This course unit utilizes continuous assessment. The project work is divided in different deadlines that students must meet to pass the course. Each deadline will be assessed after completion.
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:

Ivan Sanchez Milara

Working life cooperation:

None.

Other information:

This course replaces the course “521260S Representing structured information”.

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:

-

521321S: Elements of Information Theory and Coding, 5 op

Voimassaolo: 14.11.2005 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Rajatheva Rajatheva, Timo Kokkonen
Opintokohteen kielet: English
Leikkaavuudet:

521323S	Wireless Communications 2	5.0 op

ECTS Credits:

5

Language of instruction:

English.

Timing:

Fall, period 2

Learning outcomes:

1. can use basic methodology of information theory to calculate the capacity bounds of communication and data compression systems.

2. can estimate the feasibility of given design tasks before the execution of the detailed design.

3. understands the operating principles of block codes, cyclic codes and convolutional codes.

4. can form an encoder and decoder for common binary block codes, and is capable of using tables of the codes and shift register when solving problems.

5. can represent the operating idea of a convolutional encoder as a state machine.

6. is able to apply the Viterbi algorithm to decoding of convolutional codes.

7. is capable of specifying principles of Turbo, LDPC and Polar coding and coded modulation.

8. can evaluate error probability of codes and knows practical solutions of codes by name.

Contents:

Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, block codes, cyclic codes, burst error correcting codes, error correcting capability of block codes, convolutional codes, Viterbi algorithm, concatenated codes, and introduction to Turbo, LDPC and Polar coding and to coded modulation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h and group working.

Target group:

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

Prerequisites and co-requisites:

Signal Analysis, Telecommunication Engineering

Recommended optional programme components:

Wireless Communications I and the course support each other. Their simultaneous studying is recommended.

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, David J. C. Makay: Information Theory, Inference and Learning Algorithms, ISBN, ISBN-13: 978-0521642989, ISBN-10: 0521642981, and S. Benedetto and E. Biglieri: Principles of Digital Transmission with Wireless Applications, 1999, Chapters 3, 10 and in part 11 and 12. Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with continuous evaluation (only during lecture period) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Timo Kokkonen (Coding) / Nandana Rajatheva (Information theory)

Working life cooperation:

No

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

Opettajat: Hannu Sorvoja

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:
Hannu Sorvoja
Working life cooperation:
Yes.
Other information:
-

522991S: Master's Thesis in Radio 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:
-

521998S: Master's Thesis in Telecommunication 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:
-

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: Juha Kostamovaara

Opintokohteen kielet: English

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:

Juha Kostamovaara

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, reliability of electronics.

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:

-

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	Exam, Radio engineering 1	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.

2. can also explain factors, which are limiting the bandwidth of impedance matching networks.

3. will be able to design the impedance matching for a low noise amplifier.

4. In the impedance matching the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

5. . will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.

6. will be able to design a power divider and a directional coupler.

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, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Mode of delivery:

Face-to-face teaching

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:

-

521088S: Optoelectronics, 5 op

Voimassaolo: 01.01.2014 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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:

Juha Kostamovaara

Working life cooperation:

Does not apply.

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: Juha Röning
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 a student can explain the life cycle of the embedded system, the characteristic features related to embedded systems development, and the risks involved.
2. In addition, the student can explain the roles of the client and the system developer during the requirements specification, and the role of the iteration phase as a part of the requirements specification phase. The student can explain the factors affecting to SW/HW partitioning process,

and the concept of SW/HW dualism. The student can fairly analyze the factors affecting to the selection of the processor and the operating system. The student can recognize the basic development tools used and their possible advantages and disadvantages.
3. The student can compare various testing approaches. The student can explain how a design error affects to the final cost of the system in different phases of the development. The student can do some basic I/O programming using C programming language.

Contents:

The embedded design life cycle, the selection process, the partitioning decision, the development environment, the special software techniques, a basic toolset, JTAG/ICE, testing, I/O programming.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course is run in a project work in groups of two and follow up the progress 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:

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:

Berger, Arnold S. (2002) Embedded Systems Design: An introduction to Processes, Tools, & Techniques, CMP Books, USA. ISBN:1578200733.

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.

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:

-

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 two courses.

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Kostamovaara

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.

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:

Juha Kostamovaara

Working life cooperation:

-

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

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:

After finishing the course, the student knows the basic concepts of software and real-time systems, the different areas of project management, the phases of software development and the goals and tasks of them,
is able to use structural methods for defining systems and knows the principles of object-oriented design and analysis.
After the course, the student has basic knowledge of utilizing software tools for structural analysis and design.

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.

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

The course consists of lectures and a laboratory design exercise. The course is completed by a final exam and a successfully completed exercise. Lectures 30 h, laboratory design (in period 3) 4 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. Sixth Edition. McGraw-Hill 2005, chapters 1-11, 13-14 and 21-27. Older editions (4th and 5th) can also be used as a reference. In this case the lectures are based on chapters 1-20.

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:

-

Other information:

-

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. Basics of ac-modeling of switched-mode converters.

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, 8 to most part and chapter 13. 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:

-

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 1-2

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.

Optional Studies: Electronics

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:

-

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:

-

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

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: Juha Kostamovaara
Opintokohteen kielet: English

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:

Juha Kostamovaara

Working life cooperation:

-

Other information:

-

521124S: Sensors and Measuring Techniques, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Teemu Myllylä, Igor Meglinski
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.

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:

Igor Meglinski

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	Exam, Radio engineering 1	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.

2. can also explain factors, which are limiting the bandwidth of impedance matching networks.

3. will be able to design the impedance matching for a low noise amplifier.

4. In the impedance matching the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

5. . will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.

6. will be able to design a power divider and a directional coupler.

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, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Mode of delivery:

Face-to-face teaching

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:

-

521073S: Electroceramics and Intelligent Materials, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jantunen, Heli Maarit

Opintokohteen kielet: Finnish

Leikkaavuudet:

521103S	Electroceramics and Intelligent Materials	4.0 op

ECTS Credits:

5 ECTS credits / 132.5 hours of work

Language of instruction:

Finnish and English

Timing:

The course is held in the period 1 biannually. The course is held next on autumn 2019.

Learning outcomes:

1. Student is able to estimate the properties and usability of functional ceramics in different electronics components applications and perform calculatory structural dimensioning for them.

2. Student is able to compare and choose applicable processing methods for the fabrication of functional structures.

3. Student is able to interpret new research results of the field and recognize their application areas.

Contents:

Microstructures and special features of ceramic materials. Dielectric, polarization and electrical conductivity properties and influence of lattice defects on them. Fabrication and processing of ceramics. Ceramic conductors and insulators, piezoelectric and ferroelectric ceramics, pyroelectric and electro-optic ceramics, magnetic ceramics.

Mode of delivery:

The course will be implemented as face to face teaching.

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:

-

Recommended or required reading:

Lecture notes. Text book A.J. Moulson and J.M. Herbert: Electroceramics, Wiley, 2003.

Assessment methods and criteria:

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

Grading:

The final exam utilizes a numerical grading scale 1-5.

Person responsible:

Heli Jantunen

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 optoelectronics will be migrate towards circuit board and components on it.

Contents:

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. Optoelectronics 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:

-

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Teirikangas, Merja Elina
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:

-

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:

-

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 (min. 2 courses) min. 10 ECTS cr

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

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.

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.

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 2018.

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 electrical 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:

-

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:

-

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.

Recommended optional studies, see http://www.oulu.fi/ee/opiskelu/oppaat

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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.

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:

Juha Kostamovaara

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, reliability of electronics.

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:

-

521423S: Embedded System Project, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Röning
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 a student can explain the life cycle of the embedded system, the characteristic features related to embedded systems development, and the risks involved.
2. In addition, the student can explain the roles of the client and the system developer during the requirements specification, and the role of the iteration phase as a part of the requirements specification phase. The student can explain the factors affecting to SW/HW partitioning process,

and the concept of SW/HW dualism. The student can fairly analyze the factors affecting to the selection of the processor and the operating system. The student can recognize the basic development tools used and their possible advantages and disadvantages.
3. The student can compare various testing approaches. The student can explain how a design error affects to the final cost of the system in different phases of the development. The student can do some basic I/O programming using C programming language.

Contents:

The embedded design life cycle, the selection process, the partitioning decision, the development environment, the special software techniques, a basic toolset, JTAG/ICE, testing, I/O programming.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course is run in a project work in groups of two and follow up the progress 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:

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:

Berger, Arnold S. (2002) Embedded Systems Design: An introduction to Processes, Tools, & Techniques, CMP Books, USA. ISBN:1578200733.

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.

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:

-

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 1-2

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

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:

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:

Face-to-face 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 (Third Edition). John Wiley & Sons, 2005. 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:

Course will be given every second year in even years. Will be held next time in the spring of 2020.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

The course is held in the spring semester, during period IV.

Learning outcomes:

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. 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. Ultra wideband radio channels. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h / Exercises 12 h / compulsory laboratory work 14 h / Self-study 80 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:

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

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2019.

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	Radio Engineering II	5.0 op
521375S-01	Exam, Radio Engineering II	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:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (40 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:

-

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.

521096S: Measurement Systems, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Saarela
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:

Period 2.

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:

face-to-face teaching.

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 Optima.

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:

Juha Saarela

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: Juha Kostamovaara
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:

Juha Kostamovaara

Working life cooperation:

Does not apply.

Other information:

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521094S: Optoelectronic Sensors of Future, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Igor Meglinski
Opintokohteen kielet: Finnish
Leikkaavuudet:

521238S	Optoelectronic Measurements	4.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Period 4

Learning outcomes:

Objective: The goal of this course is to make the student familiar with optical measurement principles, sensors and device configurations used in industrial inspection tasks.
Learning outcomes: Upon completion of the course, the student is able to explain the operating principles of the most common optical measurement methods used in industrial production, name the factors affecting their performance, design certain sensor systems and evaluate the applicability of measurement methods for various measurement tasks. Additionally he is able to independently find information and discover the operating principles of various optical measurements and to condense the collected information into written and verbal report.

Contents:

Principles of optical measurements. Surface inspection, distance and profile measurements. Non-destructive testing methods. Optical measurements for process control. Material analyses with optical methods.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 42 h lectures or calculation exercises and 100 h self-studies.

Target group:

4th year students

Prerequisites and co-requisites:

Completion of the course 766329A Wave Motion and Optics is recommended.

Recommended optional programme components:

Course replaces earlier by same name but different code and credit points.

Recommended or required reading:

Lecture handouts and discourse material prepared by students. Delivery through Optima.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Igor Meglinski

Working life cooperation:

No.

521098S: Testing techniques of 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. Additionally, the student is able to operate boundary-scan technique.

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 24h/Exercises 12h/laboratory work 4h and self-studying 100h.

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 521167S Testing Techniques of Electronics or 521173S Mixed-signal Testing if the student hasn’t got credits from either one of those.

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 20 h lectures, 10 h calculation exercises 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:

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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

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.

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:

-

521321S: Elements of Information Theory and Coding, 5 op

Voimassaolo: 14.11.2005 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Rajatheva Rajatheva, Timo Kokkonen
Opintokohteen kielet: English
Leikkaavuudet:

521323S	Wireless Communications 2	5.0 op

ECTS Credits:

5

Language of instruction:

English.

Timing:

Fall, period 2

Learning outcomes:

1. can use basic methodology of information theory to calculate the capacity bounds of communication and data compression systems.

2. can estimate the feasibility of given design tasks before the execution of the detailed design.

3. understands the operating principles of block codes, cyclic codes and convolutional codes.

4. can form an encoder and decoder for common binary block codes, and is capable of using tables of the codes and shift register when solving problems.

5. can represent the operating idea of a convolutional encoder as a state machine.

6. is able to apply the Viterbi algorithm to decoding of convolutional codes.

7. is capable of specifying principles of Turbo, LDPC and Polar coding and coded modulation.

8. can evaluate error probability of codes and knows practical solutions of codes by name.

Contents:

Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, block codes, cyclic codes, burst error correcting codes, error correcting capability of block codes, convolutional codes, Viterbi algorithm, concatenated codes, and introduction to Turbo, LDPC and Polar coding and to coded modulation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h and group working.

Target group:

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

Prerequisites and co-requisites:

Signal Analysis, Telecommunication Engineering

Recommended optional programme components:

Wireless Communications I and the course support each other. Their simultaneous studying is recommended.

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, David J. C. Makay: Information Theory, Inference and Learning Algorithms, ISBN, ISBN-13: 978-0521642989, ISBN-10: 0521642981, and S. Benedetto and E. Biglieri: Principles of Digital Transmission with Wireless Applications, 1999, Chapters 3, 10 and in part 11 and 12. Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with continuous evaluation (only during lecture period) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Timo Kokkonen (Coding) / Nandana Rajatheva (Information theory)

Working life cooperation:

No

Other information:

-

521316S: Broadband Communications Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Opettajat: Rajatheva Rajatheva, Satya Joshi

Opintokohteen kielet: English

Leikkaavuudet:

521316A Broadband Communications Systems 4.0 op
521316A-01 Introduction to Broadband Transmission Techniques, exam 0.0 op
521316A-02 Introduction to Broadband Transmission Techniques, exercise work 0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

1. Student can distinguish the basic transmission technologies used in the most important commercial wireless communication systems.

2. The student can differentiate and compare the key points behind these technologies, why they are used and what are their advantages and disadvantages.

3. Student can explain how the wireless channel impacts the design of the overall system.

4. The most relevant standards are introduced and explained, so that student can attain information from past and especially the forthcoming wireless standards.

5. Observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise.

Contents:

Introduction to Detection and Estimation Theory, Performance in AWGN and flat fading channels, Fading Multipath Channels, Mobility, Propagation, Path Loss Models, Orthogonal Frequency Division Multiplexing, Wireless Systems and Standards: 3G, LTE, 5G

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h.

Target group:

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

Prerequisites and co-requisites:

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

Recommended optional programme components:

Statistical signal processing and the course support each other.

Recommended or required reading:

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

Assessment methods and criteria:

The course is passed with mid term exams (first one during lecture periods) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Nandana Rajatheva

Working life cooperation:

-

Other information:

-

521323S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S	Wireless Communications I	5.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 1	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

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 the suitable diversity methods for fading channel and related combining methods
4. can define the basic carrier and symbol synchronization methods and is able to make the performance comparison of them
5. can explain design methods signals for band-limited channels
6. can classify different channel equalizers, and perform the performance analysis

Contents:

Digital modulation methods and their performance in AWGN-channel, radio channel models, performance of digital modulation in fading channel, diversity techniques, channel equalizers in wireless communication channel, carrier and symbol synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 44 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 EE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering 521316S Broadband Communications Systems

Recommended optional programme components:

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Recommended or required reading:

Parts of book: Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.
Parts of book: J.G. Proakis: Digital Communications, 4th ed, McGraw Hill, 2001.

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

Working life cooperation:

No

Other information:

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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. Upon completing the required coursework, the student is able to list and understand the functionalities of different layers of OSI and TCP/IP protocol models
2. The course gives the skills for the student to explain the mobile network evolution through previous and existing generations of mobile networks (1G, 2G, 3G, and 4G) towards 5G.
3. The student is able to describe the basic system architecture of GSM, GPRS, EDGE, UMTS and LTE, understands the significance of emerging technologies such as Network Function Virtualization (NVF), Software Defined Networking (SDN), Multi-Access Edge Computing (MEC), Cloud Radio Access Networks (CRAN), and core network functionalities such as Evolved Packet Core (EPC).
4. The student knows the basic properties of routing protocols in fixed, wireless and ad hoc networks, and can use graph theory to solve network routing problems
5. Students can describe the main principles of network programmability, mobility control, and network security, and can apply and solve related engineering problems.
6. The student is able to simulate different types of networks in simulation environments.

Contents:

Communications architecture and protocols, mobility management, network security, network management and ad hoc, wireless local area and mobile networks. Introduction to cloud computing, edge computing, network function virtualization and software defined networking. The goal is to

present the fundamentals of the new communication architectures, trends and technologies accepted by academia and industry. Technical implementation and application of the common data and local networks are also discussed.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 30 h and the compulsory design work with a simulation program (15 h).

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:

S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies (2nd ed.), 2009; Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015.

Assessment methods and criteria:

The course is passed with a final examination and the accepted 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:

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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:

Fall, during period 1

Learning outcomes:

Upon completion the student will

1. understand the key concepts in estimation theory such as the classical and Bayesian framework.
2. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
3. can derive an estimator for a given criterion and basic data models.
4. can use the methodology of estimation theory to analyze the performance of estimators
5. can choose a proper estimator for a given purpose
6. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), matched filtering

Contents:

Estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, leas squares estimation, Bayesian estimation, linear Bayesian estimation, Kalman filters, statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching, lectures and exercises 50 h and compulsory Matlab assignments 30 h, independent work 50 h. Some lectures may be replaced with video lectures.

Target group:

Electrical, communications, computer and system engineering as well as mathematics, physics and computer science students with knowledge of statistics in master or senior undergraduate level.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra

Recommended optional programme components:

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Recommended or required reading:

Parts from books Kay, Steven M. "Fundamentals of statistical signal processing, volume I: estimation theory." (1993), Kay, Steven M. "Fundamentals of statistical signal processing: Detection theory, vol. 2." (1998).

Assessment methods and criteria:

The course is passed with two midterms exams (there will also be arranged a University Exam covering whole course around 5-6 weeks after the course) and accepted MATLAB assignments (programs + reports). In the final grade of the course, the weight for the examination is 0.7 and that for the MATLAB assignments is 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:

Markku Juntti
Janne Lehtomäki

Working life cooperation:

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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 design of baseband parts of a communications transceiver.
2. have the skills to apply estimation, detection and other statistical signal processing methods to communications transceiver and system design.
3. can use linear algebra, basics of optimization and statistical signal processing to derive receiver algorithms, in particular for soft output equalization/detection and receiver synchronization.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including (un)supervised 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.

Contents:

Review of linear algebra, matrix computations and basics of constrained optimization; transceiver baseband design targets, filter optimization, adaptive filters and algorithms, iterative algorithms, algorithm convergence, equalization and detection algorithms, channel estimation, receiver carrier and timing synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing. The recommended prerequisite is the completition of 521323S Wireless communications I.

Recommended optional programme components:

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Recommended or required reading:

Parts from books:
1. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.

2. K. Vasudevan, Digital Communications and Signal Processing, Universities Press (India) 2017.
3. S. Haykin, Adaptive Filter Theory, 3rd ed. or newer, Prentice Hall 1996.
4. T. Kailath, A. H. Sayed & G. Hassibi, “Linear Estimation”, Prentice Hall 2000.
5. G. H. Golub & C. F. Van Loan, Matrix computations, 3rd ed. or newer, Johns Hopkins University Press 1996.
6. H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
7. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems. Completing the simulation project tasks, and a mid-term exams during the course. The mid-term exams can be retaken by a final exam later. 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:

-

521385S: Mobile Telecommunication Systems, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Katz, Marcos Daniel
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, period 3

Learning outcomes:

1. Upon completing the required coursework, the student will be able to determine and fit the values of the main parameters for modern mobile telecommunication systems network planning. The course gives skills to describe mobility management, adaptive resource control and dynamic resource allocation in mobile networks.
The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

Contents:

Concept and structures of modern mobile communications systems. Basics of radio network planning and capacity. Distributed transmission power control and mobility management. Resource allocation techniques: adaptive resource control, dynamic resource allocation. Cooperative communications. Examples of digital mobile telecommunication systems in practice.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 16 h and the compulsory laboratory work (16 h)

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Telecommunication Engineering, Broadband Communications Systems and Wireless Communications 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:

The course material will be defined at the beginning of the course.

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 unit utilizes a numerical grading scale 1-5.

Person responsible:

Marcos Katz

Working life cooperation:

-

Other information:

Objective: The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

Advanced module, obligatory courses, 25 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, 25 ECTS cr

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 student is able to understand programmable networking, their benefits, and the openness of networks for innovations through programmable networks. The aim is to help the student to understand the basic principles of networking by providing a balance between the description of existing networks and the future trends in communication networks.
2. The student learns the benefits of network function virtualization (NFV), multi-access edge computing (MEC), network slicing and software defined networking (SDN). Students will understand the importance of these in future networks, MEC their use-cases, and leverage using them in designing and deploying them in modern communication networks.
3. The student understands 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.
4. Student achieves skill to design and implement simple SDNs and test for performance in both network simulators and real-life network environment. The descriptive material is used to illustrate the underlying concepts, and the practical material is used to generate a deeper interest of students in communication networks by giving them the chance to innovate themselves.

Contents:

The course will also give idea of how NFV, SDN and MEC can enable innovation in networking by providing the students with basics on to explore the networking field and perform experiments, write novel protocols and use their innovative capabilities. The course will also present interesting research areas such as network management, network security, and network load-balancing. Furthermore, the course will give hands-on experience on enabling programmable networks in a Lab environment or personal PCs/laptops using the SDN prototyping environment i.e. Mininet. For MEC and NFVs, 5G test network may be used for demonstrations, experiments and exercise work.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 15 h and the compulsory design work either with a simulation program or testbed implementation (30 h).

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. Additional reading materials related to NFV, SDN and MEC are provided in OPTIMA.

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:

-

521317S: Wireless Communications II, 8 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Antti-Heikki Tölli, Jarkko Kaleva
Opintokohteen kielet: English

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 3-4

Learning outcomes:

1. Upon completing the required coursework, the student is familiarised with the channel capacity as the basic performance measure of wireless communication links, and can explain the effect of fading channel on the capacity in a single-user single-antenna se

2. After learning the basics in a single-user multiple-input multiple-output (MIMO) communications, the student is acquainted with the capacity optimal multi-antenna transmission and reception schemes in both multiple access and broadcast channels.

3. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios.

4. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

5. Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

Contents:

Capacity of point-to-point and multiuser wireless channels, point-to-point MIMO communications, multiuser multiple antenna communications in uplink and downlink, opportunistic communications, scheduling and interference management, coordinated multi-cell transmission.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 45 h, exercises 25 h and the compulsory design work with a simulation program (25 h)

Target group:

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

Prerequisites and co-requisites:

In addition to the course Wireless Communications I, a working knowledge in digital communications, random processes, linear algebra, and detection theory is required. Also, students are asked to read chapters 1-4 from the textbook before attending the course.

Recommended optional programme components:

Prior knowledge of information theory and 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 5-10, as well as, a few recent journal publications related to multiuser MIMO downlink. 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%).
Read more about assessment criteria at the University of Oulu webpage.

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 III.

521325S: Communication 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:

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

ECTS Credits:

5 ECTS cr / 130 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 1st 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, multiantenna processing and connection establishment.
3. understands the requirements of the curren wireless communications standards and related orthogonal frequency division 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.

6. knows how to interface the software models to the common implementation architectures.

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching (lectures and exercises) 25h, Simulation and design exercises in groups 80 h, independent work & passed assignment 35 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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing, 521324S Communications signal processing I. The recommended prerequisite is the completition of 521323S Wireless communications I.

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. T.-D. Chiueh, P.-Y. Tsai, I.-W. Lai, Baseband Receiver Design for Wireless MIMO-OFDM Communications, 2nd ed. IEEE Wiley 2012.
3. .H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
4. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems and completing the simulation projects, and 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 (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.

Other information:

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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 Exam, Radio engineering 1 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.

2. can also explain factors, which are limiting the bandwidth of impedance matching networks.

3. will be able to design the impedance matching for a low noise amplifier.

4. In the impedance matching the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

5. . will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.

6. will be able to design a power divider and a directional coupler.

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, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Mode of delivery:

Face-to-face teaching

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:

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Advanced Module, Telecommunication Engineering (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.

Advanced module, optional studie s

521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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.

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:

Juha Kostamovaara

Working life cooperation:

-

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:

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:

Face-to-face 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 (Third Edition). John Wiley & Sons, 2005. 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:

Course will be given every second year in even years. Will be held next time in the spring of 2020.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

The course is held in the spring semester, during period IV.

Learning outcomes:

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. 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. Ultra wideband radio channels. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h / Exercises 12 h / compulsory laboratory work 14 h / Self-study 80 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:

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

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2019.

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	Radio Engineering II	5.0 op
521375S-01	Exam, Radio Engineering II	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:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (40 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:

-

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Opettajat: Matti Latva-aho, 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:

Matti Latva-aho, 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:

-

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 of the RF study option

521316S: Broadband Communications Systems, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Rajatheva Rajatheva, Satya Joshi
Opintokohteen kielet: English
Leikkaavuudet:

521316A	Broadband Communications Systems	4.0 op
521316A-01	Introduction to Broadband Transmission Techniques, exam	0.0 op
521316A-02	Introduction to Broadband Transmission Techniques, exercise work	0.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, period 1

Learning outcomes:

1. Student can distinguish the basic transmission technologies used in the most important commercial wireless communication systems.

2. The student can differentiate and compare the key points behind these technologies, why they are used and what are their advantages and disadvantages.

3. Student can explain how the wireless channel impacts the design of the overall system.

4. The most relevant standards are introduced and explained, so that student can attain information from past and especially the forthcoming wireless standards.

5. Observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise.

Contents:

Introduction to Detection and Estimation Theory, Performance in AWGN and flat fading channels, Fading Multipath Channels, Mobility, Propagation, Path Loss Models, Orthogonal Frequency Division Multiplexing, Wireless Systems and Standards: 3G, LTE, 5G

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-to-face teaching (lectures and exercises) 64 h.

Target group:

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

Prerequisites and co-requisites:

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

Recommended optional programme components:

Statistical signal processing and the course support each other.

Recommended or required reading:

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

Assessment methods and criteria:

The course is passed with mid term exams (first one during lecture periods) or with final exam and possible additional course tasks defined in the beginning of the course.

Grading:

The course unit 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:

Nandana Rajatheva

Working life cooperation:

-

Other information:

-

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: Juha Kostamovaara

Opintokohteen kielet: English

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:

Juha Kostamovaara

Working life cooperation:

-

Other information:

-

521323S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Jari Iinatti
Opintokohteen kielet: English
Leikkaavuudet:

521395S-01	Wireless Communications I, Exam	0.0 op
521395S	Wireless Communications I	5.0 op
521320S	Wireless Communications 2	8.0 op
521320S-01	Intermediate exam or final exam, Wireless Communications 1	0.0 op
521320S-02	Exercisework, Wireless Communications 2	0.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

Fall, period 2

Learning outcomes:

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 the suitable diversity methods for fading channel and related combining methods
4. can define the basic carrier and symbol synchronization methods and is able to make the performance comparison of them
5. can explain design methods signals for band-limited channels
6. can classify different channel equalizers, and perform the performance analysis

Contents:

Digital modulation methods and their performance in AWGN-channel, radio channel models, performance of digital modulation in fading channel, diversity techniques, channel equalizers in wireless communication channel, carrier and symbol synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercise (total 44 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 EE degree programme)

Prerequisites and co-requisites:

521330A Telecommunication Engineering 521316S Broadband Communications Systems

Recommended optional programme components:

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Recommended or required reading:

Parts of book: Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005.
Parts of book: J.G. Proakis: Digital Communications, 4th ed, McGraw Hill, 2001.

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

Working life cooperation:

No

Other information:

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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 Exam, Radio engineering 1 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.

2. can also explain factors, which are limiting the bandwidth of impedance matching networks.

3. will be able to design the impedance matching for a low noise amplifier.

4. In the impedance matching the noise figure is minimized or the gain is maximized. The impedance matching can also be made for the constant gain.

5. . will be able to design balanced and double balanced mixer and knows the advantages and the disadvantages of these mixers.

6. will be able to design a power divider and a directional coupler.

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, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Mode of delivery:

Face-to-face teaching

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:

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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:

Fall, during period 1

Learning outcomes:

Upon completion the student will

1. understand the key concepts in estimation theory such as the classical and Bayesian framework.
2. masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.
3. can derive an estimator for a given criterion and basic data models.
4. can use the methodology of estimation theory to analyze the performance of estimators
5. can choose a proper estimator for a given purpose
6. understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), matched filtering

Contents:

Estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, leas squares estimation, Bayesian estimation, linear Bayesian estimation, Kalman filters, statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-face-teaching, lectures and exercises 50 h and compulsory Matlab assignments 30 h, independent work 50 h. Some lectures may be replaced with video lectures.

Target group:

Electrical, communications, computer and system engineering as well as mathematics, physics and computer science students with knowledge of statistics in master or senior undergraduate level.

Prerequisites and co-requisites:

The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra

Recommended optional programme components:

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Recommended or required reading:

Parts from books Kay, Steven M. "Fundamentals of statistical signal processing, volume I: estimation theory." (1993), Kay, Steven M. "Fundamentals of statistical signal processing: Detection theory, vol. 2." (1998).

Assessment methods and criteria:

The course is passed with two midterms exams (there will also be arranged a University Exam covering whole course around 5-6 weeks after the course) and accepted MATLAB assignments (programs + reports). In the final grade of the course, the weight for the examination is 0.7 and that for the MATLAB assignments is 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:

Markku Juntti
Janne Lehtomäki

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

Opettajat: Teirikangas, Merja Elina

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:

-

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 design of baseband parts of a communications transceiver.
2. have the skills to apply estimation, detection and other statistical signal processing methods to communications transceiver and system design.
3. can use linear algebra, basics of optimization and statistical signal processing to derive receiver algorithms, in particular for soft output equalization/detection and receiver synchronization.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including (un)supervised 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.

Contents:

Review of linear algebra, matrix computations and basics of constrained optimization; transceiver baseband design targets, filter optimization, adaptive filters and algorithms, iterative algorithms, algorithm convergence, equalization and detection algorithms, channel estimation, receiver carrier and timing synchronization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Face-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 Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing. The recommended prerequisite is the completition of 521323S Wireless communications I.

Recommended optional programme components:

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Recommended or required reading:

Parts from books:

1. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
2. K. Vasudevan, Digital Communications and Signal Processing, Universities Press (India) 2017.
3. S. Haykin, Adaptive Filter Theory, 3rd ed. or newer, Prentice Hall 1996.
4. T. Kailath, A. H. Sayed & G. Hassibi, “Linear Estimation”, Prentice Hall 2000.
5. G. H. Golub & C. F. Van Loan, Matrix computations, 3rd ed. or newer, Johns Hopkins University Press 1996.

6. H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
7. Other literature, lecture notes and material.

Assessment methods and criteria:

Continuous evaluation by solving homework problems. Completing the simulation project tasks, and a mid-term exams during the course. The mid-term exams can be retaken by a final exam later. 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:

-

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, reliability of electronics.

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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521435S: Electronics Design III, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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.

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:

Juha Kostamovaara

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	Radio Engineering II	5.0 op
521375S-01	Exam, Radio Engineering II	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:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h and the compulsory design exercise with ADS simulation software (40 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:

-

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.

Include in the advanced module EITHER 521388S OR 521386S AND 521322S OR 521300S.

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:

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:

Face-to-face 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 (Third Edition). John Wiley & Sons, 2005. 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:

Course will be given every second year in even years. Will be held next time in the spring of 2020.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits / 130 hours of work

Language of instruction:

English

Timing:

The course is held in the spring semester, during period IV.

Learning outcomes:

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. 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. Ultra wideband radio channels. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h / Exercises 12 h / compulsory laboratory work 14 h / Self-study 80 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:

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

Working life cooperation:

No

Other information:

Course will be given every second year in odd years. Will be held next time in the spring of 2019.

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 1-2

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.

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

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Opettajat: Matti Latva-aho, 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:

Matti Latva-aho, Jari Iinatti

Working life cooperation:

-

Other information:

-

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:

-

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:

-

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, 31 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

521091S: Technical Optics, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Anssi Mäkynen
Opintokohteen kielet: Finnish
Leikkaavuudet:

521090S Technical Optics 6.0 op

ECTS Credits:

5 ECTS credits / 138 hours of work

Language of instruction:

Finnish. Text book exams in English.

Timing:

Period 2. For time being the course is lectured last time in academic year 2018-19.

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 as well as the factors affecting their performance
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 able to name and identify the main aberrations of an optical system, explain how aberrations affect its resolving power and how the ability of resolving details is described and measured
8. 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
9. 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.

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:

The course includes 28 h lectures and calculation exercises, 20 h guided design exercises introducing to optical design tools and 90 h self-studies.

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:

Completion of the course 766329A Wave Motion and Optics is recommended.

Recommended optional programme components:

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

Recommended or required reading:

Lecture handouts. Delivery through Optima. Recommended books: Donald C. O'Shea: Elements of Modern Optical Design. John Wiley & Sons, 1985; Frank L. Pedrotti, Leno M. Pedrotti, Leno S. Pedrotti: Introduction to Optics. 3rd ed., Pearson Education, 2007; Hecht: Optics. 4th ed. Addison-Wesley, 2002; Julio Chaves: Introduction to Nonimaging Optics. CRC Press, 2008.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Anssi Mäkynen

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: Juha Saarela
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:

Period 2.

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:

face-to-face teaching.

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 Optima.

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:

Juha Saarela

Working life cooperation:

No.

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Häkkinen
Opintokohteen kielet: Finnish

ECTS Credits:

5

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 notes, D. A. Johns & K. Martin: Analog integrated circuit design, Wiley & Sons 1997, chapters 1, 3, 4, 5, 7, chapter 8 partially, 11, 12 and 13. OR 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:

Juha Häkkinen

Working life cooperation:

-

521088S: Optoelectronics, 5 op

Voimassaolo: 01.01.2014 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Kostamovaara
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:

Juha Kostamovaara

Working life cooperation:

Does not apply.

Other information:

-

521124S: Sensors and Measuring Techniques, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Teemu Myllylä, Igor Meglinski
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.

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:

Igor Meglinski

Working life cooperation:

No.

521097S: Wireless Measurements, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Saarela
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 Finnish or in English if two or more foreign students participate.

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:

Juha Saarela

Working life cooperation:

No.

Advanced Modules, Optical and Electrical Measurement Techniques, 15 ECTS cr

A451292: Advanced Module, Optical and Electrical Measurement Techniques, 15 - 57 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, Compulsory Studies 15 ECTS cr (Choose) and select optional studies to make total 120 ECTS cr

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: Igor Meglinski
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:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures/exercises 42 h and self-study 100 h.

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:

Igor Meglinski

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: Igor Meglinski

Opintokohteen kielet: Finnish

Leikkaavuudet:

521107S Biomedical Instrumentation 6.0 op

ECTS Credits:

5

Language of instruction:

English.

Timing:

Period 3.

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 effects of electric current 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). Bioelectrical measurements (EKG, EEG, EMG, EOG, ERG), blood pressure and flow meters, respiration studies, measurements in a clinical laboratory, introduction to medical imaging methods and instruments, ear measurements, heart pacing and defibrillators, physical therapy devices, intensive care and operating room devices and electrical safety aspects.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures/exercises 42 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:

Igor Meglinski

Working life cooperation:

No.

521094S: Optoelectronic Sensors of Future, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Igor Meglinski

Opintokohteen kielet: Finnish

Leikkaavuudet:

521238S	Optoelectronic Measurements	4.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Period 4

Learning outcomes:

Objective: The goal of this course is to make the student familiar with optical measurement principles, sensors and device configurations used in industrial inspection tasks.
Learning outcomes: Upon completion of the course, the student is able to explain the operating principles of the most common optical measurement methods used in industrial production, name the factors affecting their performance, design certain sensor systems and evaluate the applicability of measurement methods for various measurement tasks. Additionally he is able to independently find information and discover the operating principles of various optical measurements and to condense the collected information into written and verbal report.

Contents:

Principles of optical measurements. Surface inspection, distance and profile measurements. Non-destructive testing methods. Optical measurements for process control. Material analyses with optical methods.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 42 h lectures or calculation exercises and 100 h self-studies.

Target group:

4th year students

Prerequisites and co-requisites:

Completion of the course 766329A Wave Motion and Optics is recommended.

Recommended optional programme components:

Course replaces earlier by same name but different code and credit points.

Recommended or required reading:

Lecture handouts and discourse material prepared by students. Delivery through Optima.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Igor Meglinski

Working life cooperation:

No.

A451293: Advanced Module,Testing Techniques and Printed Electronics, 10 - 57 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, below compulsory studies 15 ECTS cr and select optional studies to make total 120 ECTS cr

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.

521098S: Testing techniques of 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. Additionally, the student is able to operate boundary-scan technique.

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 24h/Exercises 12h/laboratory work 4h and self-studying 100h.

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 521167S Testing Techniques of Electronics or 521173S Mixed-signal Testing if the student hasn't got credits from either one of those.

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.

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:

-

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

Opettajat: Hannu Sorvoja

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:
Hannu Sorvoja
Working life cooperation:
Yes.
Other information:
-

523991S: Master's Thesis in Electronics Design, 30 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

523992S: Master's Thesis in Electronics Materials and Components, 30 op

Opiskelumuoto: Advanced Studies

Laji: Licenciate thesis

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521998S: Master's Thesis in Telecommunication Engineering, 30 op

Opiskelumuoto: Advanced Studies

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

Ei opintojaksokuvauksia.

522991S: Master's Thesis in Radio Engineering, 30 op

Opiskelumuoto: Advanced Studies
Laji: Diploma thesis
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

523993S: Master's Thesis in Photonics and Measurement Technology, 30 op

Opiskelumuoto: Advanced Studies
Laji: Diploma thesis
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.