Opasraportti

Electrical Engineering + Wireless Communications Engineering (2014 - 2015)

Tietotalo 1 student affairs office (TS 110 - TS114) is open daily 9.30 - 14.00.

Staff e-mails are in the form of firstname.lastname@ee.oulu.fi

More on studies

Tutkintorakenteet

MSc. Engineering, Electrical Engineering

Tutkintorakenteen tila: published

Lukuvuosi: 2014-15

Lukuvuoden alkamispäivämäärä: 01.08.2014

Option (60 - 80 op)

Compulsory, choose one of the options. Advanced modules are approximately 30 ects in total, mandatory and optional courses included.

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

Electronics Design

H451229: Module of the Option, Electronics Design, 60 - 87 op
Module of the option, all courses obligatory
A451221: Module of the Option, Electronics Design, 30 - 38 op
All compulsory
521443S: Electronics Design II, 5 op
521441S: Electronics Design and Construction Exercise, 6,5 op
521405A: Electronic System Design, 5 op
521335S: Radio Engineering 1, 6 op
521088S: Optoelectronics, 5 op
521332S: Computer Aided Circuit Design, 4 op
521423S: Embedded System Project, 5 op
477603A: Control System Design, 4 op
Advanced module, digital systems design, obligatory courses

A451273: Advanced Module/Electronics Design, Digital Systems Design (obligatory), 16 - 21 op
Compulsory
521453A: Operating Systems, 5 op
521457A: Software Engineering, 5 op
521445S: Digital Techniques 3, 6 op
521281S: Application Specific Signal Processors, 5 op
Advanced module, digital systems design, optional courses, module total approx. 30 cr.
A451274: Advanced Module/ Electronics Design, Digital Systems Design (optional), 9 - 41 op
Alternative
521150A: Introduction to Internet, 5 op
521275A: Embedded Software Project, 8 op
521485S: DSP-laboratory Work, 3,5 op
521486S: Signal Processing Systems, 4 op
521340S: Communications Networks I, 5 op
Advanced module, electronics design, electronics design (optional)
A451289: Advanced module/Electronics design, electronics design (obligatory), 15 - 40 op
Obligatory courses
521435S: Electronics Design III, 6 op
521445S: Digital Techniques 3, 6 op
521300S: Electronics Design and Construction Exercise, 6 op
Advanced module, electronics design, electronics design (obligatory)
A451290: Advanced module/Electronics design, electronics design (optional), 25 - 41 op
Optional courses
521410S: Special Course in Electronic Design, 4 - 7 op
521380S: Antennas, 4 op
521216S: Microelectronics Packaging Technology and Reliability, 7 op
521375S: Radio Engineering II, 5 op
521172S: EMC Design, 4 op
521224S: Microelectronics and Micromechanics, 6 op

Electronics Materials and Components

H451226: Module of the Option, Electronics Materials and Components, 60 - 80 op
Module of the option, all compulsory
A451222: Module of the Option, Electronics Materials and Components, 35 - 41 op
All compulsory
521103S: Electroceramics and Intelligent Materials, 4 op
521223S: Electronic and Optoelectronic Materials, 5 op
521216S: Microelectronics Packaging Technology and Reliability, 7 op
521335S: Radio Engineering 1, 6 op
521225S: RF Components and Measurements, 5 op
521443S: Electronics Design II, 5 op
521224S: Microelectronics and Micromechanics, 6 op
Advanced module, microsystems engineering, compulsory courses
A451277: Advanced Module/Electronics Materials and Components, Microsystems Engineering (obligatory), 21,5 op
Compulsory
521201S: Research methods of Materials for Electronics, 3,5 op
521203S: Micromodules, 5 op
521228S: Microsensors, 4 op
521217S: Printed Electronics, 4 op
521110S: Measuring and Testing Systems, 6 op
Advanced module, microsystems engineering optional courses, module size approx. 30 cr
A451278: Advanced Module/Electronics Materials and Components, Microsystems Engineering (optional), 8,5 op
Module total appr. 30 cr
521450S: Optoelectronics, 4 op
521405A: Electronic System Design, 5 op
464061A: Techniques of Creative Working, 3 op
463065A: Manufacturing of Plastics Products, 3,5 op
461033A: Finite Element Methods I, 3,5 op
Technical physics, advanced module, optional courses, module size approx 30 cr
A451275: Advanced Module/ Electronics Materials and Components, Technical Physics (obligatory), 22 op

Compulsory
521201S: Research methods of Materials for Electronics, 3,5 op
763312A: Quantum mechanics I, 10 op
521219S: X-ray Methods, 4,5 op
521228S: Microsensors, 4 op
Advanced module, technical physics, optional courses, module size approx. 30 cr
A451276: Advanced Module/ Electronics Materials and Components, Technical Physics (optional), 8 op
Module total appr. 30 cr
031022P: Numerical Analysis, 5 op
761668S: Computational physics and chemistry, 6 op
763628S: Condensed matter physics, 10 op
464061A: Techniques of Creative Working, 3 op

Photonics and Measurement Techniques

H451227: Module of the Option, Photonics and Measurement Technology, 60 - 80 op
Module of the option, all compulsory
A451223: Module of the Option, Photonics and Measurement Techniques, 30 - 41 op
All compulsory
521443S: Electronics Design II, 5 op
521124S: Sensors and Measuring Techniques, 5 op
521450S: Optoelectronics, 4 op
521335S: Radio Engineering 1, 6 op
521216S: Microelectronics Packaging Technology and Reliability, 7 op
521225S: RF Components and Measurements, 5 op
521110S: Measuring and Testing Systems, 6 op
521238S: Optoelectronic Measurements, 4 op
Advanced module, Photonics and printed electronics, compulsory courses
A451279: Advanced Module/ Photonics and Measurement Technology, Photonics and Printed Electronics (obligatory), 15 op
Compulsory
521217S: Printed Electronics, 4 op
521223S: Electronic and Optoelectronic Materials, 5 op
521090S: Technical Optics, 6 op
dvanced module, photonics and printed electronics, optional courses, module size approx. 30 cr
A451280: Advanced Module/ Photonics and Measurement Techniques, Photonics and Printed Electronics (optional), 15 op
Alternative
521201S: Research methods of Materials for Electronics, 3,5 op
521228S: Microsensors, 4 op
521107S: Biomedical Instrumentation, 6 op
521405A: Electronic System Design, 5 op
521172S: EMC Design, 4 op
521095S: Advanced Course of Printed Electronics, 3 op
463065A: Manufacturing of Plastics Products, 3,5 op
Advanced module, measurement and testing technology, module total approx. 30 cr.
A451281: Advanced Module/Photonics and Measurement Techniques, Measurement and Testing Techniques (obligatory), 14 op
Compulsory
521114S: Wireless Measurements, 4 op
521173S: Mixed-signal Testing, 4 op
521172S: EMC Design, 4 op
Advance module, measurement and testing technology, optional courses, module total approx 30 cr
A451282: Advanced Module/Photonics and Measurement Techniques, Measurement and Testing Techniques (optional), 16 op
Alternative
521228S: Microsensors, 4 op
521107S: Biomedical Instrumentation, 6 op
521405A: Electronic System Design, 5 op
521441S: Electronics Design and Construction Exercise, 6,5 op
521201S: Research methods of Materials for Electronics, 3,5 op

Telecommunication Engineering

H453221: Module of the Option, Telecommunication Engineering, 60 - 80 op
- *Advanced module communication networks, compulsory courses*
  - A451283: Advanced Module/ Telecommunication Engineering, Communication Networks (obligatory), 24 op
    - *Compulsory courses*
      - 521377S: Communications Networks II, 7 op
- *Advanced module communication networks, optional courses. module total approx. 30 cr.*
  - A451284: Advanced Module/ Telecommunication Engineering, Communication Networks (optional), 6 op
    - *Optional courses. module total appr. 30 cr*
      - 521317S: Wireless Communications II, 8 op
      - 521266S: Distributed Systems, 6 op
      - 521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
      - 521387S: Telecommunication Engineering Project, 4 op
      - 521386S: Radio Channels, 5 op
      - 521260S: Programmable Web Project, 5 op
- *Advanced module wireless communications, compulsory courses*
  - A451285: Advanced Module/Telecommunication Engineering, Wireless Communications (obligatory), 20 op
    - *Compulsory courses*
      - 521317S: Wireless Communications II, 8 op
      - 521375S: Radio Engineering II, 5 op
      - 521377S: Communications Networks II, 7 op
- *Advanced module wireless communications, optional courses, module total approx. 30 cr.*
  - A451286: Advanced Module/Telecommunication Engineering, Wireless Communications (optional), 10 op
    - *Optional courses. module total appr. 30 cr*
      - 521387S: Telecommunication Engineering Project, 4 op
      - 521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
      - 521386S: Radio Channels, 5 op
      - 031022P: Numerical Analysis, 5 op
- *Advanced module radi communication signal processing, compulsory courses*
  - A451287: Advanced Module/Telecommunication Engineering, Radio Communication Signal Processing (obligatory), 9 op
    - *Compulsory courses*
      - 521360S: Communication Signal Processing II, 4 op
      - 521375S: Radio Engineering II, 5 op
- *Radio communication signal processing, optional courses, module total approx. 30 cr.*
  - A451288: Advanced Module/Telecommunication Engineering, Radio Communication Signal Processing (optional), 21 op
    - *Optional courses, module total appr. 30 cr*
      - 521380S: Antennas, 4 op
      - 521317S: Wireless Communications II, 8 op
      - 521443S: Electronics Design II, 5 op
      - 521225S: RF Components and Measurements, 5 op
      - 521404A: Digital Techniques 2, 5 op
      - 521445S: Digital Techniques 3, 6 op
      - 521486S: Signal Processing Systems, 4 op
      - 521485S: DSP-laboratory Work, 3,5 op
      - 521387S: Telecommunication Engineering Project, 4 op
      - 521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
      - 521386S: Radio Channels, 5 op
      - 031022P: Numerical Analysis, 5 op
      - 521281S: Application Specific Signal Processors, 5 op

Supplementary module (15 - 30 op)

Choose optional courses so that your degree is the minimum of 120 credits.

Advanced practical training (3 op)

521016A: Advanced Practical Training, 3 op

Master's Thesis (30 op)

Choose your Thesis category among the following:

523991S Electronics design; 523992S Electronics materials and components; 523993S Photonics and measurement technology; 521998S Telecommunication Technology

The Master's Thesis requires a written maturity test.

Master's Programme in Wireless Communications Engineering

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Module of the option (41 op)

All courses are compulsory.

A451225: Module of the Option, Wireless Communications Engineering, 40 - 65 op
- *Compulsory*
  - 031025A: Introduction to Optimization, 5 op
  - 521321S: Elements of Information Theory and Coding, 5 op
  - 521320S: Wireless Communications I, 8 op
  - 521340S: Communications Networks I, 5 op
  - 521335S: Radio Engineering 1, 6 op
  - 521385S: Mobile Telecommunication Systems, 5 op
  - 521350S: Seminar in Telecommunication and Radio Engineering, 1 op
  - 521373S: Communication Signal Processing I, 6 op

Advanced module (28 - 29 op)

All courses are compulsory.

A453271: Advanced module, Wireless Communications Engineering, 16 - 35 op
- *Compulsory*
  - 521377S: Communications Networks II, 7 op
  - 521375S: Radio Engineering II, 5 op
  - 521317S: Wireless Communications II, 8 op
  - 521360S: Communication Signal Processing II, 4 op

Advanced module optional courses

A453272: Advanced module, WCE (optional), 25 - 35 op
- *Choose one of the courses*
  - 521386S: Radio Channels, 5 op

Supplementary module/Electives, WCE (10 - 41 op)

Choose the minimum of 13 cu from the course list.

A453246: Supplementary module/Electives, Wireless Communications Engineering, 10 - 41 op
- *Alternative*
  - 521443S: Electronics Design II, 5 op
  - 521433A: Laboratory Exercises on Analogue Electronics, 3 op
  - 521225S: RF Components and Measurements, 5 op
  - 521266S: Distributed Systems, 6 op

521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521380S: Antennas, 4 op
521386S: Radio Channels, 5 op
521260S: Programmable Web Project, 5 op
521273S: Biosignal Processing I, 5 op
521259S: Digital Video Processing, 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
521466S: Machine Vision, 5 op
521147S: Mobile and Social Computing, 5 op
521497S: Pattern Recognition and Neural Networks, 5 op
521479S: Software Project, 7 op
521280S: DSP Laboratory Work, 5 op
900017Y: Survival Finnish, 2 op
900013Y: Beginners' Finnish Course 1, 3 op
900053Y: Beginners' Finnish Course 2, 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.

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

Degree Programme in Electrical Engineering, B.Sc.

Tutkintorakenteen tila: published

Lukuvuosi: 2014-15

Lukuvuoden alkamispäivämäärä: 01.08.2014

Basic and Intermediate Studies (130 - 140 op)

A451120: Basic and Intermediate Studies, Electrical Engineering, 150 - 170 op
Choice of second domestic language
901008P: Second Official Language (Swedish), 2 op
900009P: Second Official Language (Finnish), 2 op
Choice of foreign language
902011P: Technical English 3, 6 op
903012P: Technical German 3, 6 op
Compulsory to all
521004P: Orientation Course for New Orientation Course for New Electrical Engineering Students, 1 op
030005P: Information Skills, 1 op
031010P: Calculus I, 5 op
031011P: Calculus II, 6 op
031019P: Matrix Algebra, 3,5 op
031017P: Differential Equations, 4 op
031021P: Probability and Mathematical Statistics, 5 op
031018P: Complex Analysis, 4 op
031050A: Signal Analysis, 4 op
761101P: Basic Mechanics, 4 op

766319A: Electromagnetism, 7 op
766326A: Atomic physics 1, 6 op
766329A: Wave motion and optics, 6 op
521209A: Electronics Components and Materials, 2 op
521205A: Principles of Semiconductor Devices, 4,5 op
521104P: Introduction to Material Physics, 5 op
521302A: Circuit Theory 1, 5 op
521306A: Circuit Theory 2, 4 op
521412A: Digital Techniques 1, 6 op
521431A: Principles of Electronics Design, 5 op
521432A: Electronics Design I, 5 op
521267A: Computer Engineering, 4 op
521109A: Electrical Measurement Principles, 5 op
521337A: Digital Filters, 5 op
521357A: Telecommunication Engineering 1, 3 op
521361A: Telecommunication Engineering II, 3 op
521384A: Basics in Radio Engineering, 5 op
521141P: Elementary Programming, 5 op
521142A: Embedded Systems Programming, 5 op

Module preparing for the option (vähintään 20.5 op)

Electronics

A451121: Module Preparing for the Option, Electronics, 20 - 30 op
Compulsory studies
521331A: Filters, 4 op
521218A: Introduction to Microfabrication Techniques, 4 op
521430A: Electronic Measurement Techniques, 6 op
521404A: Digital Techniques 2, 5 op
521433A: Laboratory Exercises on Analogue Electronics, 3 op

Technical Physics

A451122: Module Preparing for the Option, Technical Physics, 20 - 30 op
Compulsory studies
766328A: Thermophysics, 6 op
780109P: Basic Principles in Chemistry, 4 op
521218A: Introduction to Microfabrication Techniques, 4 op
521430A: Electronic Measurement Techniques, 6 op

Telecommunication Technology

A451123: Module Preparing for the Option, Telecommunication Engineering, 20 - 40 op
Compulsory studies
521484S: Statistical Signal Processing, 5 op
521370A: Laboratory Exercises in Telecommunication Engineering, 5 op
521316A: Broadband Communications Systems, 4 op

Teacher

A451124: Module Preparing for the Option, Prerequisite for Physics Teacher Education (obligatory), 20 - 31 op
Compulsory
802357A: Euclidean Spaces, 5 op
802164P: Series and Integral, 5 op
802151P: Introduction to mathematical deduction, 5 op
806113P: Introduction to Statistics, 5 op
802328A: Basics in Number Theory, 5 op
766330A: Structure of matter, 6 op
A451125: Module Preparing for the Option, Prerequisite for Physics Teacher Education (optional), 9 - 30 op
Choose to get total of 180 ECTS to your degree.
802119P: Linear Algebra II, 5 op

801389A: Basic Geometry, 6 op
800322A: Multidimensional analysis, 8 op

BSc thesis and related studies (10 op)

The extent of the BSc thesis in Electrical Engineering is 8 credits.

521033A: Engineering Study, Electronics and Communications, 3 - 10 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.

Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

761102P: Basic Thermodynamics, 2 op
477622A: Control System Design, 5 op
521308S: Electronic Research Exercise, 5 op
521105A: Electronic components project, 3 op
802352A: Euclidean Topology, 4 op
801346A: Introduction to Cryptography, 4 op
A451224: Module of the Option, Telecommunication Engineering, 40 - 41 op
521288S: Multiprocessor Programming, 5 op
766334A: Nuclear and particle physics, 2 op
802354A: Number Theory and Groups, 5 op
521025S: Power Electronics, 5 op
900082Y: Second Official Language (Finnish), Oral Skills, 1 - 3 op
900081Y: Second Official Language (Finnish), Written Skills, 1 - 2 op
Compulsory
900081Y-01: Second Official Language (Finnish), Written Skills, 1 - 2 op
900081Y-02: Second Official Language (Finnish), Oral Skills, 1 - 3 op
901049Y: Second Official Language (Swedish), Oral Skills, 1 op
901048Y: Second Official Language (Swedish), Written Skills, 1 op
802353A: Series and Integrals, 6 op
521369A: Simulations and Tools for Telecommunications, 3 op
521484A: Statistical Signal Processing, 5 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuuluvien opintokohteiden kuvaukset

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

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

Ei opintojaksokuvauksia.

Module of the option, all courses obligatory

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

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

Ei opintojaksokuvauksia.

All compulsory

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
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 semester, periods 1-2

Learning outcomes:

On completion of the study module students 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, analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits, and estimate and minimize the effects of noise on these. They should also be able to explain the terminology used with DA and AD conversion and converters and to analyze and outline their main architectural principles and also to evaluate their characteristics.

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:

-

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:

-

Other information:

-

521441S: Electronics Design and Construction Exercise, 6,5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

Leikkaavuudet:

521300S	Electronics Design and Construction Exercise	6.0 op

ECTS Credits:

6,5

Language of instruction:

Finnish, English

Timing:

Period 1-6.

Learning outcomes:

On completion of the study module a student 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. He or she is able to use independently without any help professional methods, software packages, measurement devices and tools.

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.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design, Filter Theory, Digital Filters, Computer Engineering, Embedded Systems

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:

-

Other information:

-

521405A: Electronic System Design, 5 op

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

ECTS Credits:

5.0

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

On completion of the study module a student 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. The student is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

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:

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Prerequisites and co-requisites:

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

Recommended optional programme components:

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Recommended or required reading:

Handout. 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:

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:

-

Other information:

-

521335S: Radio Engineering 1, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Risto Vuohtoniemi
Opintokohteen kielet: Finnish
Leikkaavuudet:

521326S Radio Engineering 5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

After completing the course the student recognizes different kind of impedance matching methods and can design the impedance matching network using discrete components and microstrip lines. She/he can also explain factors, which are limiting the bandwidth of impedance matching networks. The student can design the impedance matching for a low noise amplifier. 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. The student can explain the principle of a single ended, balanced and double balanced mixer and the advantages and the disadvantages of these mixers. She/he can design a power divider and a directional coupler. The student can also explain the principle of an automatic gain control (AGC). The student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Impedance matching using discrete 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 30 h, exercises 24 h and the compulsory RF design work with ADS simulation software (18 h).

Target group:

1 st year M.Sc. and WCE 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, 3rd edition, John Wiley & Sons, Inc., 2005. 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

Working life cooperation:

-

Other information:

After having passed the course the student is familiar with the basic theory and techniques of designing radio frequency circuits used in radio transceivers.

521088S: Optoelectronics, 5 op

Voimassaolo: 01.01.2014 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Kostamovaara

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Spring, periods 5-6

Learning outcomes:

On completion of the study module students should be able to explain the principles of operation of photo conductors (optic fibers), semiconductor light sources and photo detectors used in optoelectronic measurements and telecommunications, paying due attention to factors affecting their performance. They should also be able to outline circuit-level structures for optical transmitter circuits and photo detector preamplifiers and to compare them in terms of their main performance parameters. They should also be reasonably able to use the main principles of signal processing principles that are typically used in optoelectronic measurement applications.

Contents:

Wave/particle dualism of optical radiation, optical waveguides and their properties, sources of radiation (radiation of black body, LED- and laser structures), photo detectors (photo conductive detector, photo multiplier, PIN- and AP-diodes, position sensitive detectors), light source modulation, preamplifiers and their bandwidth/stability/noise analysis, signal processing concepts used in optoelectronics.

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:

-

Prerequisites and co-requisites:

Principles of semiconductor devices.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes, S. Kasap: Optoelectronics and Photonics, Principles and Practices, Prentice Hall 2001. J. Wilson, J. Hawkes, “Optoelectronics, an introduction”, Prentice Hall, 3ed, ISBN 0-13-103961-X.

Assessment methods and criteria:

Final exam.

Grading:

Numerical grading scale 1-5.

Person responsible:

Juha Kostamovaara

Working life cooperation:

-

Other information:

-

521332S: Computer Aided Circuit Design, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Aikio, Janne Petteri

Opintokohteen kielet: Finnish

Leikkaavuudet:

521305S Computer Aided Circuit Design 5.0 op

ECTS Credits:

4

Language of instruction:

Finnish. Exams can be arranged in English on demand.

Timing:

Spring, periods 4-6.

Learning outcomes:

After the course the student can

- explain the operation and requirements of the common simulation algorithms
- choose the most appropriate simulation algorithm to any design task
- recognize, solve, and circumvent the commonly emerging problems in circuit simulations
- choose the correct excitations and build the necessary test benches for circuit simulations

Contents:

Operation of a circuit simulator. The principles and limitations of different circuit simulation algorithms. Device-level and behavioral modeling.

Mode of delivery:

Classroom

Learning activities and teaching methods:

30h lectures, including demonstrations. A simulation exercise (10h).

Target group:

MSc students

Prerequisites and co-requisites:

Background in circuit theory and analog design, numerical methods.

Recommended optional programme components:

-

Recommended or required reading:

Kundert: Designer’s Guide to Spice and Spectre. Kluwer Academic.

Assessment methods and criteria:

Final exam. Also the simulation exercise needs to be passed.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Janne Aikio

Working life cooperation:

-

Other information:

-

521423S: Embedded System Project, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

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:

Autumn, periods 1-3.

Learning outcomes:

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. 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. 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 20 h, laboratory exercise in period 1-3 120 h.

Target group:

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

Prerequisites and co-requisites:

521412A Digital Techniques I, 521267A Computer Engineering and Embedded Systems.
Also recommended 521275A Embedded Software Project, Principles of Electronics Design.

Recommended optional programme components:

Digital Techniques I, Computer Engineering, Embedded Systems. Also recommended Embedded Software Project, Principles of Electronics Design.

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.

477603A: Control System Design, 4 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Process and Environmental Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Seppo Honkanen

Opintokohteen kielet: Finnish

Leikkaavuudet:

477622A	Control System Design	5.0 op
470461A	Fundamentals of Control and Systems Engineering II	5.0 op

ECTS Credits:

4 cr

Language of instruction:

Finnish

Timing:

Periods 4 and 5

Learning outcomes:

After completing the course the students can apply mathematical and graphical methods to the dynamics of process characterisation and control design. The period of study completed, the student can form PID controllers for the process, and tune them and evaluate the closed-loop requirements.

Contents:

Laplace-level vs, time level, Poles of the system, Closed loop and its design specifications, PID control and tuning, Matlab control designer tool, control design in frequency domain.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and exercises

Target group:

B.Sc. students in process and environmental engineering

Prerequisites and co-requisites:

The courses 4770xxP Introduction to process and environmental engineering II and 477602A Control system analysis recommended beforehand

Recommended optional programme components:

-

Recommended or required reading:

Lecture and exercises handouts, Åström, K & Murray, R. (2009) Feedback Systems, An Introduction for Scientists and Engineers. Princeton University Press, New Jersey, 396 s. Additional literature: Dorf, R (2010) Modern Control Systems. Prentice-Hall, New York, 1104 s., DiStefano, J (1990) Schaum's Outline of Feedback and Control Systems. 2nd ed, McGraw-Hill, 512 s. ja Ylen, J-P (1994) Säätötekniikan harjoitustehtäviä. Hakapaino Oy, 252 s.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1.5 or fail

Person responsible:

Professor Enso Ikonen and university teacher Seppo Honkanen

Working life cooperation:

No

Other information:

-

Advanced module, digital systems design, obligatory courses

A451273: Advanced Module/Electronics Design, Digital Systems Design (obligatory), 16 - 21 op

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

Ei opintojaksokuvauksia.

Compulsory

521453A: Operating Systems, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
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:

Spirng, periods 5-6

Learning outcomes:

After the course the student is capable of explaining the basic structure and functioning of operating system. He/She 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. Student is capable of explaining the cause and effect related to deadlocks and is able to analyse them related to common circumstances in operating systems. Additionally, the student 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:

Topics: 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 30 h, laboratory exercise 6 h, the rest as independent work.

The course consists of lectures and laboratory work, which includes pre-exercise and guided exercise performed in a group of one or two students in the unix environment.

Target group:

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

Prerequisites and co-requisites:

521141P Elementary Programming, 521142A Embedded Systems Programming, 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:

-

521457A: Software Engineering, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

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:

Autumn, periods 1-3.

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, 5. structural analysis

and design, 5. software testing methods and strategies, 6. introduction to object-oriented analysis and design.

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) 12 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, 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:

-

521445S: Digital Techniques 3, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish.

Timing:

Period 5-6

Learning outcomes:

After completing this course the student 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. The student is also able to use the tools needed in industrial design projects.

Contents:

1. Digital systems design process. 2. System level design and modeling of digital systems. 3. Architecture level synthesis of digital circuits. 3. FPGA circuit design and verification (technology choice, logic synthesis, physical synthesis and timing analysis) 4, ASIC-design and verification (technology choice, logic synthesis, physical synthesis, timing analysis, power analysis, design for testability).

Mode of delivery:

Classroom

Learning activities and teaching methods:

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

Target group:

-

Prerequisites and co-requisites:

Digital techniques I + II

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

Final exam or term exams, and a design excercise
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:

-

521281S: Application Specific Signal Processors, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Boutellier, Jani Joosefi
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Spring, periods 4-5.

Learning outcomes:

Objective: The course introduces the main types of processors used in digital signal processing. Practical skills are learned by processor construction exercises.
Learning outcomes: After completing the course the student can distinguish the main types of signal processors and design a couple of transport triggered architecture processors. The student is able to assemble a signal processor out of basic entities and match the processor performance and

the application requirements. The student 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 pro-cessing.

Prerequisites and co-requisites:

521267A Computer engineering, 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:

Jani Boutellier

Working life cooperation:

No.

Advanced module, digital systems design, optional courses, module total approx. 30 cr.

A451274: Advanced Module/ Electronics Design, Digital Systems Design (optional), 9 - 41 op

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

Ei opintojaksokuvauksia.

Alternative

521150A: Introduction to Internet, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Ojala, Timo Kullervo

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

All materials are in English, lectures are given in Finnish.

Timing:

Spring, periods 4-5.

Learning outcomes:

Upon completing the course the student is able to explain the structure of the public Internet and the TCP/IP protocol stack, solve simple Internet problems, and design and implement a small Internet application.

Contents:

Internet's design principles and architecture, TCP/IP protocol stack, most important access networks, most important Internet applications, basics of Internet security.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 32 h / problem solving exercises 12 h / laboratory exercises 12 h / course work 25 h / self-study 52 h. Problem solving exercises, laboratory exercises and course work are completed as group work.

Target group:

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

Prerequisites and co-requisites:

None.

Recommended optional programme components:

-

Recommended or required reading:

Will be announced at the beginning of the course.

Assessment methods and criteria:

The course uses continuous assessment so that there are 4 intermediate exams. Alternatively, the course can also be passed with a final exam. The course includes a mandatory course work.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course uses numerical grading scale 1-5.

Person responsible:

Professor Timo Ojala.

Working life cooperation:

-

521275A: Embedded Software Project, 8 op

Voimassaolo: 01.08.2007 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Tokola, Juha Röning

Opintokohteen kielet: English

ECTS Credits:

8

Language of instruction:

Material of the course is available in English, lecturing is given in English.

Timing:

Spirng, periods 4-6.

Learning outcomes:

Embedded software project is the final course in the Bachelor's degree. The skills to pass this course have been acquired in precious courses. During the course, students work in groups to implement a program into an embedded system and write a technical report of the work. The subject of the program is not necessarily covered in previous courses.
After completing the course work, students have demonstrated that they can employ their skills in acquiring information to find a feasible solution to a given problem while still addressing the constraints imposed by a given embedded system. The student has shown that they are capable of designing and then implementing the non-trivial solution as a program to the given embedded system. Furthermore, they have demonstrated that they are capable of writing good-quality scientific text, including a literature survey, theory, technical documentation, testing documentation and other necessary chapters.

Contents:

This course familairizes the student with modern embedded system development with modern methods and tools. Topics: Development tools, practical application program for an embedded system.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Pair project with monitoring meetings and a compulsory exercise. Lectures 30 h, design exercise 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, 521142A Embedded Systems Programming. In addition, 521453A Operating Systems be beneficial.

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:

Data periodicals, handouts, handbooks

Assessment methods and criteria:

Project report.
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, Teemu Tokola

Working life cooperation:

None.

521485S: DSP-laboratory Work, 3,5 op

Voimassaolo: - 31.07.2012

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Miguel Bordallo Lopez

Opintokohteen kielet: English

Language of instruction:

In English.

Timing:

Period 2-6.

Learning outcomes:

The course concentrates on implementing basic algorithms and functions of digital signal processing using common modern programmable DSP processors.
Learning outcomes: After the course the student is able to use integrated design environments of digital signal processors for implementing and testing algorithms based on floating and fixed point representation.

Contents:

Sampling, quantization noise, signal generation, decimation and interpolation, FIR and IIR filter implementations, FFT and adaptive filter implementations.

Learning activities and teaching methods:

The course is based on a starting lecture and exercises that are done using development boards of modern 32-bit digital signal processors, and the respective software development tools. The course is passed by accepted and documented exercises

Recommended optional programme components:

Digital filters, computer engineering, programming skills.

521486S: Signal Processing Systems, 4 op

Voimassaolo: - 31.07.2012

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannuksela, Jari Samuli

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Savo Glisic

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

Upon completing the required coursework, the student is able to list the functionalities of different layers of OSI and TCP/IP protocol models. The course gives the skills for the student to describe the basic structure of GSM, GPRS, EDGE, LTE and IEEE802.11 systems. The student is able to describe the basic protocol model of the UMTS radio interface and radio access network. The student knows the basic properties of routing protocols in ad hoc networks. The student will achieve skills to describe the main principles of mobility control, network security, cross-layer optimization. The course also gives the student the ability to explain the essential features of sensor networks.

Contents:

Communications architecture and protocols, adaptive network and transportation layers, mobility management, network security, network management, ad hoc and sensor networks, cross-layer optimization, examples of wireless communication networks.

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:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Parts from: S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies (2nd ed.), 2009; S. Glisic: Advanced Wireless Communications: 4G Cognitive and Cooperative Technologies (2nd ed.), 2007.

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:

Savo Glisic

Working life cooperation:

-

Other information:

Objective: The aim is to present the fundamentals of the structure, protocol and structure of digital data transmission networks. Technical implementation and application of the common data and local networks are also discussed.

Advanced module, electronics design, electronics design (optional)

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

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Obligatory courses

521435S: Electronics Design III, 6 op

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

ECTS Credits:

6

Language of instruction:

In Finnish (English as a book examination)

Timing:

Autumn/spring, periods 3-4

Learning outcomes:

On completion of the study module students should be able to detail the advantages of differential signal processing in IC realizations and to analyze and design differential amplifiers and other electronic blocks for implementation in an IC environment. They should be able to explain how an SC (switched capacitor) technology functions and to apply such a technology to sampling and filtering. 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 and to apply it for realizing integrated DA and AD converters. They should be able to account for the functioning, use and architecture of a phase-locked loop, 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 independent or group study 69h.

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

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:

Tarmo Ruotsalainen

Working life cooperation:

-

Other information:

-

521445S: Digital Techniques 3, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Jukka Lahti
Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish.

Timing:

Period 5-6

Learning outcomes:

After completing this course the student 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. The student is also able to use the tools needed in industrial design projects.

Contents:

1. Digital systems design process. 2. System level design and modeling of digital systems. 3. Architecture level synthesis of digital circuits. 3. FPGA circuit design and verification (technology choice, logic synthesis, physical synthesis and timing analysis) 4, ASIC-design and verification (technology choice, logic synthesis, physical synthesis, timing analysis, power analysis, design for testability).

Mode of delivery:

Classroom

Learning activities and teaching methods:

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

Target group:

-

Prerequisites and co-requisites:

Digital techniques I + II

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

Final exam or term exams, and a design excercise
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: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

521441S Electronics Design and Construction Exercise 6.5 op

Ei opintojaksokuvauksia.

Advanced module, electronics design, electronics design (obligatory)

A451290: Advanced module/Electronics design, electronics design (optional), 25 - 41 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Optional courses

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

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

ECTS Credits:

4-7

Language of instruction:

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

Timing:

Autumn, periods 1-2

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

Grading:

1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

Other information:

Objective: Current research issues in electronics design.

521380S: Antennas, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English
Leikkaavuudet:

521388S	Antennas	5.0 op

ECTS Credits:

4

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student can apply antenna terminology and calculate the antenna characteristics of different kind of radio systems. He/she can apply electromagnetic theory to calculate the properties of the fields radiated by wire antennas, micro strip antennas and antenna arrays. The student is also able to design wire antennas, micro strip antennas and antenna arrays for different radio systems. In addition, the student can use electromagnetic simulators to analyze and design antennas.

Contents:

ntroduction to different antenna types. Antenna parameters. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas: infinitesimal dipole, small dipole, finite length dipole, half-wavelength dipole. Antennas near the conducting plane. Loop antennas. Microstrip antennas. Antenna arrays.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory antenna design work with an electromagnetic simulation program (14 h).

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

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 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:

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in even years. Objective: After having passed the course the student knows antenna terminology, understands the role of antennas as a part of different radio systems and is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays. In addition, the student masters the preliminary design of various antenna types and arrays, as well as, knows the feasibility of electromagnetic simulators in the antenna design.

521216S: Microelectronics Packaging Technology and Reliability, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

7

Language of instruction:

In Finnish.

Timing:

4-6

Learning outcomes:

Upon completing the course the student can explain what is meant by microjoining techniques and what are the pros and cons of these. The student can tell what different kind of materials, and why, are used in IC packaging technology. He can describe the module techniques and the basics for wafer level packaging. He can explain how the electronic packaging technologies have been developed, since the invention of the transistor, up to date and how this development will continue in the future. In addition, the student can explain, study and predict the failure mechanisms of an electronic device. He can apply environmental testing and statistical methods to predict the reliability.

Contents:

Trends of packaging technologies. Microjoining from IC to substrate: flip-chip, wirebond, and TAB techniques. Metal, ceramic, and plastic package structure and manufacturing. Multi-chip-modules (MCM). Chip scale packages (CPS) and wafer level packaging (WLP). Failure mechanisms of electronic components and packaging methods and analyzing. Methods of environmental testing, screening, and quality control.

Mode of delivery:

Face to face teaching

Learning activities and teaching methods:

Lectures 28h / group work 30h / working with research machines 12h / self-study 119h.

Target group:

Major students.

Prerequisites and co-requisites:

Recommended Introduction to Microelectronics and Micromechanics

Recommended optional programme components:

Advanced course Micromodules

Recommended or required reading:

Rao R. Tummala(edit): Fundamentals of microsystems packaging, New York, McGraw-Hill, 2001. Parts of Ken Gilleo: Area Array Packaging Handbook: Manufacturing and Assembly, McGraw-Hill, 2002 and J.J. Licari, L.R. Enlow: Hybrid Microcircuit Technology Handbook: Materials, processes, Design, Testing and Production, Noyes Publications, 1998. William D. Brown (edit.): Advanced Electronic Packaging. With Emphasis on Multichip Modules. IEEE, Inc., 1999, chapters 11 and 16. Patrick D.T. O'Connor: Practical Reliability Engineering, John Wiley&Sons, 2002 chapters 8 and 9.

Assessment methods and criteria:

This course unit utilizes continuous assessment. The course can also be completed with the final exam. The assessment of the course unit is based on the learning outcomes of the course unit. Passed exam and practice work are needed for the course completion.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521375S: Radio Engineering II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: English

Leikkaavuudet:

521327S Design of Tranceivers 6.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student recognizes the blocks of a transceiver and can explain the operating principle of a transceiver. She/he can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them. The student can 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. She/he can explain nonlinear distortion and can design the automatic gain control in the system level. The student can also 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. The student can also explain the principles of frequency synthesis in a transceiver.

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:

Two hours of lectures in a week, 30 h in total. The compulsory design exercise with ADS simulation software, 30 h during periods 5 and 6.

Target group:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from books: A. Luzatto, G. Shirazi: Wireless Transceiver Design, John Wiley & Sons Ltd, 2007 and Walter Tuttlebee: Software Defined Radio.Enabling Technologies, John Wiley & Sons Ltd, 2002.

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

Working life cooperation:

-

Other information:

The aim is to understand the basic theory and techniques of a transceiver system level design. After passing the course the student knows, what should be taken into account when functional blocks of a transceiver are connected so that the performance requirements are achieved.

521172S: EMC Design, 4 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521115S EMC Design 5.0 op

ECTS Credits:

4

Language of instruction:

English.

Timing:

Period 6.

Learning outcomes:

After completing the course the student is able to name common EMC standards, and is able to use EMC testing equipment and methods. The student can explain the noise coupling mechanisms, and is able to use good design practices related to analogue and digital electronics design, grounding, cabling, filtering and 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:

Lectures 24h/Exercises 12h/Laboratory work 12h.

Target group:

-

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:

Electronics Design I, Digital Techniques I, Electronic Measurement Techniques, Measuring and Testing Systems, RF Components and Measurements.

Recommended or required reading:

Tim Williams: EMC for Product Designers, 4th edition, Oxford: Newnes, 2007. Lecture slides.

Assessment methods and criteria:

Final exam and passed laboratory 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:

Hannu Sorvoja
Teemu Myllylä

Working life cooperation:

-

Other information:

-

521224S: Microelectronics and Micromechanics, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Krisztian Kordas
Opintokohteen kielet: English
Leikkaavuudet:

521074S	Microelectronics and Micromechanics	5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Periods 4-6

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:

-

Prerequisites and co-requisites:

Passing the basic course “521218A Introduction to Microelectronics and Micromechanics” before the advanced course may be helpful, however it is not a must.

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:

1-5

Person responsible:

Krisztian Kordas

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: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Module of the option, all 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: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

All compulsory

521103S: Electroceramics and Intelligent Materials, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail

Opettajat: Antti Uusimäki

Opintokohteen kielet: Finnish

Leikkaavuudet:

521073S Electroceramics and Intelligent Materials 5.0 op

ECTS Credits:

4

Language of instruction:

Finnish

Timing:

Periods 1-3

Learning outcomes:

Upon completing the course the student is able
- to estimate the properties and usability of functional ceramics in different electronics components applications and perform calculatory structural dimensioning for them
- to compare and choose applicable processing methods for the fabrication of functional structures
- also 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:

24 hours lectures and 24 hours exercises.

Target group:

Not defined.

Prerequisites and co-requisites:

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

Recommended optional programme components:

None.

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:

Antti Uusimäki

Working life cooperation:

None.

Other information:

None.

521223S: Electronic and Optoelectronic Materials, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

Upon completing the course the student can explain the behavior of metals and insulators in steady and alternating fields, basics of magnetic materials and concepts of magnetism, properties and applications of functional electroceramics and optoelectronic materials. Student can also evaluate the usability of different materials in electronics, optoelectronics, and photonics applications.

Contents:

The course treats with conducting and insulating materials used in electronic circuit components, optoelectronics components, and transducers. Magnetic materials (soft and hard) and their use, for example, in information storages. Functional electroceramic materials and their applications. Materials for optoelectronics and photonics devices

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h, calculation exercises 20h, and three laboratory exercises 6h

Target group:

Major students.

Prerequisites and co-requisites:

Introduction to Material Physics, Principles of Semiconductor Devices

Recommended optional programme components:

Introduction to Microfabrication Techniques

Recommended or required reading:

S.O. Kasap: Principles of Electronic Materials and Devices, 3 rd edition, McGraw-Hill, 2006. (Chapters 2, 7, 8, 9)

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5. The course rank is an average weighted by 2 and 1 of exam and laboratory exercises, respectively

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521216S: Microelectronics Packaging Technology and Reliability, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

7

Language of instruction:

In Finnish.

Timing:

4-6

Learning outcomes:

Upon completing the course the student can explain what is meant by microjoining techniques and what are the pros and cons of these. The student can tell what different kind of materials, and why, are used in IC packaging technology. He can describe the module techniques and the basics for wafer level packaging. He can explain how the electronic packaging technologies have been developed, since the invention of the transistor, up to date and how this development will continue in the future. In addition, the student can explain, study and predict the failure mechanisms of an electronic device. He can apply environmental testing and statistical methods to predict the reliability.

Contents:

Trends of packaging technologies. Microjoining from IC to substrate: flip-chip, wirebond, and TAB techniques. Metal, ceramic, and plastic package structure and manufacturing. Multi-chip-modules (MCM). Chip scale packages (CPS) and wafer level packaging (WLP). Failure mechanisms of electronic components and packaging methods and analyzing. Methods of environmental testing, screening, and quality control.

Mode of delivery:

Face to face teaching

Learning activities and teaching methods:

Lectures 28h / group work 30h / working with research machines 12h / self-study 119h.

Target group:

Major students.

Prerequisites and co-requisites:

Recommended Introduction to Microelectronics and Micromechanics

Recommended optional programme components:

Advanced course Micromodules

Recommended or required reading:

Rao R. Tummala(edit): Fundamentals of microsystems packaging, New York, McGraw-Hill, 2001. Parts of Ken Gilleo: Area Array Packaging Handbook: Manufacturing and Assembly, McGraw-Hill, 2002 and J.J. Licari, L.R. Enlow: Hybrid Microcircuit Technology Handbook: Materials, processes, Design, Testing and Production, Noyes Publications, 1998. William D. Brown (edit.): Advanced Electronic Packaging. With Emphasis on Multichip Modules. IEEE, Inc., 1999, chapters 11 and 16. Patrick D.T. O'Connor: Practical Reliability Engineering, John Wiley&Sons, 2002 chapters 8 and 9.

Assessment methods and criteria:

This course unit utilizes continuous assessment. The course can also be completed with the final exam. The assessment of the course unit is based on the learning outcomes of the course unit. Passed exam and practice work are needed for the course completion.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521335S: Radio Engineering 1, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S Radio Engineering 5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

After completing the course the student recognizes different kind of impedance matching methods and can design the impedance matching network using discrete components and microstrip lines. She/he can also explain factors, which are limiting the bandwidth of impedance matching networks. The student can design the impedance matching for a low noise amplifier. 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. The student can explain the principle of a single ended, balanced and double balanced mixer and the advantages and the disadvantages of these mixers. She/he can design a power divider and a directional coupler. The student can also explain the principle of an automatic gain control (AGC). The student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Impedance matching using discrete 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 30 h, exercises 24 h and the compulsory RF design work with ADS simulation software (18 h).

Target group:

1 st year M.Sc. and WCE 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, 3rd edition, John Wiley & Sons, Inc., 2005. 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

Working life cooperation:

-

Other information:

After having passed the course the student is familiar with the basic theory and techniques of designing radio frequency circuits used in radio transceivers.

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Kinnunen, Jari Hannu

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

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. The student also knows the operating principles of transfer lines, antennas and filters and of their design. 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 different measurement techniques in different measurement situations. In addition 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

Learning activities and teaching methods:

Lectures 24h/calculation exercises 12h/laboratory exercises 12h/design exercises 12h

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:

-

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 and design exercises
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:

Jari Hannu and Matti Kinnunen

Working life cooperation:

-

Other information:

Kurssissa käydään läpi tavallisimmat RF-komponentit ja -mittausmenetelmät, jotka ovat käytössä RF- ja mikroaaltoalueilla. Kurssi antaa valmiudet komponenttien toiminnan ja valintaperusteiden ymmärtämiseen sekä sähkömagneettisten kenttien ja suurtaajuuspiirien mittauksiin.

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
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 semester, periods 1-2

Learning outcomes:

On completion of the study module students 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, analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits, and estimate and minimize the effects of noise on these. They should also be able to explain the terminology used with DA and AD conversion and converters and to analyze and outline their main architectural principles and also to evaluate their characteristics.

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:

-

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:

-

Other information:

-

521224S: Microelectronics and Micromechanics, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Krisztian Kordas
Opintokohteen kielet: English
Leikkaavuudet:

521074S	Microelectronics and Micromechanics	5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Periods 4-6

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:

-

Prerequisites and co-requisites:

Passing the basic course “521218A Introduction to Microelectronics and Micromechanics” before the advanced course may be helpful, however it is not a must.

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:

1-5

Person responsible:

Krisztian Kordas

Working life cooperation:

-

Other information:

-

Advanced module, microsystems engineering, compulsory courses

A451277: Advanced Module/Electronics Materials and Components, Microsystems Engineering (obligatory), 21,5 op

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

Ei opintojaksokuvauksia.

Compulsory

521201S: Research methods of Materials for Electronics, 3,5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Marina Tjunina
Opintokohteen kielet: English

ECTS Credits:

3,5

Language of instruction:

In English.

Timing:

Periods 4 -6

Learning outcomes:

Student will be able to describe experimental methods of materials characterization, to explain their physical principles and limitations, and meaning of measurement results. Student will be able to properly select and apply the characterization methods.

Contents:

Optical methods (microscopy, interferometry, ellipsometry; absorption, photoelectron, Raman, and infrared spectroscopies). X-ray methods (scattering, diffraction, fluorescence, spectroscopies). Electron microscopies (scanning, transmission, electron diffraction, and spectrosco-pies). Scanning tunneling and atomic force microscopies. Ion-beam methods.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures 20 h/ Exercises as group work 20 h/ Self-study as online work 55 h.

Target group:

Not defined.

Prerequisites and co-requisites:

766326A Atom physics; 766329A Waves and optics; 521104P Introduction to materials physics.

Recommended optional programme components:

None.

Recommended or required reading:

Lectures.

Assessment methods and criteria:

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

Grading:

Numerical grading 1 – 5.

Person responsible:

Marina Tyunina

Working life cooperation:

Yes. Demonstrations at Center of Microscopy and Nanotechnology.

Other information:

The course gives an overview of experimental methods of characterization of morphology, crystal, surface, and electronic structure, atomic composition, and basic properties of materials. Emphasis is on materials and nanostructures for electronics.

521203S: Micromodules, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Period 4-6.

Learning outcomes:

Upon completing the course 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. He can explain why active and passive components are being, more and more, embedded to be a part of the circuit board. The student can tell what is the meaning of SOB, MCM, SOC, SIP, and SOP and how the system level packaging technology will be developed during the next 10 – 20 years. In addition he can explain why and how optoelectronics will be migrate towards circuit board and components on it, and can explain the packaging methods of MEMS components. Upon completing the course the student can make small-scale literature reviews.

Contents:

System level packaging technologies: SOC, SIP, and SOP. Multilayer printed circuit boards and embedding components. Optoelectronics and MEMS component packaging.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

L ectures and a literature review.

Target group:

Major students

Prerequisites and co-requisites:

Introduction to Microfabrication techniques, Microelectronics Packaging Technology and Reliability.

Recommended optional programme components:

-

Recommended or required reading:

R.R.Tummala and M. Swaminathan, Introduction to System-on-Package (SOP), McGraw-Hill, 2008.

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5. The course rank is an average weighted by 2 and 1 of exam and literature review.

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521228S: Microsensors, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521072S Microsensors 5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

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

Contents:

Principles of sensing and sensor physics. Energy conversion forms and sensor signals. Processing of sensor signals. Microsensor fabrication by three different microtechnology; monolitchic (silicon technology), thin-film technology, and thick film technology. Advanced fabrication methods. Main types of thermal, radiation, mechanical, magnetic, and (bio) chemical sensors. Sensor performance. Smart sensors and microsensor array devices.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h, calculation exercises 8h.

Target group:

Major students.

Prerequisites and co-requisites:

Introduction to Material Physics, Introduction to Microfabrication Techniques.

Recommended optional programme components:

Introduction to Microfabrication Techniques.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1996

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5.

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521217S: Printed Electronics, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Fabritius

Opintokohteen kielet: Finnish

Leikkaavuudet:

521089S Printed Electronics 5.0 op

ECTS Credits:

4

Language of instruction:

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

Timing:

4-6

Learning outcomes:

After passing this course, student understands the basics of the materials and printing/deposition methods used in printed electronics. In addition, he/she understands operational principles passive /active components and the utilized in fabrication techniques of optoelectronic components

Contents:

Materials; conductive and semiconductive polymers, conductive particular inks, insulator materials, photo active polymers. Printing methods: gravure, flexo, screen, inkjet and nanoimprinting. Components; Organic solar cells, organic light emitting diodes, organic transistors, passive components

Mode of delivery:

Classroom.

Learning activities and teaching methods:

Lectures 24 h, supervised exercises 6 h and self-study 70 h.

Target group:

Course is mandatory in some advanced studies of module of electrical engineering

Prerequisites and co-requisites:

Not defined.

Recommended optional programme components:

None.

Recommended or required reading:

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

Assessment methods and criteria:

Exam and accepted exercises (e.g. seminar presentation)
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Tapio Fabritius

Working life cooperation:

-

Other information:

-

521110S: Measuring and Testing Systems, 6 op

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tuomas Happonen, Juha Saarela

Opintokohteen kielet: Finnish

Leikkaavuudet:

521096S Measurement Systems 5.0 op

Language of instruction:

Finnish. In English if there are more than 2 foreign students in the class.

Timing:

Period 4.

Learning outcomes:

The goal of this course is to teach measurement and testing systems generally. Constructions, connections, software, data acquisition as well as widely used interfaces are included in this course. Also methods to analyze measured signals especially to take care of eliminating disturbances are considered.
Learning outcomes: After completing the course the student is able to explain the principles of measuring and testing systems, and is able to compare the properties and performance of different communication techniques used in measurement systems. The student is able to design an application which controls a measurement system and stores the measurement data. Additionally, the student is able to realize essential multisensor systems and large systems which utilize data networks, and can give examples of practical measurement systems found in the industry and in medicine.

Contents:

Basics of measurement and testing systems, data transmission in measurement systems, software and data acquisition, design of measurement system, examples of measurement systems in industry and medicine, wide measurement systems using data networks, test system applications.

Learning activities and teaching methods:

Lectures and laboratory exercises. Final exam and passed laboratory exercises.

Recommended optional programme components:

Electronic Measurement Techniques .

Recommended or required reading:

Handout. Lab-View material

Advanced module, microsystems engineering optional courses, module size approx. 30 cr

A451278: Advanced Module/Electronics Materials and Components, Microsystems Engineering (optional), 8,5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Module total appr. 30 cr

521450S: Optoelectronics, 4 op

Voimassaolo: - 31.07.2014
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

4

Language of instruction:

Finnish.

Timing:

Period 5-6

Learning outcomes:

On completion of the study module students should be able to explain the principles of operation of photo conductors (optic fibers), semiconductor light sources and photo detectors used in optoelectronic measurements and telecommunications, paying due attention to factors affecting their performance. They should also be able to outline circuit-level structures for optical transmitter circuits and photo detector preamplifiers and to compare them in terms of their main performance parameters. They should also be reasonably able to use the main principles of signal processing principles that are typically used in optoelectronic measurement applications.

Contents:

Wave/particle dualism of optical radiation, optical waveguides and their properties, sources of radiation (radiation of black body, LED- and laser structures), photo detectors (photo conductive detector, photo multiplier, PIN- and AP-diodes, position sensitive detectors), light source modulation, preamplifiers and their bandwidth/stability/noise analysis, signal processing concepts used in optoelectronics.

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:

-

Prerequisites and co-requisites:

Principles of semiconductor devices.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes, S. Kasap: Optoelectronics and Photonics, Principles and Practices, Prentice Hall 2001. J. Wilson, J. Hawkes, “Optoelectronics, an introduction”, Prentice Hall, 3ed, ISBN 0-13-103961-X.

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:

-

Other information:

-

521405A: Electronic System Design, 5 op

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

ECTS Credits:

5.0

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

On completion of the study module a student 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. The student is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

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:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

Handout. 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:

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:

-

Other information:

-

464061A: Techniques of Creative Working, 3 op

Voimassaolo: - 31.07.2021
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Mechanical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Niskanen, Juhani
Opintokohteen kielet: Finnish
Leikkaavuudet:

464104A	Product innovations	5.0 op

Ei opintojaksokuvauksia.

463065A: Manufacturing of Plastics Products, 3,5 op

Voimassaolo: - 31.07.2021
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Mechanical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Jouko Heikkala
Opintokohteen kielet: Finnish
Leikkaavuudet:

463105A	Casting techniques	8.0 op

ECTS Credits:

3,5 ects cr

Language of instruction:

Finnish

Timing:

Lectures and exercises during periods 2.-3.

Learning outcomes:

The aim of this course is to give the student a basic knowledge of the manufacturing of plastic parts and their production tooling.
Course outcomes: After the course, the student will know the basic terminology of plastics processing as well as how to utilize computer-aided methods and systems with different manufacturing processes in machine shops. The student can describe the main features, capabilities and limitations of different methods and machinery in plastic processing. Additionally, the student can apply his/her knowledge to designing production-friendly plastics products and their tooling.

Contents:

Properties of common plastic materials; Processes and machinery in manufacturing of plastic parts; Design of plastics parts and their tooling; Assembly of plastic components; Computer-aided tools for designing plastics parts and their manufacturing processes
In the project section of the course, the student's knowledge is applied to solving practical problems in manufacturing.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

The course consists of classes as well as a group project. During periods 2 and 3, classes will be held,in Finnish, at the same time as the project. The grade will based on the exam and project.

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

CAD

Recommended or required reading:

Course notes (mainly in Finnish); Contemporary articles
References: Chanda, M. & Roy, S. K.: Plastics Technology Handbook, 4th Edition, CRC Press, 2007, (selected parts)-

Assessment methods and criteria:

Final exam. The final grade is based on the combined points from the exam (grade 0.6) and exercises (grade 0.4).
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

prof. Jussi A. Karjalainen

Working life cooperation:

-

Other information:

-

461033A: Finite Element Methods I, 3,5 op

Voimassaolo: 01.08.2007 - 31.07.2021
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Mechanical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Lumijärvi, Jouko Veikko Juhani
Opintokohteen kielet: Finnish
Leikkaavuudet:

461107A	Finite Element Methods I	5.0 op
461014S	Finite Element Methods	5.0 op

Ei opintojaksokuvauksia.

Technical physics, advanced module, optional courses, module size approx 30 cr

A451275: Advanced Module/ Electronics Materials and Components, Technical Physics (obligatory), 22 op

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

Ei opintojaksokuvauksia.

Compulsory

521201S: Research methods of Materials for Electronics, 3,5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Marina Tjunina
Opintokohteen kielet: English

ECTS Credits:

3,5

Language of instruction:

In English.

Timing:

Periods 4 -6

Learning outcomes:

Student will be able to describe experimental methods of materials characterization, to explain their physical principles and limitations, and meaning of measurement results. Student will be able to properly select and apply the characterization methods.

Contents:

Optical methods (microscopy, interferometry, ellipsometry; absorption, photoelectron, Raman, and infrared spectroscopies). X-ray methods (scattering, diffraction, fluorescence, spectroscopies). Electron microscopies (scanning, transmission, electron diffraction, and spectrosco-pies). Scanning tunneling and atomic force microscopies. Ion-beam methods.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures 20 h/ Exercises as group work 20 h/ Self-study as online work 55 h.

Target group:

Not defined.

Prerequisites and co-requisites:

766326A Atom physics; 766329A Waves and optics; 521104P Introduction to materials physics.

Recommended optional programme components:

None.

Recommended or required reading:

Lectures.

Assessment methods and criteria:

Final written exam.

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

Grading:

Numerical grading 1 – 5.

Person responsible:

Marina Tyunina

Working life cooperation:

Yes. Demonstrations at Center of Microscopy and Nanotechnology.

Other information:

The course gives an overview of experimental methods of characterization of morphology, crystal, surface, and electronic structure, atomic composition, and basic properties of materials. Emphasis is on materials and nanostructures for electronics.

763312A: Quantum mechanics I, 10 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763612S	Quantum mechanics I	10.0 op

ECTS Credits:

10 credits

Language of instruction:

English (or Finnish, depending on the participants)

Timing:

3rd autumn

Learning outcomes:

Applications of modern nanotechnology based on quantum mechanics belong to our everyday life. Particles in this micro world are in quantum states classified with quantum numbers and corresponding wave functions. Quantum states and wave functions are solutions of the Schrödinger equation and their eigenvalues are the measurable quantities. After the course student can present basic principles and postulates of quantum mechanics and can solve the Schrödinger equation in one- and three-dimensional problems, which have important applications in condensed matter theory as well as in atomic, nuclear and molecular physics. One of the basic principles of quantum mechanics is the Heisenberg uncertainty principle, which states, for example, that the position and velocity of a particle cannot be measured exactly at the same time. After the course students can derive the uncertainty principle and interpret what happens in a quantum mechanical measurement.

Contents:

The course begins with the introduction of the basic principles and postulates of quantum mechanics, such as the Schrödinger equation. As an example, several one-dimensional problems for scattering and bound states are solved. Special emphasis is put on the symmetry of the system. In three-dimensional problems the symmetry is connected with the angular momentum. The corresponding operators and quantum numbers are derived. As examples the hydrogen atom and harmonic oscillator are solved. The Heisenberg uncertainty relation is presented. An introduction to the periodic table of elements is presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 50 h, 13 exercises (á 3 h), self-study 178 h

Target group:

Compulsory for theoretical physicists and physicists. Also for the other students of the University of Oulu.

Prerequisites and co-requisites:

Atomic physics (766326A) and knowledge of differential equations.

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

J. Tuorila: Kvanttimekaniikka I (2013, in Finnish). D. Griffiths: Introduction to Quantum Mechanics (2005).
Course material availability can be checked here.

Assessment methods and criteria:

Two written intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Jani Tuorila

Working life cooperation:

No work placement period

Other information:

https://noppa.oulu.fi/noppa/kurssi/763312A/etusivu

521219S: X-ray Methods, 4,5 op

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

ECTS Credits:

4,5

Language of instruction:

In Finnish. In English if there are more than 5 international students in the class.

Timing:

Spring, periods 4-5

Learning outcomes:

After completing the course, student can explain the general principles of interaction between X-rays and solid matter and can explain the physics underlying behind these phenomena. He or she can explain how X-ray spectroscopy is used for elemental analysis. Also, student can 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. Chemical analysis by X-ray spectroscopy, WDS and EDS. X-ray scattering. X-ray 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 24 h / self-access writing of work report 24 h / self-access learning 28 h.

Target group:

Mandatory in advanced module ”Technical Physics”.

Prerequisites and co-requisites:

Basic BSc physics and mathematics.

Recommended optional programme components:

-

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 unit utilizes a numerical grading scale 1-5.

Person responsible:

Juha Hagberg

Working life cooperation:

-

Other information:

-

521228S: Microsensors, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521072S	Microsensors	5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

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

Contents:

Principles of sensing and sensor physics. Energy conversion forms and sensor signals. Processing of sensor signals. Microsensor fabrication by three different microtechnology; monolitchic (silicon technology), thin-film technology, and thick film technology. Advanced fabrication methods. Main types of thermal, radiation, mechanical, magnetic, and (bio) chemical sensors. Sensor performance. Smart sensors and microsensor array devices.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h, calculation exercises 8h.

Target group:

Major students.

Prerequisites and co-requisites:

Introduction to Material Physics, Introduction to Microfabrication Techniques.

Recommended optional programme components:

Introduction to Microfabrication Techniques.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1996

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5.

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

Advanced module, technical physics, optional courses, module size approx. 30 cr

A451276: Advanced Module/ Electronics Materials and Components, Technical Physics (optional), 8 op

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

Ei opintojaksokuvauksia.

Module total appr. 30 cr

031022P: Numerical Analysis, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Marko Huhtanen
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Spring semester, periods 4-5

Learning outcomes:

The student recognizes what numerical solution methods can be used to solve some spesific mathematical problems, can perform the required steps in the numerical algorithm and is able to perform the error analysis.

Contents:

Numerical linear algebra. Numerical methods for systems of equations, Basics of the approximation theory. Numerical quadratures. Numerical methods for ordinary and partial differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 44 h / Group work 22 h.

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

J. Douglas Faires and Richar L. Burden, Numerical methods; Alfio Quarteroni, Riccardo Sacco, Fausto Saleri, Numerical mathematics

Assessment methods and criteria:

Intermediate exams or a final exam.

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Marko Huhtanen

Working life cooperation:

-

Other information:

-

761668S: Computational physics and chemistry, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

6 credits

Language of instruction:

English

Timing:

Not lectured every year.

Learning outcomes:

After successful completion, student has a basic knowledge of computer simulation methods to study the microscopic systems (atoms, molecules and solids) in physics, chemistry, bio- and materials sciences. Student understands the application possibilities and restrictions of the methods and has versatile capabilities to use them in solving of various problems.

Contents:

The course builds a foundation for further studies of computational physics and chemistry and the use of these methods in research. Subjects: electronic structure of finite systems, solid-state electronic structure, Monte Carlo and molecular dynamics simulations, quantum simulations, least-squares method, neural networks and genetic algorithms.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 35 h, 4 practical works, self-study 125 h

Target group:

Advanced undergraduate students in physics, chemistry and materials sciences and graduate students.

Prerequisites and co-requisites:

Atomic Physics 1 (766326A), Thermophysics (766328A), and Molecular Quantum Mechanics (761661S) courses or comparable knowledge. Basic programming and computer abilities.

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Lecture notes based on: Leach: Molecular Modelling: Principles and Applications, 2nd ed. (Prentice Hall, 2001). Jensen: Introduction to Computational Chemistry (Wiley, 1999). Allen and Tildesley: Computer Simulation of Liquids (Oxford, 1987) .Atkins and Friedman: Molecular Quantum Mechanics, 4th ed. (Oxford, 2005). Thijssen: Computational Physics (Cambridge, 1999). Giordano and Nakanishi: Computational Physics, 2nd ed. (Pearson, 2006). Pang: An Introduction to Computational Physics, 2nd ed. (Cambridge, 2006). Hill, Subramanian, and Maiti: Molecular Modeling Techniques in Material Sciences, (CRC, Taylor&Francis, 2005).
Course material availability can be checked here.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Perttu Lantto

Working life cooperation:

No work placement period

Other information:

https://wiki.oulu.fi/display/761668S/

763628S: Condensed matter physics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763636S	Condensed matter physics	5.0 op

ECTS Credits:

10 credits

Language of instruction:

English

Timing:

3th -5th year

Learning outcomes:

To learn to apply quantum mechanics and statistical physics to solid state, in particular to crystal structure and scattering from it, electronic structure and transport properties in noninteracting electron model, interacting electron gas and lattice vibrations.

Contents:

Modern technology is largely based on the understanding of condensed matter. Condensed matter has many interesting physical properties that are consequences of large number of particles and their interactions. The course starts with crystal structure of solids and its studies by scattering experiments. Surfaces and more complicated structures are discussed briefly. The electronic structure is first studied using free electron picture. The effect of crystal lattice is studied as small perturbation as well as starting from localized atomic states. The Coulomb interaction between electrons is studied using Hartree-Fock equations. Lattice vibrations are studied using simple models and the lattice specific heat is calculated. Electron dynamics is studied using semiclassical equations. Electrical and thermal conduction is solved using Boltzmann equation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 50 h, 12 exercise sessions (24 h), self-study 193 h

Target group:

Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.

Prerequisites and co-requisites:

763333A Solid state physics, 763312A Quantum mechanics I, 766328A Thermophysics

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Michael P. Marder: Condensed Matter Physics. N.W. Ashcroft & N.D. Mermin: Solid state Physics. Course material availability can be checked here.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Jani Tuorila

Working life cooperation:

No work placement period

Other information:

https://wiki.oulu.fi/display/763628S/

464061A: Techniques of Creative Working, 3 op

Voimassaolo: - 31.07.2021
Opiskelumuoto: Intermediate Studies
Laji: Course

Vastuuyksikkö: Field of Mechanical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Niskanen, Juhani
Opintokohteen kielet: Finnish
Leikkaavuudet:

464104A Product innovations 5.0 op

Ei opintojaksokuvauksia.

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

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

Ei opintojaksokuvauksia.

Module of the option, all compulsory

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: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

All compulsory

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
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 semester, periods 1-2
Learning outcomes:

On completion of the study module students 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, analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits, and estimate and minimize the effects of noise on these. They should also be able to explain the terminology used with DA and AD conversion and converters and to analyze and outline their main architectural principles and also to evaluate their characteristics.

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:

-

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:

-

Other information:

-

521124S: Sensors and Measuring Techniques, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Myllylä, Risto Antero, Matti Kinnunen
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish. Materials also available in English.

Timing:

Periods 1-2.

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:

Lectures and exercises.

Learning activities and teaching methods:

Lectures and exercises. The course is passed by a final exam.

Target group:

1st year MSc students.

Prerequisites and co-requisites:

Not defined.

Recommended optional programme components:

Not defined.

Recommended or required reading:

H. N. Norton: Handbook of Transducers, Prentice Hall P T R, 1989 or 2002; lecture notes (in Finnish); exercise notes (also in English)

Assessment methods and criteria:

The course is passed by a final exam.

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

Grading:

1-5

Person responsible:

Matti Kinnunen

Working life cooperation:

None.

Other information:

None.

521450S: Optoelectronics, 4 op

Voimassaolo: - 31.07.2014
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

4

Language of instruction:

Finnish.

Timing:

Period 5-6

Learning outcomes:

On completion of the study module students should be able to explain the principles of operation of photo conductors (optic fibers), semiconductor light sources and photo detectors used in optoelectronic measurements and telecommunications, paying due attention to factors affecting their performance. They should also be able to outline circuit-level structures for optical transmitter circuits and photo detector preamplifiers and to compare them in terms of their main performance parameters. They should also be reasonably able to use the main principles of signal processing principles that are typically used in optoelectronic measurement applications.

Contents:

Wave/particle dualism of optical radiation, optical waveguides and their properties, sources of radiation (radiation of black body, LED- and laser structures), photo detectors (photo conductive detector, photo multiplier, PIN- and AP-diodes, position sensitive detectors), light source modulation, preamplifiers and their bandwidth/stability/noise analysis, signal processing concepts used in optoelectronics.

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:

-

Prerequisites and co-requisites:

Principles of semiconductor devices.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes, S. Kasap: Optoelectronics and Photonics, Principles and Practices, Prentice Hall 2001. J. Wilson, J. Hawkes, “Optoelectronics, an introduction”, Prentice Hall, 3ed, ISBN 0-13-103961-X.

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:

-

Other information:

-

521335S: Radio Engineering 1, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521326S Radio Engineering 5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

After completing the course the student recognizes different kind of impedance matching methods and can design the impedance matching network using discrete components and microstrip lines. She/he can also explain factors, which are limiting the bandwidth of impedance matching networks. The student can design the impedance matching for a low noise amplifier. 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. The student can explain the principle of a single ended, balanced and double balanced mixer and the advantages and the disadvantages of these mixers. She/he can design a power divider and a directional coupler. The student can also explain the principle of an automatic gain control (AGC). The student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Impedance matching using discrete 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 30 h, exercises 24 h and the compulsory RF design work with ADS simulation software (18 h).

Target group:

1 st year M.Sc. and WCE 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, 3rd edition, John Wiley & Sons, Inc., 2005. 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

Working life cooperation:

-

Other information:

After having passed the course the student is familiar with the basic theory and techniques of designing radio frequency circuits used in radio transceivers.

521216S: Microelectronics Packaging Technology and Reliability, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

7

Language of instruction:

In Finnish.

Timing:

4-6

Learning outcomes:

Upon completing the course the student can explain what is meant by microjoining techniques and what are the pros and cons of these. The student can tell what different kind of materials, and why, are used in IC packaging technology. He can describe the module techniques and the basics for wafer level packaging. He can explain how the electronic packaging technologies have been developed, since the invention of the transistor, up to date and how this development will continue in the future. In addition, the student can explain, study and predict the failure mechanisms of an electronic device. He can apply environmental testing and statistical methods to predict the reliability.

Contents:

Trends of packaging technologies. Microjoining from IC to substrate: flip-chip, wirebond, and TAB techniques. Metal, ceramic, and plastic package structure and manufacturing. Multi-chip-modules (MCM). Chip scale packages (CPS) and wafer level packaging (WLP). Failure mechanisms of electronic components and packaging methods and analyzing. Methods of environmental testing, screening, and quality control.

Mode of delivery:

Face to face teaching

Learning activities and teaching methods:

Lectures 28h / group work 30h / working with research machines 12h / self-study 119h.

Target group:

Major students.

Prerequisites and co-requisites:

Recommended Introduction to Microelectronics and Micromechanics

Recommended optional programme components:

Advanced course Micromodules

Recommended or required reading:

Rao R. Tummala(edit): Fundamentals of microsystems packaging, New York, McGraw-Hill, 2001. Parts of Ken Gilleo: Area Array Packaging Handbook: Manufacturing and Assembly, McGraw-Hill, 2002 and J.J. Licari, L.R. Enlow: Hybrid Microcircuit Technology Handbook: Materials, processes, Design, Testing and Production, Noyes Publications, 1998. William D. Brown (edit.): Advanced Electronic Packaging. With Emphasis on Multichip Modules. IEEE, Inc., 1999, chapters 11 and 16. Patrick D.T. O'Connor: Practical Reliability Engineering, John Wiley&Sons, 2002 chapters 8 and 9.

Assessment methods and criteria:

This course unit utilizes continuous assessment. The course can also be completed with the final exam. The assessment of the course unit is based on the learning outcomes of the course unit. Passed exam and practice work are needed for the course completion.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Kinnunen, Jari Hannu

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

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. The student also knows the operating principles of transfer lines, antennas and filters and of their design. 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 different measurement techniques in different measurement situations. In addition 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

Learning activities and teaching methods:

Lectures 24h/calculation exercises 12h/laboratory exercises 12h/design exercises 12h

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:

-

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 and design exercises
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:

Jari Hannu and Matti Kinnunen

Working life cooperation:

-

Other information:

Kurssissa käydään läpi tavallisimmat RF-komponentit ja -mittausmenetelmät, jotka ovat käytössä RF- ja mikroaaltoalueilla. Kurssi antaa valmiudet komponenttien toiminnan ja valintaperusteiden ymmärtämiseen sekä sähkömagneettisten kenttien ja suurtaajuuspiirien mittauksiin.

521110S: Measuring and Testing Systems, 6 op

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tuomas Happonen, Juha Saarela

Opintokohteen kielet: Finnish

Leikkaavuudet:

521096S	Measurement Systems	5.0 op

Language of instruction:

Finnish. In English if there are more than 2 foreign students in the class.

Timing:

Period 4.

Learning outcomes:

The goal of this course is to teach measurement and testing systems generally. Constructions, connections, software, data acquisition as well as widely used interfaces are included in this course. Also methods to analyze measured signals especially to take care of eliminating disturbances are considered.
Learning outcomes: After completing the course the student is able to explain the principles of measuring and testing systems, and is able to compare the properties and performance of different communication techniques used in measurement systems. The student is able to design an application which controls a measurement system and stores the measurement data. Additionally, the student is able to realize essential multisensor systems and large systems which utilize data networks, and can give examples of practical measurement systems found in the industry and in medicine.

Contents:

Basics of measurement and testing systems, data transmission in measurement systems, software and data acquisition, design of measurement system, examples of measurement systems in industry and medicine, wide measurement systems using data networks, test system applications.

Learning activities and teaching methods:

Lectures and laboratory exercises. Final exam and passed laboratory exercises.

Recommended optional programme components:

Electronic Measurement Techniques .

Recommended or required reading:

Handout. Lab-View material

521238S: Optoelectronic Measurements, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Anssi Mäkynen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521094S Optoelectronic Sensors of Future 5.0 op

ECTS Credits:

4

Language of instruction:

Finnish. English in case of book examinations.

Timing:

Period 6.

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 oral report.

Contents:

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

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

The course includes 25 h lectures, 10 h exercises and 74 h independent work.

Target group:

2nd year electrical engineering MSc students

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

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:

Anssi Mäkynen

Working life cooperation:

-

Other information:

-

Advanced module, Photonics and printed electronics, compulsory courses

A451279: Advanced Module/ Photonics and Measurement Technology, Photonics and Printed Electronics (obligatory), 15 op

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

Ei opintojaksokuvauksia.

Compulsory

521217S: Printed Electronics, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Tapio Fabritius
Opintokohteen kielet: Finnish
Leikkaavuudet:

521089S Printed Electronics 5.0 op

ECTS Credits:

4

Language of instruction:

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

Timing:

4-6

Learning outcomes:

After passing this course, student understands the basics of the materials and printing/deposition methods used in printed electronics. In addition, he/she understands operational principles passive /active components and the utilized in fabrication techniques of optoelectronic components

Contents:

Materials; conductive and semiconductive polymers, conductive particular inks, insulator materials, photo active polymers. Printing methods: gravure, flexo, screen, inkjet and nanoimprinting. Components; Organic solar cells, organic light emitting diodes, organic transistors, passive components

Mode of delivery:

Classroom.

Learning activities and teaching methods:

Lectures 24 h, supervised exercises 6 h and self-study 70 h.

Target group:

Course is mandatory in some advanced studies of module of electrical engineering

Prerequisites and co-requisites:

Not defined.

Recommended optional programme components:

None.

Recommended or required reading:

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

Assessment methods and criteria:

Exam and accepted exercises (e.g. seminar presentation)
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Tapio Fabritius

Working life cooperation:

-

Other information:

-

521223S: Electronic and Optoelectronic Materials, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

Upon completing the course the student can explain the behavior of metals and insulators in steady and alternating fields, basics of magnetic materials and concepts of magnetism, properties and applications of functional electroceramics and optoelectronic materials. Student can also evaluate the usability of different materials in electronics, optoelectronics, and photonics applications.

Contents:

The course treats with conducting and insulating materials used in electronic circuit components, optoelectronics components, and transducers. Magnetic materials (soft and hard) and their use, for example, in information storages. Functional electroceramic materials and their applications. Materials for optoelectronics and photonics devices

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h, calculation exercises 20h, and three laboratory exercises 6h

Target group:

Major students.

Prerequisites and co-requisites:

Introduction to Material Physics, Principles of Semiconductor Devices

Recommended optional programme components:

Introduction to Microfabrication Techniques

Recommended or required reading:

S.O. Kasap: Principles of Electronic Materials and Devices, 3 rd edition, McGraw-Hill, 2006. (Chapters 2, 7, 8, 9)

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5. The course rank is an average weighted by 2 and 1 of exam and laboratory exercises, respectively

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521090S: Technical Optics, 6 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Anssi Mäkynen
Opintokohteen kielet: Finnish
Leikkaavuudet:

521091S	Technical Optics	5.0 op

ECTS Credits:

6

Language of instruction:

Finnish. English in case of book examinations.

Timing:

Periods 1-3.

Learning outcomes:

Upon completion of the course, the student is capable of explaining the basic facts of geometrical and physical optics and explaining the operating principles of simple optical components and instruments as well as the factors affecting their performance. He is able to describe an optical system as a principal point representation, is able to trace the most important paraxial rays through the system and estimate the radiometric properties and resolving power of an ideal optical system. He 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. The student 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 should approach a given design task. He 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 30 h lectures, 10 h exercises and design exercises introducing to optical design tools 20 h.

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

Lecture handouts. 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:

-

Other information:

-

dvanced module, photonics and printed electronics, optional courses, module size approx. 30 cr

A451280: Advanced Module/ Photonics and Measurement Techniques, Photonics and Printed Electronics (optional), 15 op

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

Ei opintojaksokuvauksia.

Alternative

521201S: Research methods of Materials for Electronics, 3,5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Marina Tjunina

Opintokohteen kielet: English

ECTS Credits:

3,5

Language of instruction:

In English.

Timing:

Periods 4 -6

Learning outcomes:

Student will be able to describe experimental methods of materials characterization, to explain their physical principles and limitations, and meaning of measurement results. Student will be able to properly select and apply the characterization methods.

Contents:

Optical methods (microscopy, interferometry, ellipsometry; absorption, photoelectron, Raman, and infrared spectroscopies). X-ray methods (scattering, diffraction, fluorescence, spectroscopies). Electron microscopies (scanning, transmission, electron diffraction, and spectrosco-pies). Scanning tunneling and atomic force microscopies. Ion-beam methods.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures 20 h/ Exercises as group work 20 h/ Self-study as online work 55 h.

Target group:

Not defined.

Prerequisites and co-requisites:

766326A Atom physics; 766329A Waves and optics; 521104P Introduction to materials physics.

Recommended optional programme components:

None.

Recommended or required reading:

Lectures.

Assessment methods and criteria:

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

Grading:

Numerical grading 1 – 5.

Person responsible:

Marina Tyunina

Working life cooperation:

Yes. Demonstrations at Center of Microscopy and Nanotechnology.

Other information:

The course gives an overview of experimental methods of characterization of morphology, crystal, surface, and electronic structure, atomic composition, and basic properties of materials. Emphasis is on materials and nanostructures for electronics.

521228S: Microsensors, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521072S Microsensors 5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

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

Contents:

Principles of sensing and sensor physics. Energy conversion forms and sensor signals. Processing of sensor signals. Microsensor fabrication by three different microtechnology; monolitchic (silicon technology), thin-film technology, and thick film technology. Advanced fabrication methods. Main types of thermal, radiation, mechanical, magnetic, and (bio) chemical sensors. Sensor performance. Smart sensors and microsensor array devices.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h, calculation exercises 8h.

Target group:

Major students.

Prerequisites and co-requisites:

Introduction to Material Physics, Introduction to Microfabrication Techniques.

Recommended optional programme components:

Introduction to Microfabrication Techniques.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1996

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5.

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521107S: Biomedical Instrumentation, 6 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521093S Biomedical Instrumentation 5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

5-6

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 54 h and self-study 100 h.

Target group:

Students interested in biomedical measurements.

Prerequisites and co-requisites:

None

Recommended optional programme components:

Course replaces course 521126S Biomedical measurements

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:

None

Other information:

None.

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:

5.0

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

On completion of the study module a student 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. The student is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

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:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

Handout. 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:

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:

-

Other information:

-

521172S: EMC Design, 4 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

521115S EMC Design 5.0 op

ECTS Credits:

4

Language of instruction:

English.

Timing:

Period 6.

Learning outcomes:

After completing the course the student is able to name common EMC standards, and is able to use EMC testing equipment and methods. The student can explain the noise coupling mechanisms, and is able to use good design practices related to analogue and digital electronics design, grounding, cabling, filtering and 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:

Lectures 24h/Exercises 12h/Laboratory work 12h.

Target group:

-

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:

Electronics Design I, Digital Techniques I, Electronic Measurement Techniques, Measuring and Testing Systems, RF Components and Measurements.

Recommended or required reading:

Tim Williams: EMC for Product Designers, 4th edition, Oxford: Newnes, 2007. Lecture slides.

Assessment methods and criteria:

Final exam and passed laboratory 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:

Hannu Sorvoja
Teemu Myllylä

Working life cooperation:

-

Other information:

-

521095S: Advanced Course of Printed Electronics, 3 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Tapio Fabritius
Opintokohteen kielet: Finnish
Leikkaavuudet:

521089S Printed Electronics 5.0 op

ECTS Credits:

3

Language of instruction:

Finnish/English

Timing:

2

Learning outcomes:

After passing this course, student understands physical principle of organic photovoltaic (OPV) and organic light emetting diodes (OLED) and the utilized different component structures. In addition, he /she understands the materials of OPV and OLED layer structure and utilized fabrications methods.

Contents:

OPV- and OLED-structures, materials and farication methods

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Intensive course.

Target group:

Course is optional in some advanced modules in electrical engineering

Prerequisites and co-requisites:

Printed electronics.

Recommended optional programme components:

-

Recommended or required reading:

Lecture handout.

Assessment methods and criteria:

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

Grading:

Numeric scale 1-5.

Person responsible:

Tapio Fabritius

Working life cooperation:

-

Other information:

-

463065A: Manufacturing of Plastics Products, 3,5 op

Voimassaolo: - 31.07.2021

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mechanical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jouko Heikkala

Opintokohteen kielet: Finnish

Leikkaavuudet:

463105A Casting techniques 8.0 op

ECTS Credits:

3,5 ects cr

Language of instruction:

Finnish

Timing:

Lectures and exercises during periods 2.-3.

Learning outcomes:

The aim of this course is to give the student a basic knowledge of the manufacturing of plastic parts and their production tooling.
Course outcomes: After the course, the student will know the basic terminology of plastics processing as well as how to utilize computer-aided methods and systems with different manufacturing processes in machine shops. The student can describe the main features, capabilities and limitations of different methods and machinery in plastic processing. Additionally, the student can apply his/her knowledge to designing production-friendly plastics products and their tooling.

Contents:

Properties of common plastic materials; Processes and machinery in manufacturing of plastic parts; Design of plastics parts and their tooling; Assembly of plastic components; Computer-aided tools for designing plastics parts and their manufacturing processes
In the project section of the course, the student’s knowledge is applied to solving practical problems in manufacturing.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

The course consists of classes as well as a group project. During periods 2 and 3, classes will be held,in Finnish, at the same time as the project. The grade will based on the exam and project.

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

CAD

Recommended or required reading:

Course notes (mainly in Finnish); Contemporary articles
References: Chanda, M. & Roy, S. K.: Plastics Technology Handbook, 4th Edition, CRC Press, 2007, (selected parts)-

Assessment methods and criteria:

Final exam. The final grade is based on the combined points from the exam (grade 0.6) and exercises (grade 0.4).
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

prof. Jussi A. Karjalainen

Working life cooperation:

-

Other information:

-

Advanced module, measurement and testing technology, module total approx. 30 cr.

A451281: Advanced Module/Photonics and Measurement Techniques, Measurement and Testing Techniques (obligatory), 14 op

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

Ei opintojaksokuvauksia.

Compulsory

521114S: Wireless Measurements, 4 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Esko Alasaarela
Opintokohteen kielet: Finnish
Leikkaavuudet:

521097S Wireless Measurements 5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish or in English if two or more foreign students participate.

Timing:

Period 4

Learning outcomes:

Upon completing the course, the student can apply wireless technologies in industrial, traffic, environmental and healthcare measurements. He/she can tell and argument the benefits and challenges of using wireless measurement solutions and is able to apply the most important standards in his/her engineering work. In addition, he/she can use a representing set of industrial and scientific applications of wireless measurements to develop his/her own solutions.

Contents:

Basics of wireless measurement technologies and standards, wireless sensors and sensor networks, wireless industrial measurement and testing 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:

25 h lectures and seminars. The course is lectured intensively within one period. At the end of the period the students prepare presentations about contemporary themes selected by them or proposed by the teacher and give 15-20 minutes presentation to other students in the seminars.

Target group:

Last phase students

Prerequisites and co-requisites:

Basics of measurement technology and electronic measurement technology or equivalent basic knowledge.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes (in English) prepared by the teacher and contemporary seminar presentations with their source material.

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:

1-5

Person responsible:

Esko Alasaarela

Working life cooperation:

-

Other information:

-

521173S: Mixed-signal Testing, 4 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Kinnunen
Opintokohteen kielet: Finnish

ECTS Credits:

4

Language of instruction:

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

Timing:

Period 5

Learning outcomes:

After completing the course the student can compare different testing techniques of analogue and digital electronics, which have been implemented using either embedded testing methods or external automatic testing equipment. Additionally, the student is able to analyze tests made using an automatic test instrument, compare different test interfaces and data busses, and use principles of design of a high-quality printed test circuit board.

Contents:

Design for testability, DC- and parametric measurements, dynamic tests, constructions of testers, test signal generation and measurement, mixed-signal test buses, converter tests, data analysis, diagnostics, DSP-based tests, embedded testing.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h/Exercises 12h, independent work 75h.

Target group:

Course is compulsory to elecrical engineering students in measuring and testing techniques module.

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the following courses prior to enrolling for the course unit: Electronics Design I, Measuring and Testing systems

Recommended optional programme components:

-

Recommended or required reading:

M. Burns, G. W. Roberts: An Introduction to Mixed-Signal IC Test and Measurement. Lecture slides.

Assessment methods and criteria:

Final 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:

Matti Kinnunen

Working life cooperation:

-

Other information:

-

521172S: EMC Design, 4 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

521115S	EMC Design	5.0 op

ECTS Credits:

4

Language of instruction:

English.

Timing:

Period 6.

Learning outcomes:

After completing the course the student is able to name common EMC standards, and is able to use EMC testing equipment and methods. The student can explain the noise coupling mechanisms, and is able to use good design practices related to analogue and digital electronics design, grounding, cabling, filtering and 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:

Lectures 24h/Exercises 12h/Laboratory work 12h.

Target group:

-

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:

Electronics Design I, Digital Techniques I, Electronic Measurement Techniques, Measuring and Testing Systems, RF Components and Measurements.

Recommended or required reading:

Tim Williams: EMC for Product Designers, 4th edition, Oxford: Newnes, 2007. Lecture slides.

Assessment methods and criteria:

Final exam and passed laboratory 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:

Hannu Sorvoja
Teemu Myllylä

Working life cooperation:

-

Other information:

-

Advance module, measurement and testing technology, optional courses, module total approx 30 cr

A451282: Advanced Module/Photonics and Measurement Techniques, Measurement and Testing Techniques (optional), 16 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Alternative

521228S: Microsensors, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

521072S Microsensors 5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

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

Contents:

Principles of sensing and sensor physics. Energy conversion forms and sensor signals. Processing of sensor signals. Microsensor fabrication by three different microtechnology; monolitchic (silicon technology), thin-film technology, and thick film technology. Advanced fabrication methods. Main types of thermal, radiation, mechanical, magnetic, and (bio) chemical sensors. Sensor performance. Smart sensors and microsensor array devices.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24h, calculation exercises 8h.

Target group:

Major students.

Prerequisites and co-requisites:

Introduction to Material Physics, Introduction to Microfabrication Techniques.

Recommended optional programme components:

Introduction to Microfabrication Techniques.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1996

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading 1-5.

Person responsible:

Professor Jyrki Lappalainen

Working life cooperation:

-

Other information:

-

521107S: Biomedical Instrumentation, 6 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521093S Biomedical Instrumentation 5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

5-6

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 54 h and self-study 100 h.

Target group:

Students interested in biomedical measurements.

Prerequisites and co-requisites:

None

Recommended optional programme components:

Course replaces course 521126S Biomedical measurements

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:

None

Other information:

None.

521405A: Electronic System Design, 5 op

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

ECTS Credits:

5.0

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

On completion of the study module a student 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. The student is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

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:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

Handout. 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:

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:

-

Other information:

-

521441S: Electronics Design and Construction Exercise, 6,5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Määttä
Opintokohteen kielet: Finnish
Leikkaavuudet:

521300S	Electronics Design and Construction Exercise	6.0 op

ECTS Credits:

6,5

Language of instruction:

Finnish, English

Timing:

Period 1-6.

Learning outcomes:

On completion of the study module a student 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. He or she is able to use independently without any help professional methods, software packages, measurement devices and tools.

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.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Independent design and construction work 180h

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

Analogue Electronics I-II, Digital Techniques I-II, Electronic System Design, Filter Theory, Digital Filters, Computer Engineering, Embedded Systems

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:

-

Other information:

-

521201S: Research methods of Materials for Electronics, 3,5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Marina Tjunina
Opintokohteen kielet: English

ECTS Credits:

3,5

Language of instruction:

In English.

Timing:

Periods 4 -6

Learning outcomes:

Student will be able to describe experimental methods of materials characterization, to explain their physical principles and limitations, and meaning of measurement results. Student will be able to properly select and apply the characterization methods.

Contents:

Optical methods (microscopy, interferometry, ellipsometry; absorption, photoelectron, Raman, and infrared spectroscopies). X-ray methods (scattering, diffraction, fluorescence, spectroscopies). Electron microscopies (scanning, transmission, electron diffraction, and spectrosco-pies). Scanning tunneling and atomic force microscopies. Ion-beam methods.

Mode of delivery:

Blended teaching

Learning activities and teaching methods:

Lectures 20 h/ Exercises as group work 20 h/ Self-study as online work 55 h.

Target group:

Not defined.

Prerequisites and co-requisites:

766326A Atom physics; 766329A Waves and optics; 521104P Introduction to materials physics.

Recommended optional programme components:

None.

Recommended or required reading:

Lectures.

Assessment methods and criteria:

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

Grading:

Numerical grading 1 – 5.

Person responsible:

Marina Tyunina

Working life cooperation:

Yes. Demonstrations at Center of Microscopy and Nanotechnology.

Other information:

The course gives an overview of experimental methods of characterization of morphology, crystal, surface, and electronic structure, atomic composition, and basic properties of materials. Emphasis is on materials and nanostructures for electronics.

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

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

Ei opintojaksokuvauksia.

Advanced module communication networks, compulsory courses

A451283: Advanced Module/ Telecommunication Engineering, Communication Networks (obligatory), 24 op

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

Ei opintojaksokuvauksia.

Compulsory courses

521377S: Communications Networks II, 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Savo Glisic
Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

Upon completing the required coursework, the student is able to construct simple theoretical queuing theory models and analyze the simulation results of these models. The student achieves skills to explain simple Markovian birth-death process and apply that model in queuing systems. The course gives skills for the student to describe functionalities of a communication network with game theoretic models. The student knows the decomposition methods of network utility function and is capable of using that knowledge for network optimization.

Contents:

Introduction to concepts in queuing theory, birth-death process, queuing systems and their measures of effectiveness, Little's result, blocking in queuing systems, open and closed (Jackson) queuing networks, advanced routing in data networks, multiple access techniques, network information theory, cognitive networks.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

1 st year M.Sc. and WCE students.

Prerequisites and co-requisites:

Communication Networks I

Recommended optional programme components:

-

Recommended or required reading:

Parts from S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies, 2009, S. Glisic: Advanced Wireless Communications: 4G Cognitive and Cooperative Technologies, 2007.

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:

Savo Glisic

Working life cooperation:

-

Other information:

Objective: 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 development of analytical tools. The descriptive material is used to illustrate the underlying concepts, and the analytical material is used to generate a deeper and more precise understanding of the concepts. The course presents the basic principles of queuing theory giving mathematical tools to apply the theory to practical communication systems.

Advanced module communication networks, optional courses. module total approx. 30 cr.

A451284: Advanced Module/ Telecommunication Engineering, Communication Networks (optional), 6 op

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

Ei opintojaksokuvauksia.

Optional courses. module total appr. 30 cr

521317S: Wireless Communications II, 8 op

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

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

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 setting as well as in multi-user uplink and downlink. 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. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

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:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

In addition to the course Wireless Communications II, 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:

Wiil be replaced by 521317S Wireless Communications II. Objective: Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

521266S: Distributed Systems, 6 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Ojala, Timo Kullervo

Opintokohteen kielet: English

Leikkaavuudet:

521290S	Distributed Systems	5.0 op

Language of instruction:

In English.

Timing:

Spring, periods 4-5.

Learning outcomes:

Upon completing the course the student is able to explain the key principles of distributed systems, apply them in evaluating the major design paradigms used in implementing distributed systems, solve distributed systems related problems, and design and implement a small distributed system.

Contents:

Architectures, processes, com-munication, naming, synchronization, consistency and replication, fault tolerance, security, distributed object-based systems, distributed file systems, distributed web-based systems, distributed coordination-based systems.

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

Lectures 30 h, exercises 26 h, project work 50 h, self-study 54 h. Project work is completed as 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:

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

Recommended or required reading:

Required literature: Andrew S. Tanenbaum and Maarten van Steen, Distributed Systems – Principles and Paradigms, Second Edition, Prentice Hall, 2007, ISBN 978-0132392273, 704 pages.

Assessment methods and criteria:

The course uses continuous assessment so that there are 3 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:

Professor Timo Ojala

Working life cooperation:

None.

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Latva-aho

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

After completing the course the student can prepare a presentation of predetermined length of her /his thesis and have experience on presenting the topic. In addition, she/he has experience on evaluating other students' presentations and has a general view of completed diploma theses.

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

Grading:

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

Person responsible:

Matti Latva-aho

Working life cooperation:

-

Other information:

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.

521387S: Telecommunication Engineering Project, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Antti-Heikki Tölli

Opintokohteen kielet: Finnish

Leikkaavuudet:

521322S	Telecommunication Engineering Project	5.0 op

ECTS Credits:

4

Language of instruction:

English/Finnish

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

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

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work

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:

1 st and 2 nd 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:

-

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:

Work report is marked with the scale 1-5.

Person responsible:

Markus Berg / Antti Tölli

Working life cooperation:

-

Other information:

-

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course, the student can define what the radio channel is and is able to distinguish it into modellable parts. He/she is capable to adopt radio wave propagation mechanisms: free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. The student can also describe how the radiation properties of different kind of antennas and antenna arrays affect the characteristics, quality and capacity of a radio channel. In addition, the student can apply physical and empirical models of path loss, slow fading (shadowing), narrowband or wideband fast fading and noise in order to calculate the link budget, power delay profile and other characteristics of a radio link. He /she can analyze which are the dominating propagation mechanisms in a fixed terrestrial, ionospheric and satellite links, outdoor and indoor mobile communications, MIMO (multiple-input-multiple output) communications and ultra wideband communications. Moreover, he/she is able to calculate the effects of the dominating propagation mechanisms on different kind of radio channels. He/she can summarize how to overcome the radio channel impairments and how to measure the properties of different radio channels.

Contents:

Radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radiowave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Effects of antennas on the radio channel. Principles of the radio channel modeling. Noise calculations. Radiowave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modeling for outdoor mobile systems. Radiowave 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. Mitigation methods of propagation phenomena. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 26 h and exercises 20 h

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007. Curt A. Levis, Joel T. Johnson & Fernando L. Teixeira: Radiowave propagation. Physics and applications. John Wiley & Sons Ltd, 2010. Henry L. Bertoni: Radio propagation for modern wireless systems. Prentice Hall PTR, 2000.

Assessment methods and criteria:

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

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in odd years. Objective: After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial, ionospheric and satellite channels. He/she understands the physics, composition and importance of the propagation models and can apply them in practice to radio communication, radio navigation, radio broadcasting and radar systems.

521260S: Programmable Web Project, 5 op

Voimassaolo: 01.08.2006 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Rautiainen

Opintokohteen kielet: English

Leikkaavuudet:

ay521260S	Programmable Web Project (OPEN UNI)	5.0 op

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Spring, periods 4-6.

Learning outcomes:

Objective: The objective of the course is to supply the student with basic understanding of RESTful Web Services and related technologies.
Learning outcomes: Upon completing the required coursework, the student is able to design and implement different components of a RESTful Web Service including the Web client. The student becomes familiar with basic technologies to store data on the server, serialize data in the Web and to create Web based clients.

Contents:

RESTful Web Services, serialization languages (XML, JSON), data storage, HTML5 and AJAX.

Mode of delivery:

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

Learning activities and teaching methods:

Lectures 4 h, guided laboratory work 10 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 space in the classes.

Prerequisites and co-requisites:

Elementary programming.

Recommended optional programme components:

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

Recommended or required reading:

Will be announced at the first lecture.

Assessment methods and criteria:

This course unit utilizes continuous assessment. The students return each chapter of the project report separately and get from the teachers feedback to each chapter.
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:

Mika Rautiainen

Working life cooperation:

None.

Other information:

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

Advanced module wireless communications, compulsory courses

A451285: Advanced Module/Telecommunication Engineering, Wireless Communications (obligatory), 20 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Module

Laji: Study module

Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory courses

521317S: Wireless Communications II, 8 op

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

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

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 setting as well as in multi-user uplink and downlink. 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. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

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:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

In addition to the course Wireless Communications II, 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:

Wiil be replaced by 521317S Wireless Communications II. Objective: Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

521375S: Radio Engineering II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: English

Leikkaavuudet:

521327S	Design of Tranceivers	6.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student recognizes the blocks of a transceiver and can explain the operating principle of a transceiver. She/he can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them. The student can 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. She/he can explain nonlinear distortion and can design the automatic gain control in the system level. The student can also 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. The student can also explain the principles of frequency synthesis in a transceiver.

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:

Two hours of lectures in a week, 30 h in total. The compulsory design exercise with ADS simulation software, 30 h during periods 5 and 6.

Target group:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from books: A. Luzatto, G. Shirazi: Wireless Transceiver Design, John Wiley & Sons Ltd, 2007 and Walter Tuttlebee: Software Defined Radio.Enabling Technologies, John Wiley & Sons Ltd, 2002.

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

Working life cooperation:

-

Other information:

The aim is to understand the basic theory and techniques of a transceiver system level design. After passing the course the student knows, what should be taken into account when functional blocks of a transceiver are connected so that the performance requirements are achieved.

521377S: Communications Networks II, 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Savo Glisic
Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

Upon completing the required coursework, the student is able to construct simple theoretical queuing theory models and analyze the simulation results of these models. The student achieves skills to explain simple Markovian birth-death process and apply that model in queuing systems. The course gives skills for the student to describe functionalities of a communication network with game theoretic models. The student knows the decomposition methods of network utility function and is capable of using that knowledge for network optimization.

Contents:

Introduction to concepts in queuing theory, birth-death process, queuing systems and their measures of effectiveness, Little's result, blocking in queuing systems, open and closed (Jackson)

queuing networks, advanced routing in data networks, multiple access techniques, network information theory, cognitive networks.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

1 st year M.Sc. and WCE students.

Prerequisites and co-requisites:

Communication Networks I

Recommended optional programme components:

-

Recommended or required reading:

Parts from S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies, 2009, S. Glisic: Advanced Wireless Communications: 4G Cognitive and Cooperative Technologies, 2007.

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:

Savo Glisic

Working life cooperation:

-

Other information:

Objective: 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 development of analytical tools. The descriptive material is used to illustrate the underlying concepts, and the analytical material is used to generate a deeper and more precise understanding of the concepts. The course presents the basic principles of queuing theory giving mathematical tools to apply the theory to practical communication systems.

Advanced module wireless communications, optional courses, module total approx. 30 cr.

A451286: Advanced Module/Telecommunication Engineering, Wireless Communications (optional), 10 op

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

Ei opintojaksokuvauksia.

Optional courses. module total appr. 30 cr

521387S: Telecommunication Engineering Project, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Berg, Antti-Heikki Tölli

Opintokohteen kielet: Finnish

Leikkaavuudet:

521322S Telecommunication Engineering Project 5.0 op

ECTS Credits:

4

Language of instruction:

English/Finnish

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

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

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work

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:

1 st and 2 nd 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:

-

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:

Work report is marked with the scale 1-5.

Person responsible:

Markus Berg / Antti Tölli

Working life cooperation:

-

Other information:

-

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Latva-aho

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

After completing the course the student can prepare a presentation of predetermined length of her /his thesis and have experience on presenting the topic. In addition, she/he has experience on evaluating other students' presentations and has a general view of completed diploma theses.

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

Grading:

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

Person responsible:

Matti Latva-aho

Working life cooperation:

-

Other information:

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.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course, the student can define what the radio channel is and is able to distinguish it into modellable parts. He/she is capable to adopt radio wave propagation mechanisms: free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. The student can also describe how the radiation properties of different kind of antennas and antenna arrays affect the characteristics, quality and capacity of a radio channel. In addition, the student can apply physical and empirical models of path loss, slow fading (shadowing), narrowband or wideband fast fading and noise in order to calculate the link budget, power delay profile and other characteristics of a radio link. He /she can analyze which are the dominating propagation mechanisms in a fixed terrestrial, ionospheric and satellite links, outdoor and indoor mobile communications, MIMO (multiple-input-multiple output) communications and ultra wideband communications. Moreover, he/she is able to calculate the effects of the dominating propagation mechanisms on different kind of radio channels. He/she can summarize how to overcome the radio channel impairments and how to measure the properties of different radio channels.

Contents:

Radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radiowave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Effects of antennas on the radio channel. Principles of the radio channel modeling. Noise calculations. Radiowave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modeling for outdoor mobile systems. Radiowave 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. Mitigation methods of propagation phenomena. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 26 h and exercises 20 h

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007. Curt A. Levis, Joel T. Johnson & Fernando L. Teixeira: Radiowave propagation. Physics and applications. John Wiley & Sons Ltd, 2010. Henry L. Bertoni: Radio propagation for modern wireless systems. Prentice Hall PTR, 2000.

Assessment methods and criteria:

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

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in odd years. Objective: After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial, ionospheric and satellite channels. He/she understands the physics, composition and importance of the propagation models and can apply them in practice to radio communication, radio navigation, radio broadcasting and radar systems.

031022P: Numerical Analysis, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Marko Huhtanen
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Spring semester, periods 4-5

Learning outcomes:

The student recognizes what numerical solution methods can be used to solve some spesific mathematical problems, can perform the required steps in the numerical algorithm and is able to perform the error analysis.

Contents:

Numerical linear algebra. Numerical methods for systems of equations, Basics of the approximation theory. Numerical quadratures. Numerical methods for ordinary and partial differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 44 h / Group work 22 h.

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

J. Douglas Faires and Richar L. Burden, Numerical methods; Alfio Quarteroni, Riccardo Sacco, Fausto Saleri, Numerical mathematics

Assessment methods and criteria:

Intermediate exams or a final exam.

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Marko Huhtanen

Working life cooperation:

-

Other information:

-

Advanced module radi communication signal processing, compulsory courses

A451287: Advanced Module/Telecommunication Engineering, Radio Communication Signal Processing (obligatory), 9 op

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

Ei opintojaksokuvauksia.

Compulsory courses

521360S: Communication Signal Processing II, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Juntti, Markku Johannes
Opintokohteen kielet: English
Leikkaavuudet:

521325S Communication Signal Processing 5.0 op

ECTS Credits:

4

Language of instruction:

English

Timing:

Fall, periods 2-3

Learning outcomes:

After completing the course the student recognizes the blocks of all-digital receiver and can explain the basis for them. She/he can derive the key algorithms of the receiver and perform joint optimization of transmitter and receiver. The student can design the synchronization algorithms of a receiver and the related filtering and sample rate conversions. He/she can derive the performance of the algorithms and methods to compare them. In addition, she/he can utilize and develop algorithms for fading channels.

Contents:

Filter banks, synthesis and performance of synchronization algorithms in AWGN channels, frequency estimation, interpolation in synchronization, synchronization and channel estimation in fading channels, transceiver optimization, the impact of a cyclic prefix or guard interval.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 20 h and exercises 25 h out of which some are Matlab based problems.

Target group:

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

Prerequisites and co-requisites:

Statistical Signal Processing, Wireless Communications I.

Recommended optional programme components:

Recommended: Communication Signal Processing I

Recommended or required reading:

Parts from books: P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, Signal Processing and Optimization for Transceiver Systems, Cambridge University Press, 2010 ISBN 978-0-521-76079-9 and H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998. Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with final examination and by solving homework problems. Grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Markku Juntti

Working life cooperation:

-

Other information:

Objective: Digital communication knowledge is deepened by applying the statistical signal processing techniques to the design and optimization of receiver baseband algorithms. The main goal is to learn the principles which are used to optimize the transmitter and receiver based on communication, information, detection and estimation theories.

521375S: Radio Engineering II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: English

Leikkaavuudet:

521327S	Design of Tranceivers	6.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student recognizes the blocks of a transceiver and can explain the operating principle of a transceiver. She/he can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them. The student can 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. She/he can explain nonlinear distortion and can design the automatic gain control in the system level. The student can also 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. The student can also explain the principles of frequency synthesis in a transceiver.

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:

Two hours of lectures in a week, 30 h in total. The compulsory design exercise with ADS simulation software, 30 h during periods 5 and 6.

Target group:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from books: A. Luzatto, G. Shirazi: Wireless Transceiver Design, John Wiley & Sons Ltd, 2007 and Walter Tuttlebee: Software Defined Radio.Enabling Technologies, John Wiley & Sons Ltd, 2002.

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

Working life cooperation:

-

Other information:

The aim is to understand the basic theory and techniques of a transceiver system level design. After passing the course the student knows, what should be taken into account when functional blocks of a transceiver are connected so that the performance requirements are achieved.

Radio communication signal processing, optional courses, module total approx. 30 cr.

A451288: Advanced Module/Telecommunication Engineering, Radio Communication Signal Processing (optional), 21 op

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

Ei opintojaksokuvauksia.

Optional courses, module total appr. 30 cr

521380S: Antennas, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English
Leikkaavuudet:

521388S Antennas 5.0 op

ECTS Credits:

4

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student can apply antenna terminology and calculate the antenna characteristics of different kind of radio systems. He/she can apply electromagnetic theory to calculate the properties of the fields radiated by wire antennas, micro strip antennas and antenna arrays. The student is also able to design wire antennas, micro strip antennas and antenna arrays for different radio systems. In addition, the student can use electromagnetic simulators to analyze and design antennas.

Contents:

ntroduction to different antenna types. Antenna parameters. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas: infinitesimal dipole, small dipole, finite length dipole, half-wavelength dipole. Antennas near the conducting plane. Loop antennas. Microstrip antennas. Antenna arrays.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory antenna design work with an electromagnetic simulation program (14 h).

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

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 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:

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in even years. Objective: After having passed the course the student knows antenna terminology, understands the role of antennas as a part of different radio systems and is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays. In addition, the student masters the preliminary design of various antenna types and arrays, as well as, knows the feasibility of electromagnetic simulators in the antenna design.

521317S: Wireless Communications II, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti-Heikki Tölli

Opintokohteen kielet: English

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

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 setting as well as in multi-user uplink and downlink. 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. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

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:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

In addition to the course Wireless Communications II, 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:

Wiil be replaced by 521317S Wireless Communications II. Objective: Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
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 semester, periods 1-2

Learning outcomes:

On completion of the study module students 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, analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits, and estimate and minimize the effects of noise on these. They should also be able to explain the terminology used with DA and AD

conversion and converters and to analyze and outline their main architectural principles and also to evaluate their characteristics.

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:

-

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:

-

Other information:

-

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Kinnunen, Jari Hannu
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

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. The student also knows the operating principles of transfer lines, antennas and filters and of their design. 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 different measurement techniques in different measurement situations. In addition 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

Learning activities and teaching methods:

Lectures 24h/calculation exercises 12h/laboratory exercises 12h/design exercises 12h

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:

-

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 and design exercises
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:

Jari Hannu and Matti Kinnunen

Working life cooperation:

-

Other information:

Kurssissa käydään läpi tavallisimmat RF-komponentit ja -mittausmenetelmät, jotka ovat käytössä RF- ja mikroaaltoalueilla. Kurssi antaa valmiudet komponenttien toiminnan ja valintaperusteiden ymmärtämiseen sekä sähkömagneettisten kenttien ja suurtaajuuspiirien mittauksiin.

521404A: Digital Techniques 2, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

After completing this course the student 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.

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:

Finnish BSc students.

Prerequisites and co-requisites:

Digital techniques I.

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

Final exam or term exams, and a design excercise.
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:

-

521445S: Digital Techniques 3, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

ECTS Credits:

6

Language of instruction:

In Finnish.

Timing:

Period 5-6

Learning outcomes:

After completing this course the student 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. The student is also able to use the tools needed in industrial design projects.

Contents:

1. Digital systems design process. 2. System level design and modeling of digital systems. 3. Architecture level synthesis of digital circuits. 3. FPGA circuit design and verification (technology choice, logic synthesis, physical synthesis and timing analysis) 4, ASIC-design and verification (technology choice, logic synthesis, physical synthesis, timing analysis, power analysis, design for testability).

Mode of delivery:

Classroom

Learning activities and teaching methods:

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

Target group:

-

Prerequisites and co-requisites:

Digital techniques I + II

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

Final exam or term exams, and a design excercise
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:

-

521486S: Signal Processing Systems, 4 op

Voimassaolo: - 31.07.2012
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Hannuksela, Jari Samuli
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521485S: DSP-laboratory Work, 3,5 op

Voimassaolo: - 31.07.2012
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Miguel Bordallo Lopez
Opintokohteen kielet: English

Language of instruction:

In English.

Timing:

Period 2-6.

Learning outcomes:

The course concentrates on implementing basic algorithms and functions of digital signal processing using common modern programmable DSP processors.
Learning outcomes: After the course the student is able to use integrated design environments of digital signal processors for implementing and testing algorithms based on floating and fixed point representation.

Contents:

Sampling, quantization noise, signal generation, decimation and interpolation, FIR and IIR filter implementations, FFT and adaptive filter implementations.

Learning activities and teaching methods:

The course is based on a starting lecture and exercises that are done using development boards of modern 32-bit digital signal processors, and the respective software development tools. The course is passed by accepted and documented exercises

Recommended optional programme components:

Digital filters, computer engineering, programming skills.

521387S: Telecommunication Engineering Project, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg, Antti-Heikki Tölli
Opintokohteen kielet: Finnish
Leikkaavuudet:

521322S	Telecommunication Engineering Project	5.0 op

ECTS Credits:

4

Language of instruction:

English/Finnish

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

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

Contents:

Varies depending on the topic.

Mode of delivery:

Independent work

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:

1 st and 2 nd 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:

-

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:

Work report is marked with the scale 1-5.

Person responsible:

Markus Berg / Antti Tölli

Working life cooperation:

-

Other information:

-

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

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Latva-aho
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

After completing the course the student can prepare a presentation of predetermined length of her /his thesis and have experience on presenting the topic. In addition, she/he has experience on evaluating other students' presentations and has a general view of completed diploma theses.

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

Grading:

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

Person responsible:

Matti Latva-aho

Working life cooperation:

-

Other information:

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.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course, the student can define what the radio channel is and is able to distinguish it into modellable parts. He/she is capable to adopt radio wave propagation mechanisms: free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. The student can also describe how the radiation properties of different kind of antennas and antenna arrays affect the characteristics, quality and capacity of a radio channel. In addition, the student can apply physical and empirical models of path loss, slow fading (shadowing), narrowband or wideband fast fading and noise in order to calculate the link budget, power delay profile and other characteristics of a radio link. He /she can analyze which are the dominating propagation mechanisms in a fixed terrestrial, ionospheric and satellite links, outdoor and indoor mobile communications, MIMO (multiple-input-multiple output) communications and ultra wideband communications. Moreover, he/she is able to calculate the effects of the dominating propagation mechanisms on different kind of radio channels. He/she can summarize how to overcome the radio channel impairments and how to measure the properties of different radio channels.

Contents:

Radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radiowave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Effects of antennas on the radio channel. Principles of the radio channel modeling. Noise calculations. Radiowave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modeling for outdoor mobile systems. Radiowave 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. Mitigation methods of propagation phenomena. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 26 h and exercises 20 h

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007. Curt A. Levis, Joel T. Johnson & Fernando L. Teixeira: Radiowave propagation. Physics and applications. John Wiley & Sons Ltd, 2010. Henry L. Bertoni: Radio propagation for modern wireless systems. Prentice Hall PTR, 2000.

Assessment methods and criteria:

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

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in odd years. Objective: After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial, ionospheric and satellite channels. He/she understands the physics, composition and importance of the propagation models and can apply them in practice to radio communication, radio navigation, radio broadcasting and radar systems.

031022P: Numerical Analysis, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Marko Huhtanen
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Spring semester, periods 4-5

Learning outcomes:

The student recognizes what numerical solution methods can be used to solve some spesific mathematical problems, can perform the required steps in the numerical algorithm and is able to perform the error analysis.

Contents:

Numerical linear algebra. Numerical methods for systems of equations, Basics of the approximation theory. Numerical quadratures. Numerical methods for ordinary and partial differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 44 h / Group work 22 h.

Target group:

-

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

J. Douglas Faires and Richar L. Burden, Numerical methods; Alfio Quarteroni, Riccardo Sacco, Fausto Saleri, Numerical mathematics

Assessment methods and criteria:

Intermediate exams or a final exam.

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Marko Huhtanen

Working life cooperation:

-

Other information:

-

521281S: Application Specific Signal Processors, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Boutellier, Jani Joosefi

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Spring, periods 4-5.

Learning outcomes:

Objective: The course introduces the main types of processors used in digital signal processing. Practical skills are learned by processor construction exercises.
Learning outcomes: After completing the course the student can distinguish the main types of signal processors and design a couple of transport triggered architecture processors. The student is able to assemble a signal processor out of basic entities and match the processor performance and the application requirements. The student 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 pro-cessing.

Prerequisites and co-requisites:

521267A Computer engineering, 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:

Jani Boutellier

Working life cooperation:

No.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S Advanced practical training 5.0 op

ECTS Credits:
3
Language of instruction:
Finnish/English
Timing:
1-6
Learning outcomes:
After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.
Contents:
Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.
Mode of delivery:
Independent work.

Learning activities and teaching methods:
The students acquire their training job themselves.
Target group:
MSc students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass/Fail
Person responsible:
Jari Hannu
Working life cooperation:
Yes.
Other information:
-

A451225: Module of the Option, Wireless Communications Engineering, 40 - 65 op

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

Ei opintojaksokuvauksia.

Compulsory

031025A: Introduction to Optimization, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Ruotsalainen Keijo
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall semester, periods 1-2

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 40 h / Group work 20 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:

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

Grading:

Numerical grading scale 1-5.

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: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Timo Kokkonen, Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521323S Wireless Communications 2 5.0 op

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Fall, periods 1-3

Learning outcomes:

Upon completing the required coursework, the student is able to use the basic methodology of information theory to calculate the capacity bounds of communication and data compression systems. He can estimate the feasibility of given design tasks before the execution of the detailed design. What is more, she can independently search for information and knowledge related to communication engineering, system design and signal processing. The student understands the operating principles of block codes, cyclic codes and convolutional codes. He 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. She can represent the operating idea of a convolutional encoder as a state machine, the student is able to apply the Viterbi algorithm to decoding of convolutional codes, and is capable of specifying principles of turbo coding and coded modulation. Moreover, he 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, rate distortion theory, introduction to network information theory, block codes, cyclic codes, burst error correcting codes, error correcting capability of block codes, convolutional codes, Viterbi algorithm, concatenated codes, and introduction to turbo coding and to coded modulation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 h, exercises 20 h

Target group:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

Signal Analysis, Telecommunication Engineering II

Recommended optional programme components:

Wireless Communications I

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, 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 weekly exams (only during lecture periods) or with final exam.

Grading:

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

Person responsible:

Markku Juntti / Timo Kokkonen

Working life cooperation:

-

Other information:

-

521320S: Wireless Communications I, 8 op

Voimassaolo: 01.08.2007 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti

Opintokohteen kielet: English

Leikkaavuudet:

521395S	Wireless Communications I	5.0 op
521323S	Wireless Communications 2	5.0 op

ECTS Credits:

8

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

After completing the course the student can analyze the performance of multilevel digital modulation methods in AWGN channel. She/he can explain the effect of fading channel on the performance of the modulation method and can analyze the performance. She/he recognizes the suitable diversity methods for fading channel and related combining methods. Student can define the basic carrier and symbol synchronization methods and is able to make the performance comparison of them. Student can explain design methods signals for band-limited channels and can classify different channel equalizers, and perform the performance analysis. In addition, the student can utilize channel capacity evaluation for fading channels, he/she recognizes the basic methods for link adaptation and multi-antenna communication.

Contents:

Radio channel models, channel capacity, digital modulation method and their performance in AWGN-channel, carrier and symbol synchronization, performance of digital modulation in fading channel, diversity techniques, adaptive modulation and coding, multi-antenna techniques and channel equalizers in wireless communication.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 h, exercises 20 h and the compulsory antenna design work with a simulation program (20 h)

Target group:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

Telecommunication Engineering II, / Broadband communication systems

Recommended optional programme components:

Recommended **:** Statistical Signal Processing

Recommended or required reading:

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

Assessment methods and criteria:

The course is passed with final examination (during lecture periods possibility to pass with intermediate exams) and accepted design exercise. Grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

Replaced by 521320S Wireless Communications I. Objective: Understanding of the basic theory and the knowledge of different fields required in digital communication are deepened. Also, communication techniques in fading channels are discussed. An overview of wireless communication systems is given, and ability to design simple communication receivers is created.

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Savo Glisic
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

Upon completing the required coursework, the student is able to list the functionalities of different layers of OSI and TCP/IP protocol models. The course gives the skills for the student to describe the basic structure of GSM, GPRS, EDGE, LTE and IEEE802.11 systems. The student is able to describe the basic protocol model of the UMTS radio interface and radio access network. The student knows the basic properties of routing protocols in ad hoc networks. The student will achieve skills to describe the main principles of mobility control, network security, cross-layer optimization. The course also gives the student the ability to explain the essential features of sensor networks.

Contents:

Communications architecture and protocols, adaptive network and transportation layers, mobility management, network security, network management, ad hoc and sensor networks, cross-layer optimization, examples of wireless communication networks.

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:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Parts from: S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies (2nd ed.), 2009; S. Glisic: Advanced Wireless Communications: 4G Cognitive and Cooperative Technologies (2nd ed.), 2007.

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:

Savo Glisic

Working life cooperation:

-

Other information:

Objective: The aim is to present the fundamentals of the structure, protocol and structure of digital data transmission networks. Technical implementation and application of the common data and local networks are also discussed.

521335S: Radio Engineering 1, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Risto Vuohtoniemi
Opintokohteen kielet: Finnish
Leikkaavuudet:

521326S	Radio Engineering	5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

After completing the course the student recognizes different kind of impedance matching methods and can design the impedance matching network using discrete components and microstrip lines. She/he can also

explain factors, which are limiting the bandwidth of impedance matching networks. The student can design the impedance matching for a low noise amplifier. 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. The student can explain the principle of a single ended, balanced and double balanced mixer and the advantages and the disadvantages of these mixers. She/he can design a power divider and a directional coupler. The student can also explain the principle of an automatic gain control (AGC). The student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Impedance matching using discrete 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 30 h, exercises 24 h and the compulsory RF design work with ADS simulation software (18 h).

Target group:

1 st year M.Sc. and WCE 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, 3rd edition, John Wiley & Sons, Inc., 2005. 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

Working life cooperation:

-

Other information:

After having passed the course the student is familiar with the basic theory and techniques of designing radio frequency circuits used in radio transceivers.

521385S: Mobile Telecommunication Systems, 5 op

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

ECTS Credits:

5

Language of instruction:

English

Timing:

Fall, periods 1-3

Learning outcomes:

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.

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 design work with a simulation program (16 h)

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Telecommunication Engineering II, Broadband Communications Systems and Wireless Communications I.

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

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

Person responsible:

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.

521350S: Seminar in Telecommunication and Radio Engineering, 1 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521362S	Electonics and Communications Engineering Seminar	0.0 op

ECTS Credits:

1

Language of instruction:

English

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

After completing the course the student can prepare a presentation of predetermined length of her/his thesis and have experience on presenting the topic. In addition, she/he has experience on evaluating other students' presentations and has a general view of completed diploma theses.

Contents:

The content is determined by the diploma work topics and other current research topics.

Mode of delivery:

Seminar presentations

Learning activities and teaching methods:

Seminar sessions when necessary during the whole year.

Target group:

2 nd year M.Sc. and WCE students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Instructions for preparing a diploma work in the degree program.

Assessment methods and criteria:

The student is required to participate in at least 4 seminars. In one of those, the student has to give an oral presentation of his/her diploma work. Presentations are given in English. Seminars are given during the whole year when necessary.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

The course unit utilizes grading passed.

Person responsible:

Jari Iinatti

Working life cooperation:

-

Other information:

Objective: The aim is to familiarize the students to the diploma work requirements. The students get practice in preparing and giving an oral presentation. At the same time they learn about current research and development projects going on in the university and in the industry.

521373S: Communication Signal Processing I, 6 op

Voimassaolo: 01.08.2004 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521324S	Statistical Signal Processing 2	5.0 op

ECTS Credits:

6

Language of instruction:

English

Timing:

Spring, periods 4-5

Learning outcomes:

Upon completing the required coursework, the student is able to use the methodology of signal processing to design communication systems and their receivers. He or she will be able to design and implement various equalizer algorithms. The student can estimate the complexity of various equalizer algorithms.

Contents:

Communication receiver as a statistical optimization problem, optimal linear filters, matrix algorithms, adaptive algorithms, linear and nonlinear equalizers, multi-antenna signal processing.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h, exercises 16 h and the compulsory design work with a simulation program (16 h).

Target group:

2nd year M.Sc. and WCE students

Prerequisites and co-requisites:

Statistical signal processing, Telecommunication Engineering II, Wireless Communications I

Recommended optional programme components:

-

Recommended or required reading:

Parts from books: Jinho Choi: Adaptive and Iterative Signal Processing in Communications, Cambridge University Press, 2006 (318 pages) ISBN-13 978-0-521-86486-2 and Simon Haykin: Adaptive Filter Theory, 3rd ed. Prentice Hall, 1996. (989 pages) ISBN: 0-13-322760-X. Lecture notes and other literature.

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:

Markku Juntti

Working life cooperation:

-

Other information:

Objective: Statistical signal processing methods are applied to design the key functionalities of a communication receiver and in particular its equalizer. In addition, the expertise on statistical and adaptive signal processing is deepened and enlarged regarding linear estimation, adaptive signal processing and multi-antenna signal processing.

A453271: Advanced module, Wireless Communications Engineering, 16 - 35 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory

521377S: Communications Networks II, 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Savo Glisic
Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

Upon completing the required coursework, the student is able to construct simple theoretical queuing theory models and analyze the simulation results of these models. The student achieves skills to explain simple Markovian birth-death process and apply that model in queuing systems. The course gives skills for the student to describe functionalities of a communication network with game theoretic models. The student knows the decomposition methods of network utility function and is capable of using that knowledge for network optimization.

Contents:

Introduction to concepts in queuing theory, birth-death process, queuing systems and their measures of effectiveness, Little's result, blocking in queuing systems, open and closed (Jackson) queuing networks, advanced routing in data networks, multiple access techniques, network information theory, cognitive networks.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

1 st year M.Sc. and WCE students.

Prerequisites and co-requisites:

Communication Networks I

Recommended optional programme components:

-

Recommended or required reading:

Parts from S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies, 2009, S. Glisic: Advanced Wireless Communications: 4G Cognitive and Cooperative Technologies, 2007.

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:

Savo Glisic

Working life cooperation:

-

Other information:

Objective: 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 development of analytical tools. The descriptive material is used to illustrate the underlying concepts, and the analytical material is used to generate a deeper and more precise understanding of the concepts. The course presents the basic principles of queuing theory giving mathematical tools to apply the theory to practical communication systems.

521375S: Radio Engineering II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: English

Leikkaavuudet:

521327S Design of Tranceivers 6.0 op

ECTS Credits:

5

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student recognizes the blocks of a transceiver and can explain the operating principle of a transceiver. She/he can classify different architectures used in a single and a multi-antenna transceiver and understand the basis for them. The student can 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. She/he can explain nonlinear distortion and can design the automatic gain control in the system level. The student can also 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. The student can also explain the principles of frequency synthesis in a transceiver.

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:

Two hours of lectures in a week, 30 h in total. The compulsory design exercise with ADS simulation software, 30 h during periods 5 and 6.

Target group:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

Radio Engineering I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Parts from books: A. Luzatto, G. Shirazi: Wireless Transceiver Design, John Wiley & Sons Ltd, 2007 and Walter Tuttlebee: Software Defined Radio.Enabling Technologies, John Wiley & Sons Ltd, 2002.

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

Working life cooperation:

-

Other information:

The aim is to understand the basic theory and techniques of a transceiver system level design. After passing the course the student knows, what should be taken into account when functional blocks of a transceiver are connected so that the performance requirements are achieved.

521317S: Wireless Communications II, 8 op

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

ECTS Credits:

8

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

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 setting as well as in multi-user uplink and downlink. 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. After the course, the student has also gained understanding on the applicability of multiuser MIMO communication schemes in realistic multi-cell scenarios. Finally, it is explained how these technologies are deployed in current and future wireless systems and standards.

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:

1 st year M.Sc. and WCE students

Prerequisites and co-requisites:

In addition to the course Wireless Communications II, 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:

Wiil be replaced by 521317S Wireless Communications II. Objective: Target is to deepen the understanding of the fundamental multiantenna transmission and reception concepts used in broadband wireless and in particular mobile systems.

521360S: Communication Signal Processing II, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521325S	Communication Signal Processing	5.0 op

ECTS Credits:

4

Language of instruction:

English

Timing:

Fall, periods 2-3

Learning outcomes:

After completing the course the student recognizes the blocks of all-digital receiver and can explain the basis for them. She/he can derive the key algorithms of the receiver and perform joint optimization of transmitter and receiver. The student can design the synchronization algorithms of a receiver and the related filtering and sample rate conversions. He/she can derive the performance of the algorithms and methods to compare them. In addition, she/he can utilize and develop algorithms for fading channels.

Contents:

Filter banks, synthesis and performance of synchronization algorithms in AWGN channels, frequency estimation, interpolation in synchronization, synchronization and channel estimation in fading channels, transceiver optimization, the impact of a cyclic prefix or guard interval.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 20 h and exercises 25 h out of which some are Matlab based problems.

Target group:

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

Prerequisites and co-requisites:

Statistical Signal Processing, Wireless Communications I.

Recommended optional programme components:

Recommended: Communication Signal Processing I

Recommended or required reading:

Parts from books: P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, Signal Processing and Optimization for Transceiver Systems, Cambridge University Press, 2010 ISBN 978-0-521-76079-9 and H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998. Lecture notes and other literature.

Assessment methods and criteria:

The course is passed with final examination and by solving homework problems. Grade is based on exam. Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Markku Juntti

Working life cooperation:

-

Other information:

Objective: Digital communication knowledge is deepened by applying the statistical signal processing techniques to the design and optimization of receiver baseband algorithms. The main goal is to learn the principles which are used to optimize the transmitter and receiver based on communication, information, detection and estimation theories.

A453272: Advanced module, WCE (optional), 25 - 35 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Module
Laji: Study module
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Choose one of the courses

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course, the student can define what the radio channel is and is able to distinguish it into modellable parts. He/she is capable to adopt radio wave propagation mechanisms: free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. The student can also describe how the radiation properties of different kind of antennas and antenna arrays affect the characteristics, quality and capacity of a radio channel. In addition, the student can apply physical and empirical models of path loss, slow fading (shadowing), narrowband or wideband fast fading and noise in order to calculate the link budget, power delay profile and other characteristics of a radio link. He/she can analyze which are the dominating propagation mechanisms in a fixed terrestrial, ionospheric and satellite links, outdoor and indoor mobile communications, MIMO (multiple-input-multiple output) communications and ultra wideband communications. Moreover, he/she is able to calculate the effects of the dominating propagation mechanisms on different kind of radio channels. He/she can summarize how to overcome the radio channel impairments and how to measure the properties of different radio channels.

Contents:

Radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radiowave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Effects of antennas on the radio channel. Principles of the radio channel modeling. Noise calculations. Radiowave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modeling for outdoor mobile systems. Radiowave 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. Mitigation methods of propagation phenomena. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 26 h and exercises 20 h

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007. Curt A. Levis, Joel T. Johnson & Fernando L. Teixeira: Radiowave propagation. Physics and applications. John Wiley & Sons Ltd, 2010. Henry L. Bertoni: Radio propagation for modern wireless systems. Prentice Hall PTR, 2000.

Assessment methods and criteria:

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

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in odd years. Objective: After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial, ionospheric and satellite channels. He /she understands the physics, composition and importance of the propagation models and can apply them in practice to radio communication, radio navigation, radio broadcasting and radar systems.

A453246: Supplementary module/Electives, Wireless Communications Engineering, 10 - 41 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Supplementary Module

Laji: Study module

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Alternative

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

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 semester, periods 1-2

Learning outcomes:

On completion of the study module students 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, analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits, and estimate and minimize the effects of noise on these. They should also be able to explain the terminology used with DA and AD conversion and converters and to analyze and outline their main architectural principles and also to evaluate their characteristics.

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:

-

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:

-

Other information:

-

521433A: Laboratory Exercises on Analogue Electronics, 3 op

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

521307A	Laboratory Exercises on Analogue Electronics	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish, English.

Timing:

1 - 3

Learning outcomes:

On completion of the study module students should be able to design basic electronic structural blocks and verify their functionality in a CAD simulation environment. They should be able independently to realize and test a small-scale design object employing analogue circuit techniques.

Contents:

Passive RC-circuits, diodes and their applications, bipolar junction transistor, MOS-transistors, operational amplifiers and their applications, power amplifiers.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Independent work.

Target group:

-

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:

Principles of Electronics Design and Electronics Design I.

Recommended or required reading:

Not defined.

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:

None.

Other information:

None

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Kinnunen, Jari Hannu
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

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. The student also knows the operating principles of transfer lines, antennas and filters and of their design. 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 different measurement techniques in different measurement situations. In addition 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

Learning activities and teaching methods:

Lectures 24h/calculation exercises 12h/laboratory exercises 12h/design exercises 12h

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:

-

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 and design exercises
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:

Jari Hannu and Matti Kinnunen

Working life cooperation:

-

Other information:

Kurssissa käydään läpi tavallisimmat RF-komponentit ja -mittausmenetelmät, jotka ovat käytössä RF- ja mikroaaltoalueilla. Kurssi antaa valmiudet komponenttien toiminnan ja valintaperusteiden ymmärtämiseen sekä sähkömagneettisten kenttien ja suurtaajuuspiirien mittauksiin.

521266S: Distributed Systems, 6 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Ojala, Timo Kullervo
Opintokohteen kielet: English
Leikkaavuudet:

521290S	Distributed Systems	5.0 op

Language of instruction:

In English.

Timing:

Spring, periods 4-5.

Learning outcomes:

Upon completing the course the student is able to explain the key principles of distributed systems, apply them in evaluating the major design paradigms used in implementing distributed systems, solve distributed systems related problems, and design and implement a small distributed system.

Contents:

Architectures, processes, com-munication, naming, synchronization, consistency and replication, fault tolerance, security, distributed object-based systems, distributed file systems, distributed web-based systems, distributed coordination-based systems.

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

Lectures 30 h, exercises 26 h, project work 50 h, self-study 54 h. Project work is completed as 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:

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

Recommended or required reading:

Required literature: Andrew S. Tanenbaum and Maarten van Steen, Distributed Systems – Principles and Paradigms, Second Edition, Prentice Hall, 2007, ISBN 978-0132392273, 704 pages.

Assessment methods and criteria:

The course uses continuous assessment so that there are 3 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:

Professor Timo Ojala

Working life cooperation:

None.

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

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Latva-aho
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

ECTS Credits:

3-7

Language of instruction:

English

Timing:

Fall&Spring, periods 1-6

Learning outcomes:

After completing the course the student can prepare a presentation of predetermined length of her/his thesis and have experience on presenting the topic. In addition, she/he has experience on evaluating other students' presentations and has a general view of completed diploma theses.

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

Grading:

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

Person responsible:

Matti Latva-aho

Working life cooperation:

-

Other information:

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.

521380S: Antennas, 4 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Markus Berg
Opintokohteen kielet: English
Leikkaavuudet:

521388S	Antennas	5.0 op

ECTS Credits:

4

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course the student can apply antenna terminology and calculate the antenna characteristics of different kind of radio systems. He/she can apply electromagnetic theory to calculate the properties of the fields radiated by wire antennas, micro strip antennas and antenna arrays. The student is also able to design wire antennas, micro strip antennas and antenna arrays for different radio systems. In addition, the student can use electromagnetic simulators to analyze and design antennas.

Contents:

ntroduction to different antenna types. Antenna parameters. Antennas as a part of a radio system. Radiation of an antenna from the Maxwell's equations. Typical linear wire antennas: infinitesimal dipole, small dipole, finite length dipole, half-wavelength dipole. Antennas near the conducting plane. Loop antennas. Microstrip antennas. Antenna arrays.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h, exercises 16 h and the compulsory antenna design work with an electromagnetic simulation program (14 h).

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

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 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:

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in even years. Objective: After having passed the course the student knows antenna terminology, understands the role of antennas as a part of different radio systems and is familiar with the theories explaining the electromagnetic radiation of usual antenna types and antenna arrays. In addition, the student masters the preliminary design of various antenna types and arrays, as well as, knows the feasibility of electromagnetic simulators in the antenna design.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

Language of instruction:

English

Timing:

Spring, periods 4-6

Learning outcomes:

After completing the course, the student can define what the radio channel is and is able to distinguish it into modellable parts. He/she is capable to adopt radio wave propagation mechanisms: free-space

propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. The student can also describe how the radiation properties of different kind of antennas and antenna arrays affect the characteristics, quality and capacity of a radio channel. In addition, the student can apply physical and empirical models of path loss, slow fading (shadowing), narrowband or wideband fast fading and noise in order to calculate the link budget, power delay profile and other characteristics of a radio link. He/she can analyze which are the dominating propagation mechanisms in a fixed terrestrial, ionospheric and satellite links, outdoor and indoor mobile communications, MIMO (multiple-input-multiple output) communications and ultra wideband communications. Moreover, he/she is able to calculate the effects of the dominating propagation mechanisms on different kind of radio channels. He/she can summarize how to overcome the radio channel impairments and how to measure the properties of different radio channels.

Contents:

Radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radiowave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Effects of antennas on the radio channel. Principles of the radio channel modeling. Noise calculations. Radiowave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modeling for outdoor mobile systems. Radiowave 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. Mitigation methods of propagation phenomena. Measurement methods of radio channels.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 26 h and exercises 20 h

Target group:

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

Prerequisites and co-requisites:

Basics of Radio Engineering, Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007. Curt A. Levis, Joel T. Johnson & Fernando L. Teixeira: Radiowave propagation. Physics and applications. John Wiley & Sons Ltd, 2010. Henry L. Bertoni: Radio propagation for modern wireless systems. Prentice Hall PTR, 2000.

Assessment methods and criteria:

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

Markus Berg

Working life cooperation:

-

Other information:

Course will be given every second year in odd years. Objective: After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial, ionospheric and satellite channels. He /she understands the physics, composition and importance of the propagation models and can apply them in practice to radio communication, radio navigation, radio broadcasting and radar systems.

521260S: Programmable Web Project, 5 op

Voimassaolo: 01.08.2006 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Rautiainen

Opintokohteen kielet: English

Leikkaavuudet:

ay521260S Programmable Web Project (OPEN UNI) 5.0 op

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Spring, periods 4-6.

Learning outcomes:

Objective: The objective of the course is to supply the student with basic understanding of RESTful Web Services and related technologies.
Learning outcomes: Upon completing the required coursework, the student is able to design and implement different components of a RESTful Web Service including the Web client. The student becomes familiar with basic technologies to store data on the server, serialize data in the Web and to create Web based clients.

Contents:

RESTful Web Services, serialization languages (XML, JSON), data storage, HTML5 and AJAX.

Mode of delivery:

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

Learning activities and teaching methods:

Lectures 4 h, guided laboratory work 10 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 space in the classes.

Prerequisites and co-requisites:

Elementary programming.

Recommended optional programme components:

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

Recommended or required reading:

Will be announced at the first lecture.

Assessment methods and criteria:

This course unit utilizes continuous assessment. The students return each chapter of the project report separately and get from the teachers feedback to each chapter.
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:

Mika Rautiainen

Working life cooperation:

None.

Other information:

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

521273S: Biosignal Processing I, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Seppänen

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Lectures are given in Finnish or in English. Laboratory work is given in Finnish and English. The examination can be taken in Finnish or English.

Timing:

Autumn, periods 2 and 3.

Learning outcomes:

After passing the course, student knows special characteristics of the biosignals and typical signal processing methods. Student can solve small-scale problems related to biosignal analysis.

Contents:

Biomedical signals. Digital filtering. Time-domain and frequency-domain analysis, Nonstationarity of biomedical signals. Event detection. Signal characterization.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 10 hours (5 times 2 hours) and laboratory work 20 hours (10 times 2 hours), the rest as independent work, written exam.

Target group:

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

Prerequisites and co-requisites:

The mathematical studies of the BSc of computer science and engineering or equivalent studies, digital filtering, 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:

The course is based on the book "Biomedical Signal Analysis, A Case-Study Approach", R.M Rangayyan. 516 pages. + Lecture transparencies + Task assignment specific material.

Assessment methods and criteria:

Laboratory work is supervised by assistants who also check that the task assignments are completed properly. The course ends with a written exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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.

521259S: Digital Video Processing, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Heikkilä, Janne Tapani
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish.

Timing:

Autumn, periods 2-3.

Learning outcomes:

In this course students become familiar with basics of video processing and communications. The emphasis is in video representation and coding.
After completing the course the student is able to explain the basic formats and representations of digital video signals. He can analyze the frequency properties of video signals as well as the effects of sampling of multi-dimensional signals, and he can specify digital filters for video sampling rate conversions. He is able to model video content by using simple two- and three-dimensional models, and apply certain well-known methods for video motion estimation. The student can explain the essential parts of the techniques used in video coding and the most important properties of common video coding standards. He can also describe the general principles of scalable video coding and error resilient video coding.

Contents:

1. Video formation, 2. Fourier analysis of video signals, 3. Sampling of multi-dimensional signals, 4. Video sampling rate conversion, 5. Video modeling, 6. Motion estimation, 7. Foundations of video coding, 8. Waveform-based coding, 9. Scalable video coding, 10. Video compression standards, 11. Error control in video communications.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures (24 h), exercises (10 h) and Matlab design exercise (10 h). The rest as independent work.

Target group:

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

Prerequisites and co-requisites:

521467A Digital Image Processing, 521337A Digital Filters.

Recommended optional programme components:

521466S Machine Vision, 521488S Multimedia Systems. These courses provide complementary information on analysis and processing of digital video. The courses are recommended to be studied either in advance or simultaneously.

Recommended or required reading:

Y. Wang, J. Ostermann, Y. Zhang: Video processing and communications, Prentice-Hall, 2002, chapters 1-6, 8, 9, 11, 13, 14. Lecture notes and exercise material. All course material is in English.

Assessment methods and criteria:

The course is passed with final exam and accepted Matlab 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:

Janne Heikkilä

Working life cooperation:

No.

521145A: Human-Computer Interaction, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

Timing:

Autumn, periods 2-3

Learning outcomes:

Upon completing the course the student is able to explain the Human Computer Interaction (HCI) fundamentals, explain evaluation and prototyping techniques, explain 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 (20 h), exercises (20 h), and practical work (95 h). The course is passed with an approved practical work. The implementation is fully English.

Target group:

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

Prerequisites and co-requisites:

None. No prior courses are required.

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 is project-based. Students have to complete three group-based activities throughout the semester: design & prototyping (40%), conduct an evaluation (40%), and complete a report of the activities (20%). Passing criteria: all 3 elements (designs, evaluation, report) 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:

Vassilis Kostakos

521279S: Signal Processing Systems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannuksela, Jari Samuli

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

English

Timing:

Autumn, periods 1-3.

Learning outcomes:

After the course the student can explain the challenges of signal processing hardware, software, and design methodologies. He 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. In addition, the student is able to explain the most important algorithm implementation structures and can identify their usage contexts. After the course the 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

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:

Final exam and approved design exercises.
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:

Jari Hannuksela

Working life cooperation:

No.

521148S: Ubiquitous Computing Fundamentals, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Language of instruction:

In English.

Timing:

Autumn, periods 2-3.

Learning outcomes:

Upon completing the course the student is able to apply the knowledge and methods provided in the course in the design, implementation and evaluation of ubiquitous computing systems.

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 18 h, exercises 18 h, project work 50 h, self-study 47 h. Exercises and project work are completed as 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:

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

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 an approved 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:

Professor Timo Ojala.

Working life cooperation:

None.

521281S: Application Specific Signal Processors, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail

Opettajat: Boutellier, Jani Joosefi

Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Spring, periods 4-5.

Learning outcomes:

Objective: The course introduces the main types of processors used in digital signal processing. Practical skills are learned by processor construction exercises.
Learning outcomes: After completing the course the student can distinguish the main types of signal processors and design a couple of transport triggered architecture processors. The student is able to assemble a signal processor out of basic entities and match the processor performance and the application requirements. The student 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 pro-cessing.

Prerequisites and co-requisites:

521267A Computer engineering, 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:

Jani Boutellier

Working life cooperation:

No.

521493S: Computer Graphics, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Guoying Zhao

Opintokohteen kielet: English

Leikkaavuudet:

521140S Computer Graphics 5.0 op

ECTS Credits:

7

Language of instruction:

In English.

Timing:

Spring, periods 5-6.

Learning outcomes:

Upon completing the required coursework, student is able to specify and design 2D graphics algorithms including: line and circle drawing, polygon filling and clipping, and 3D computer graphics algorithms including transformations, viewing, hidden surface removal, shading, texture mapping and hierarchical modeling. Moreover, student is able to explain the relationship between the 2D and 3D versions of such algorithms, and also has 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 (40 hours) and self-study (50 h). In addition student will independently solve programming assignments (100 hours).

Target group:

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

Prerequisites and co-requisites:

Pro-gramming 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.

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: Interactive Computer Graphics, 5th, Addison-Wesley 2008
2) Reference: Peter Shirley, Michael Ashikhmin, Michael Gleicher, et al. : Fundamentals of Computer Graphics, second edition, AK Peters, Ltd. 2005
3) Lecture notes (in English)
4) Materials in the internet (e.g. OpenGL redbook)

- OpenGL Programming Guide or ‘The Red Book’:

http://unreal.srk.fer.hr/theredbook/

- OpenGL Video Tutorial:

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 a fail.

Person responsible:

Guoying Zhao, Jie Chen, Jukka Holappa

Working life cooperation:

-

521466S: Machine Vision, 5 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Heikkilä, Janne Tapani
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Spring, periods 5-6.

Learning outcomes:

Upon completion of the course, the student can utilize common machine vision methods for various image analysis problems. He is able to carry out region segmentation and pattern recognition using color, texture and shape descriptors computed from images. He can use motion information in image analysis and model matching in image registration and object recognition. The student can explain the basics of geometric computer vision and is able to calibrate cameras as well as to obtain 3D coordinate measurements from the scene using for example stereo imaging. After the course the student has the rudimentary skills to use the Matlab environment and its tools for implementing machine vision methods and analyzing the results.

Contents:

1. Introduction, 2. Imaging and image representation, 3. Binary image analysis, 4. Pattern recognition concepts, 5. Color and shading, 6. Texture, 7. Content-based image retrieval, 8. Motion from 2D image sequences, 9. Image segmentation, 10. Matching in 2D, 11. Perceiving 3D from 2D images, 12. 3D models and matching.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures (30 h), exercises (15 h) and Matlab design exercise (10 h). The rest as independent work.

Target group:

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

Prerequisites and co-requisites:

521467A Digital Image Processing.

Recommended optional programme components:

521497S Pattern Recognition and Neural Networks. This course provides complementary information on pattern recognition and classification applied in machine vision. It is recommended to be studied simultaneously.

Recommended or required reading:

Shapiro L.G., Stockham G.C.: Computer vision, Prentice Hall, 2001. Lecture notes, exercise material. All course material is in English.

Assessment methods and criteria:

The course is passed with final exam and accepted Matlab 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:

Janne Heikkilä

Working life cooperation:

No.

521147S: Mobile and Social Computing, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521046A	Mobile Computing	5.0 op
521045S	Mobile Computing	5.0 op

Language of instruction:

In English.

Timing:

Spring, periods 4-5

Learning outcomes:

Upon completing the course the student is able to implement mobile user interfaces, implement online social network applications, explain the fundamental concepts of context awareness and online communities.

Contents:

Mobile interface design and implementation, mobile sensor acquisition, context awareness, social platforms, crowdsourcing, online communities, graph theory.

Mode of delivery:

Face to face teaching.

Learning activities and teaching methods:

Lectures, exercises, and practical work. The course is passed with an approved practical work. The implementation is fully English.

Target group:

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

Prerequisites and co-requisites:

No prior courses are required.

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 is project-based. Students have to complete two group-based activities throughout the semester: build a mobile application (50%), build an online social application (50%). Passing criteria: both elements (mobile application, social application) 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.

521497S: Pattern Recognition and Neural Networks, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Seppänen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521289S Machine Learning 5.0 op

ECTS Credits:

5

Language of instruction:

Lectures are given in Finnish or in English. Programming exercises and calculation exercises are given in Finnish and English. The examination can be taken in Finnish or English.

Timing:

Spirng, periods 5 and 6.

Learning outcomes:

After completing the course the student can solve basic statistical calculation problems of pattern recognition and design simple optimal classifiers from the basic theory and assess their performance. The student can explain the Bayesian decision theory and apply it to derive minimum error classifiers and minimum cost classifiers. The student can apply the basics of gradient search method to design a linear discriminant function. In addition, (s)he can explain the structure and operating principle of some common neural networks.

Contents:

Introduction. Bayesian decision theory. Discriminant functions. Parametric and non-parametric classification. Feature extraction. Classifier design. Example classifiers. Neural networks like Perceptron and SOM.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Introduction Lecture, Exercises 20 hours (10 times 2 hours), Programming Exercises 16 hours (8 times 2 hours), programming work compulsory, written exam.

Target group:

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

Prerequisites and co-requisites:

The mathematical studies of the BSc of computer science and engineering or equivalent studies, 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:

Duda RO, Hart PE, Stork DG, Pattern classification, John Wiley & Sons Inc., 2nd edition, 2001. Haykin S, Neural networks, MacMillan College Publishing Company, 1994 (or more recent). Handouts.

Assessment methods and criteria:

Programming work and calculation exercises are supervised by assistants who also check that the task assignments are completed properly. The course has 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.

521479S: Software Project, 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Röning
Opintokohteen kielet: English

ECTS Credits:

7

Language of instruction:

Finnish/English, material available in English.

Timing:

Spring, periods 4-6.

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, 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:

Juha Röning

Working life cooperation:

-

521280S: DSP Laboratory Work, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Miguel Bordallo Lopez, Teemu Nyländen
Opintokohteen kielet: English

ECTS Credits:

5

Language of instruction:

In English.

Timing:

Periods 2-6 (it can be done from November to May).
Autumn and Spring.

Learning outcomes:

After the course the student is able to use integrated design environments of digital signal processors for designing, implementing and testing signal processing algorithms.

Contents:

Algorithm design, Sampling, quantization noise, signal generation, decimation and interpolation, FIR and IIR filter implementations, FFT implementations, DSP-assembly coding and optimization, Multi-rate signal processing, LMS adaptive filters implementations, CIC filtering.

Mode of delivery:

Starting lectures and independent exercises.

Learning activities and teaching methods:

The course is based on a starting lecture and exercises that are done using development boards of modern 32-bit digital signal processors, and the respective software development tools. The course is passed by accepted and documented exercises.

Target group:

Students interested in signal processing, processor architectures, embedded systems programming. Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:

521337A Digital filters, 521267A Computer Engineering, programming skills.

Recommended optional programme components:

521279S Signal processing systems. This course provides complementary information on the DSP-laboratory Work course.

Recommended or required reading:

Exercise instruction booklet, processor handbooks and develop-ment environment handbooks. All material is in English.

Assessment methods and criteria:

The exercises will be passed or failed according to the functionality and overall quality.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Miguel Bordallo López

Working life cooperation:

No.

900017Y: Survival Finnish, 2 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900017Y Survival Finnish Course (OPEN UNI) 2.0 op

Proficiency level:

A1.1

Status:

-

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 twice a week (12 h) and self study (38 h).

Target group:

International degree and post-graduate degree 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 1-5.

Person responsible:

Anne Koskela

Working life cooperation:

-

Other information:

Sign-up in WebOodi. The lessons will be held once a week during a 6-week period.

900013Y: Beginners' Finnish Course 1, 3 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900013Y	Beginners' Finnish Course 1 (OPEN UNI)	2.0 op

Proficiency level:

A1.2

Status:

-

Required proficiency level:

A1.1, Completion of the Survival Finnish course (900017Y) or the equivalent language skills.

ECTS Credits:

2 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

Learning activities and teaching methods:

Lessons twicea week (24h) and self study (26 h).

Target group:

International degree and post-graduate degree 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. The lessons will be held twice a week during a 6-week period.

900053Y: Beginners' Finnish Course 2, 5 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay900053Y	Beginners' Finnish Course 2 (OPEN UNI)	4.0 op

Proficiency level:

A1.3

Status:

-

Required proficiency level:

A1.2, completion of the Beginners’ Finnish course 1 (900013Y) or the equivalent language skills.

ECTS Credits:

4 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

Learning activities and teaching methods:

Lessons twice a week (50 h) and self study (50 h).

Target group:

International degree and post-graduate degree 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 written midterm and final exams 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 lessons will be held **twice a week** during a 13-week period.

521016A: Advanced Practical Training, 3 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S Advanced practical training 5.0 op

ECTS Credits:
3
Language of instruction:
Finnish/English
Timing:
1-6
Learning outcomes:
After advanced practical training the student can describe one possible future job, or another kind of position in an already familiar working environment. The student can identify problems in the working environment and solve them. The student can apply theoretical knowledge acquired in the studies to practical tasks. The student can identify roles of a diploma-engineer in the work place.
Contents:
Training in the research laboratories, development laboratories and process laboratories, among others, of the industry and institutions in the field of their study is recommended to the students. The basic requirement is that the practice must be performed in a job supervised by a person who has taken an engineering degree.
The technical goal of practical training is to give a general insight of the field in which the trainee will work after having taken the degree and to support and to promote theoretical studying. Likewise, the training has to acquaint the trainee with the social points of the industrial production and with industrial safety and has to give a sufficient picture of the technical details of the performing of different work. Furthermore, the training has to give a general idea of the technical and economic organizing, administration and management of a company and its production.
Mode of delivery:
Independent work.

Learning activities and teaching methods:
The students acquire their training job themselves.
Target group:
MSc students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Students write a report on the compulsory MSc stage practical training lasting at least two months. This report is reviewed by degree program representatives. More detailed instructions for the report are available on the WWW pages of the degree program.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Pass/Fail
Person responsible:
Jari Hannu
Working life cooperation:
Yes.
Other information:
-

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

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

A451120: Basic and Intermediate Studies, Electrical Engineering, 150 - 170 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Basic and Intermediate Studies
Laji: Study module
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Choice of second domestic language

901008P: Second Official Language (Swedish), 2 op

Voimassaolo: 01.08.1995 -
Opiskelumuoto: Basic Studies
Laji: Course
Opintokohteen kielet: Swedish
Leikkaavuudet:

ay901008P Second Official Language (Swedish) (OPEN UNI) 2.0 op

Proficiency level:

B1/B2/C1 (Common European Framework of Reference)

Status:

This course is compulsory to all students except those who have at least 60 ECTS credits of Swedish studies in their degrees. The language proficiency provided by the course unit is equivalent to the language proficiency required of a state official with an academic degree working in a bilingual municipality area (Act 424/03 and Decree 481/03).
According to the requirements of the law, the student must be able to use Swedish both orally and in writing in various professional situations. Achieving this kind of proficiency during a course unit that lasts for only one semester requires that the student has already achieved the necessary starting proficiency level prior to taking the course.

Required proficiency level:

The required starting proficiency level for students of all faculties is a grade of 7 or higher from the Swedish studies at secondary school (B-syllabus) or equivalent knowledge AND a passing grade from the proficiency test held at the beginning of the course unit. Based on this proficiency test the students are directed to brush up on their language skills if it is deemed necessary; mastering basic vocabulary and grammar is a prerequisite to achieving the necessary language proficiency for the various communication situations one faces in professional life.
If a student has not completed Swedish studies (B-language) at secondary school with a grade of 7 or higher, or his/her language skills are otherwise lacking, he/she must achieve the required proficiency level BEFORE taking this compulsory Swedish course.

ECTS Credits:

2 ECTS credits

Language of instruction:

Swedish

Timing:

Students of the School of Architecture: autumn term of 1st year of studies
Studenst of Students of Industrial Engineering and Management : autumn semester of the 2nd year of

studies
Students of Process Engineering and Environmental Engineering: autumn or spring semester of the second year of studies
Mechanical Engineering: autumn or spring semester of the third year of studies
The Faculty of Information Technology and Electrical Engineering: Students of Electrical Engineering and Computer Science Engineering: Autumn or spring term of 1st year of studies.

Learning outcomes:

Upon completion of the course unit the student should be able to read and understand texts from his/her academic field and make conclusions based on them. The student should be able to write typical professional emails and short reports. He/she should be able to carry himself/herself according to Swedish etiquette when acting as host or guest. The student should also be able to discuss current events and special field-specific matters, use the vocabulary of education and plan and give short oral presentations relating to his/her own field.

Contents:

Communicative oral and written exercises, which aim to develop the student's Swedish proficiency in areas relevant to his/her academic field and future professional tasks. The student practises oral presentation and pronunciation. Situational exercises done individually and in pairs and groups. Discussions in small groups. Current texts about the student's special field. Written exercises relating to the student's professional field. Practising presentation skills.

Mode of delivery:

Contact teaching

Learning activities and teaching methods:

1 x 90 minutes of contact teaching per week and self-directed study, 53 hours per course.

Target group:

See Timing

Prerequisites and co-requisites:

See Required Proficiency Level

Recommended optional programme components:

-

Recommended or required reading:

Study material will be provided by the teacher.

Assessment methods and criteria:

The course unit focuses on improving both oral and written language skills and requires active attendance and participation in exercises, which also require preparation time. 100% attendance is required. The course unit tests both oral and written language skills.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Oral and written language proficiencies are tested separately and assessed using the so called KORU-criteria (publication of HAMK University of Applied Sciences, 2006). Separate grades will be awarded for the successful completions of both oral and written portions of the course unit: the possible passing grades are **satisfactory skills and good skills** (see language decree 481/03). The grades are based on continuous assessment and testing.

Person responsible:

See contact teachers on the Language and Communication home page http://www.oulu.fi/languagesandcommunication/student_counselling

Working life cooperation:

-

Other information:

Students sign up for teaching in WebOodi. A student can only sign up for one teaching group. When signing up , it is imperative that the student fills in his/her university email address (paju.oulu.fi), major subject and Swedish grades attained during secondary education in the Further Information field. Information in sign-up periods and course unit timetables can be found in WebOodi.

900009P: Second Official Language (Finnish), 2 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Basic Studies

Laji: Course

Opintokohteen kielet: Finnish

Proficiency level:

B1/B2/C2

Status:

This course is compulsory to students who received their schooling in Swedish.
The language proficiency provided by the course unit is equivalent to the language proficiency required of a state official with an academic degree working in a bilingual municipality area (Act 424/03 and Decree 481 /03).

Required proficiency level:

Successful completion of the A-syllabus in Finnish (A-finska) during secondary education or equivalent knowledge.

ECTS Credits:

3 credits

Language of instruction:

-

Timing:

Second year of studies

Learning outcomes:

Upon completion of the course the student should have attained the required proficiency level in Finnish to be able to function in his/her studies and professional work tasks. The student should be able to manage in various oral communication situations, read literature from his/her academic field and write fluent texts about his/her special field. The student should also be able to understand standard spoken Finnish as well as Finnish of his/her own special field.
The language proficiency provided by the course unit is equivalent to the language proficiency required of a state official with an academic degree working in a bilingual municipality area (Act 424/03 and Decree 481 /03).

Contents:

Taking the course exam and participating in the teaching, if necessary.

Mode of delivery:

Contact teaching

Learning activities and teaching methods:

The course exam consists of a written section (4 hours) and an oral section (1 hour). 60 hours of contact teaching is arranged for students who fail the exam. Active and regular participation in the teaching is required.

Target group:

Students in the Faculty of Technology who received their schooling in Swedish.

Prerequisites and co-requisites:

Successful completion of the A-syllabus in Finnish (A-finska) during secondary education or equivalent knowledge.

Recommended optional programme components:

-

Recommended or required reading:

To be agreed on.

Assessment methods and criteria:

This course is usually completed by taking the course exam held by the Language Centre. The exam tests the student's Finnish language skills: written and oral text production, reading and listening comprehension and special field-specific language skills. Students who fail the exam may attend Finnish language teaching, after which they must retake and pass the exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Separate grades are given for written and oral language skills: the possible passing grades are satisfactory skills and good skills. Satisfactory skills equal B1 proficiency and good skills equal B2 proficiency or higher in the Common European Framework of Reference for Languages (CEFR).

Person responsible:

Anne Koskela

Working life cooperation:

-

Other information:

The written exam is held during the autumn semester. Students sign up for the exam in WebOodi. The date of the oral exam is agreed upon separately. Students must bring a copy of their matriculation examination certificate with them when they come to the exam. If they have completed the Central Government's language proficiency exam, they must bring a copy of that certificate with them as well.

Choice of foreign language

902011P: Technical English 3, 6 op

Voimassaolo: 01.08.1995 -
Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

Proficiency level:

CEFR B2 - C1

Status:

This course is compulsory for the students who have chosen English as their foreign language. (See the foreign language requirements for your own degree programme.)

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:

6 ECTS credits (The workload is 160 hours.)
STUDENTS OF ENGINEERING: The course consists of 3 x 2-ECTS modules.
STUDENTS OF ARCHITECTURE: The course consists of 2 x 3-ECTS modules.
Students with the matriculation exam grade *Laudatur* or *Eximia cum laude approbatur* will be exempted from part of the course (2 ECTS credits).

Language of instruction:

English

Timing:

STUDENTS OF ENGINEERING:
PYO, KO, TuTa: *1st & 2nd* years of studies, beginning 1st year autumn.
SO & CSE: 2nd & 3rd years of studies, beginning 2nd year autumn.
STUDENTS OF ARCHITECTURE:
1st & 2nd years of studies, beginning 1st year spring and continuing 2nd year autumn.

Learning outcomes:

By the end of the course, you will be able to

- demonstrate efficient strategies and methods for developing and maintaining your English proficiency
- communicate using the core vocabulary required for professional language use in your field
- apply language skills, intercultural awareness and presentation techniques necessary for working in a multicultural environment
- use language, culture and communication skills at a B2-C1 CEFR level in accordance with your own professional needs.

Contents:

In this course, you will focus on developing oral and written English language skills which enable you to follow developments in your own professional field and manage successfully in an international, intercultural working environment.

STUDENTS OF ENGINEERING:
The course consists of three modules:

1. first, **Professional English for Technology** (PET, 2 ECTS credits),
2. then **two modules** (2 ECTS credits each) from a free-choice module menu, in which each module has its own content. These modules allow you to develop further skills in specific core areas. Read the module descriptions with care so that you choose modules which match your own needs, interests and level.

   TuTa students, however, take ONE module from the free-choice menu and then, in second year autumn, the Business Plan module, which is integrated with a course in their own department (*555222A Tuotantotalouden harjoitustyöt*) .

STUDENTS OF ARCHITECTURE:
The course consists of two modules:
See the course description of each module (902011P-38 module A and 902011P-39 module B for a detailed explanation of the course content.

Mode of delivery:

STUDENTS OF ENGINEERING: The mode of delivery varies according to the modules you take. See the course descriptions for the individual modules.
STUDENTS OF ARCHITECTURE: face-to-face teaching in the premises of your own department and independent study

Learning activities and teaching methods:

STUDENTS OF ENGINEERING: The teaching methods and learning activities depend on which free-choice modules you choose. See the course descriptions for the individual modules.
STUDENTS OF ARCHITECTURE:
The classroom teaching comprises about 50% of the total student workload for the course and includes mini-lectures, group and teamwork, student presentations. The independent work component comprises online work and independent study in preparation for classroom activities.

Target group:

Students of the Faculty of Technology
- all Engineering Departments
- the Department of Architecture

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Materials will be provided by the teacher.

Assessment methods and criteria:

Assessment methods vary according to the individual modules taken. The assessment criteria are based on the learning outcomes of the module.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

pass / fail.

Person responsible:

Each department in the Technical Faculty has its own Languages and Communication contact teacher for questions about English studies.

Working life cooperation:

-

Other information:

See the Languages and Communication Study Guide, English, TTK.

903012P: Technical German 3, 6 op

Voimassaolo: 01.08.1995 -
Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: German

Ei opintojaksokuvauksia.

Compulsory to all

521004P: Orientation Course for New Orientation Course for New Electrical Engineering Students, 1 op

Voimassaolo: 01.08.2013 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Maritta Juvani
Opintokohteen kielet: Finnish

ECTS Credits:

1

Language of instruction:

Finnish, English when needed.

Timing:

Autumn, periods 1-3.

Learning outcomes:

After completing this course, students are familiar with academic studies and study-related services. Students know how to plan and schedule their studies based on their program curriculum. Students can use the necessary information and computer systems.

Contents:

Issues related to starting the studies. The university, student organizations, social services offered to students (such as financial aid, sports and health services). University of Oulu, Departments of electrical Engineering and Telecommunications Engineering, university administration. Degrees and studies in electrical engineering, student exchange and PhD studies. Professional profile and current employment situation of the MSc in technology. Study planning and techniques, personal study plan (PSP). Introduction to the library and data services (Oula database). Department of Computer Science and Engineering website, Noppa, Lukkari and other information systems and tools, introduction to the use of work station.

Mode of delivery:

Contact teaching.

Learning activities and teaching methods:

Student tutoring, teacher tutoring, laboratory exercises on the use of work station, information sessions offered by the Faculty of Technology and degree program, independent work; total of 30 hours.

Target group:

1st year electrical engineering BSc students

Prerequisites and co-requisites:

None.

Recommended optional programme components:

None.

Recommended or required reading:

Study guidebook, websites.

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.

Grading:

Pass/fail.

Person responsible:

Maritta juvani

Working life cooperation:

None.

Other information:

None.

030005P: Information Skills, 1 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Faculty of Technology
Arvostelu: 1 - 5, pass, fail
Opettajat: Koivuniemi, Mirja-Liisa, Sassali, Jani Henrik
Opintokohteen kielet: Finnish
Leikkaavuudet:

030004P	Introduction to Information Retrieval	0.0 op

ECTS Credits:

1 ECTS credit

Language of instruction:

Finnish

Timing:

2nd or 3rd year

Learning outcomes:

Students know the different phases of information retrieval process and basic techniques of scientific information retrieval. They will find the most important reference databases of their discipline and know how to evaluate information sources and retrieval results.

Contents:

Retrieval of scientific information, the retrieval process, key databases of the discipline, and evaluation of information retrieval and information sources.

Mode of delivery:

Blended teaching: classroom training, web-based learning material and exercises in Optima environment, a final assignment on a topic of the student’s own choice

Learning activities and teaching methods:

Training sessions 8h, group working 7h, self-study 12h

Target group:

Compulsory for all students of the Faculty of Technology, the Faculty of Information Technology and Electrical Engineering and the Faculty of Architecture. In the Faculty of Science compulsory for students of biology, physics, geosciences, chemistry and geography. Optional for students of biochemistry and mathematics.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Web learning material https://wiki.oulu.fi/display/030005P.

Assessment methods and criteria:

Passing the course requires participation in the training sessions and successful completion of the course assignments.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

pass/fail

Person responsible:

Science and Technology Library Tellus, tellustieto (at) oulu.fi

Working life cooperation:

-

Other information:

-

031010P: Calculus I, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Lusikka
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay031010P	Calculus I (OPEN UNI)	5.0 op

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Autumn semester, periods 1-3.

Learning outcomes:

After completing the course the student identifies concepts of vector algebra and can use vector algebra for solving problems of analytic geometry. The student can also explain basic characteristics of elementary functions and is able to analyse the limit and the continuity of real valued functions of one variable. Furthermore, the student 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 55 h / Group work 22 h.

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Grossmann, S.I.: Calculus of One Variable; Grossmann, 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:

Numerical grading scale 1-5.

Person responsible:

Ilkka Lusikka

Working life cooperation:

-

Other information:

-

031011P: Calculus II, 6 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Lusikka
Opintokohteen kielet: Finnish
Leikkaavuudet:

031075P	Calculus II	5.0 op
ay031011P	Calculus II (OPEN UNI)	6.0 op

ECTS Credits:

6

Language of instruction:

Finnish

Timing:

Spring semester, periods 4-6.

Learning outcomes:

After completing the course the student is able to examine the convergence of series and power series of real terms and estimate the truncation error. Furthermore, the student can explain the use of power series e.g. in calculating limits and approximations for definite integrals and is able to solve problems related to differential and integral calculus of real and vector valued functions of several variables.

Contents:

Sequences, series and power 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 62 h / Group work 26 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; Grossmann, S.I.: Multivariable Calculus, Linear Algebra and Differential Equations.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Lusikka

Working life cooperation:

-

Other information:

-

031019P: Matrix Algebra, 3,5 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Peltola
Opintokohteen kielet: Finnish
Leikkaavuudet:

031078P	Matrix Algebra	5.0 op

ECTS Credits:

3,5

Language of instruction:

Finnish

Timing:

Autumn semester, periods 1-3

Learning outcomes:

After completing the course the student is able to apply arithmetic operations of matrices. He can solve system of linear equations by matrix methods and can apply iterative methods to find the solution of the system of linear equations. The student is able to recognise the vector space and can relate the consepts of linear transform and matrix. He can analyse matrices by the parameters, vectors and vector spaces of matrices. The student is able to diagonalize matrices and apply diagonalization to the simple applications.

Contents:

Vectors and matrices. Systems of linear equations. Vector spaces and linear transformations. The rank, nullity, row space and the column space of a matrix. The determinant of a matrix. Eigenvalues and eigenvectors of a matrix. The diagonalization with applications. The iterative methods of solving linear system of equations. The theorems of Gershgorin and Cayley- Hamilton.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 h / Group work 20 h.

Target group:

-

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Grossman, S.I. : Elementary Linear Algebra, David C. Lay: Linear Algebra and Its Applications.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Matti Peltola

Working life cooperation:

-

Other information:

-

031017P: Differential Equations, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Ruotsalainen Keijo
Opintokohteen kielet: Finnish
Leikkaavuudet:

800320A	Differential equations	5.0 op
031076P	Differential Equations	5.0 op

ECTS Credits:

4

Language of instruction:

Finnish

Timing:

Spring, period 4-6

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 44 h / Group work 28 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

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Martti hamina

Working life cooperation:

-

Other information:

-

031021P: Probability and Mathematical Statistics, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
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

Language of instruction:

Finnish

Timing:

Spring semester, periods 4-6

Learning outcomes:

After completing the course the student knows the key concepts of probability and the most important random variables and is able to use them in calculating probabilities and parameters of probability distributions. In addition, the student is able to analyze statistical data by calculating interval and point estimates for the parameters. The student is also able to formulate statistical hypotheses and test them.

Contents:

The key concepts of probability, random variable, parameters of probability distributions, estimation of parameters, hypothesis testing.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 44 h/Exercises 22 h/Self-study 68 h.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisites are the course 031010P Calculus I and some parts of the course 031011P Calculus II.

Recommended optional programme components:

-

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:

Numerical grading scale 1-5.

Person responsible:

Jukka Kemppainen

Working life cooperation:

-

Other information:

-

031018P: Complex Analysis, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

031077P	Complex analysis	5.0 op

ECTS Credits:

4

Language of instruction:

Finnish

Timing:

Fall semester, periods 1-2

Learning outcomes:

After completing the course the student is able to calculate the derivative and integral of complex function, is able to calculate contour integrals, understands Cauchy's integral theorem and its consequences, is able to form the series representation of analytic function and use the Residue theory for computing line integrals. Furthermore the student is able to apply complex analysis analysis techniques to simple problems in signal processing.

Contents:

Complex numbers and functions, complex derivative and analyticity, complex series, Cauchy's integral theorem and its consequences, Laurent and Taylor expansions, Residue, the argument principle, Möbiius transformation, applications to signal analysis

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 h / Group work 20 h.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses Calculus I and II, Differential Equations.

Recommended optional programme components:

Prerequisite to signal Analysis.

Recommended or required reading:

E.B. Saff and A.D. Saddler, Fundamentals of Complex Analysis with applications to engineering and science.

Assessment methods and criteria:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Keijo Ruotsalainen

Working life cooperation:

-

Other information:

-

031050A: Signal Analysis, 4 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Kotila, Vesa Iisakki, Pasi Ruotsalainen
Opintokohteen kielet: Finnish
Leikkaavuudet:

031080A Signal Analysis 5.0 op

ECTS Credits:

4

Language of instruction:

Finnish

Timing:

3-4

Learning outcomes:

After 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. The student is able to study the stationarity, the ergodicity, the mutual dependence and the frequency content of random signals by means of the auto- and cross-correlation functions, the covariance function and the power- and cross-power spectral densities. The student is able to explain the mathematical grounds of the most central optimal systems used in signal estimation, and can solve related problems.

Contents:

Signals, classification, frequency. Orthogonal expansions. Fourier analysis, analog and digital signal, fast Fourier transform. Random variable. Random signal. Stationarity, ergodicity, autocorrelation. Power spectral density. Autoregressive, Gaussian and Poisson processes. Signal estimation, orthogonality principle, Yule-Walker equations, Wiener filter. Matched filter.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 h /Group work 20 h. Homework assignments.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses 031019P Matrix Algebra, 031021P Probability and Mathematical Statistics, 031018P Complex Analysis.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. 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:

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

Grading:

Numerical grading scale 1-5.

Person responsible:

Vesa Kotila, Pasi Ruotsalainen

Working life cooperation:

-

Other information:

-

761101P: Basic Mechanics, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

761118P	Mechanics 1	5.0 op
761118P-01	Mechanics 1, lectures and exam	0.0 op
761118P-02	Mechanics 1, lab. exercises	0.0 op
761111P-01	Basic mechanics, lectures and exam	0.0 op
761111P-02	Basic mechanics, lab. exercises	0.0 op
761111P	Basic mechanics	5.0 op
761101P2	Basic Mechanics	4.0 op

ECTS Credits:

4 credits

Language of instruction:

The lectures will be in Finnish. The textbook is in English and exercises are selected from the textbook. For further information, contact the responsible person of the course.

Timing:

Autumn

Learning outcomes:

The student is able to describe the basic concepts of mechanics and to apply those when solving the problems related to mechanics.

Contents:

We encounter many phenomena related to mechanics in our everyday life. Most engineering sciences are based on mechanics and mechanics forms the basis of many other fields of physics, including modern physics.
Contents in brief: Short summary of vector calculus. Kinematics, projectile motion and circular motion. Newton's laws of motion. Work and different forms of energy. Momentum, impulse and collisions. Rotational motion and moment of inertia. Torque and angular momentum. Rigid body equilibrium problems. Gravitation. Periodic motion. Fluid mechanics.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 32 h, 8 exercises (16 h), self-study 59 h

Target group:

For the students of the University of Oulu

Prerequisites and co-requisites:

Knowledge of vector calculus and basics of differential and integral calculus

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 13th edition, 2012, chapters 1-14. Also older editions can be used.
Lecture material: Finnish lecture material will be available on the web page of the course.
Course material availability can be checked here.

Assessment methods and criteria:

Four mini examinations and end examination or final examination
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Anita Aikio

Working life cooperation:

No work placement period

Other information:

https://noppa.oulu.fi/noppa/kurssi/761101P/etusivu

766319A: Electromagnetism, 7 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

761119P	Electromagnetism 1	5.0 op
761312A	Electromagnetism 2	5.0 op
761119P-01	Electromagnetism 1, lectures and exam	0.0 op
761119P-02	Electromagnetism 1, lab. exercises	0.0 op
761113P	Electricity and magnetism	5.0 op
761113P-01	Electricity and magnetism, lectures and exam	0.0 op

761113P-02 Electricity and magnetism, lab. exercises 0.0 op
761103P Electricity and Magnetism 4.0 op
766321A Electromagnetism I 4.0 op
766322A Electromagnetism II 4.0 op

ECTS Credits:

7 credits

Language of instruction:

Finnish

Timing:

2nd autumn

Learning outcomes:

The student identifies the basic concepts of electromagnetic theory and is able to derive the individual results of electromagnetic field theory and electric circuits. He can apply field theory in simple problems and can solve both direct and alternating current circuits.

Contents:

Electromagnetism is a physical theory which was developed mainly in the 1800's. A central concept in electromagnetism is field. Electromagnetism has joined the theories of electricity and magnetism into a unified theory and, finally, merged optics into the same framework. It also contains a clue to the theory of relativity and therefore it has had a great impact on the later development of physics. Our present society is largely affected by the applications of electromagnetism, since both electricity and magnetism have a profound role e.g. in the production and transport of energy, in domestic lightning, in telecommunications and in information technology.
Contents in brief: Mathematical tools, electric charge, Coulomb's law and electric field, potential and potential energy, Gauss' law, dielectric media, volume polarisation and induced charges, conductors, capacitors, energy density of electric field, Laplace's and Poisson's equations magnetic field, Lorentz-force, the absence of magnetic monopoles Ampère's and Biot-Savart's laws, vector potential, magnetic moment, magnetic field vector, magnets, Faraday's law, inductance, magnetic energy, alternating currents, power in alternating current circuits, three-phase lines, linear circuits, Kirchhoff's laws, alternating current bridges, continuity equation, displacement current, Maxwell's equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 46 h, 12 exercises (24 h), self-study 90 h

Target group:

No specific target qroup

Prerequisites and co-requisites:

Courses in mathematics. 763101P Mathematics for physics.

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

T. Nygrén: Sähkömagnetismi (in Finnish, available on web pages of the Department). English material are available on various textbooks like I.S. Grant ja W.R. Phillips: Electromagnetism (2nd edition, Wiley & Sons) or Cheng: Fundamentals of Engineering Electromagnetics (Addison-Wesley).

Assessment methods and criteria:

Two written intermediate examinations or final examination
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Anita Aikio

Working life cooperation:

No work placement period

Other information:

https://wiki.oulu.fi/display/766319A/

766326A: Atomic physics 1, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761313A	Atomic physics 1	5.0 op
761326A	Atomic physics	6.0 op
761105P	Atomic and Nuclear Physics	3.0 op

ECTS Credits:

6 credits

Language of instruction:

Finnish

Timing:

Second autumn term

Learning outcomes:

Student can list differences between the classical and quantum mechanical concepts, and the limitations of classical physics, when investigating atom-sized particles. Student is able to describe some interaction mechanisms of electromagnetic radiation and matter. Student can describe the principles used when the wave functions and energies of some simple systems are determined. Student can take advantage of the periodic table of elements in finding the chemical and physical properties of atoms based on its electronic structure. Student can explain the physical conditions necessary when molecular bonds are created and can describe the basics of vibrational, rotational and electronical energy states of molecules.

Contents:

The quantum mechanics is one of the important theories of modern physics. Quantum mechanical theory has changed our understanding of the universe, especially the nature of matter and radiation. In the atom physics course, the quantum mechanics is examined with the aid of simple examples. The quantum mechanical phenomena occur only when investigating the microscopical elements of matter, i.e. atoms, electrons and nuclei. In the beginning of the course, the historical events which led to the development of the quantum mechanics in the early 20th century are discussed. In this context, the interaction processes between matter and electromagnetic radiation, like black-body radiation, the photoelectric effect, and scattering, are examined. In quantum mechanics, particles are usually described with the aid of wave functions. De Broglie wavelength, the group and phase velocities of particles, and Heisenberg uncertainty principle serve as introduction to the wave properties of particles. The Bohr's atomic model, electronic transitions of atoms, and emission spectra of atoms are also discussed in the first part of the atom physics course.
The second part of the course goes deeper into the quantum mechanics. The solution of wave functions and energies for some simple systems, like hydrogen atom, are described. Additionally, many-electron atoms, molecules, and chemical bondings of atoms are discussed briefly. Some modern research methods which are used to study the atomic and molecular physics are introduced. Applications which exploit the atom physical phenomena in everyday life are also discussed.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 46 h, exercises 24 h, self-study 90 h

Target group:

No specific target qroup

Prerequisites and co-requisites:

No specific prerequisites

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Books: A. Beiser: Concepts of Modern Physics, McGraw-Hill Inc., R. Eisberg and R. Resnick: Quantum physics of atoms, molecules, solids, nuclei and particles, John Wiley & Sons.
Course material availability can be checked here.

Assessment methods and criteria:

Two written intermediate examinations or one final examination
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Saana-Maija Huttula

Working life cooperation:

No work placement period

Other information:

https://wiki.oulu.fi/display/766326A/

766329A: Wave motion and optics, 6 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

761310A	Wave motion and optics	5.0 op
761310A-01	Wave motion and optics, lectures and exam	0.0 op
761310A-02	Wave motion and optics, lab. exercises	0.0 op
766349A	Wave motion and optics	7.0 op

ECTS Credits:

6 credits

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, production and measurement of light, propagation of light, image formation in mirrors and lenses, matrix method in ray tracing, aberrations, optical instruments, interference, interferometry, polarization, Fraunhofer diffraction, diffraction grating, laser principles.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 46 h, exercises 24 h, self-study 90 h

Target group:

No specific target qroup

Prerequisites and co-requisites:

763101P Mathematics for physics

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.
Course material availability can be checked here.

Assessment methods and criteria:

Four written intermediate examinations or one final examination
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0 – 5, where 0 = fail

Person responsible:

Seppo Alanko

Working life cooperation:

No work placement period

Other information:

https://noppa.oulu.fi/noppa/kurssi/766329a/etusivu

521209A: Electronics Components and Materials, 2 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Jari Hannu
Opintokohteen kielet: Finnish
Leikkaavuudet:

521077P	Introduction to Electronics	5.0 op

ECTS Credits:

2

Language of instruction:

Finnish

Timing:

4-5

Learning outcomes:

Student is able to identify and classify electronics components and compare their properties. Students can describe electric conductivity and apply the phenomenon on designing and choosing resistors. Student is able to estimate the difference between dielectric materials and how they affect the properties of a capacitor. Student can compare properties of magnetic materials and how identify they affect on inductive components. Student can identify semiconductivity and is able to list typical semiconductor components. Student can classify different circuit board techniques and is able to choose proper coupling techniques. In addition student can identify the future technologies of electronics materials

Contents:

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:

Classroom teaching

Learning activities and teaching methods:

Lectures (24 h) and lecture exercises. The course is passed by a final exam or other method presented at the lectures.

Target group:

First year electrical engineering students.

Prerequisites and co-requisites:

None.

Recommended optional programme components:

Electricity and Magnetism

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:

Lecture assignments and final exam
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Jari Hannu

Working life cooperation:

-

Other information:

-

521205A: Principles of Semiconductor Devices, 4,5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Hagberg
Opintokohteen kielet: Finnish
Leikkaavuudet:

521071A	Principles of Semiconductor Devices	5.0 op

ECTS Credits:

4,5

Language of instruction:

Finnish / English

Timing:

Periods 4 - 6

Learning outcomes:

Student will be able to explain physical phenomena in semiconductor materials and junctions; describe main types and characteristics of semiconductor diodes and transistors. Student 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. Schwitching devices.

Mode of delivery:

Lectures and exercises.

Learning activities and teaching methods:

Lectures 30h/ Exercises 30h/ Self-study 60h.

Target group:

-

Prerequisites and co-requisites:

521104P Introduction to materials physics.

Recommended optional programme components:

-

Recommended or required reading:

Lectures. 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:

Numerical grading 1 – 5.

Person responsible:

Juha Hagberg

Working life cooperation:

-

Other information:

-

521104P: Introduction to Material Physics, 5 op

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

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Periods 1-3.

Learning outcomes:

After completing the course, student is able to explain the basic concepts related to materials physics. The student can outline the crystal structure of the solids and the crystalline binding and is able to explain the principles of the theory used in describing the different kinds of waves traveling in solids. Moreover, he or she can explain the principles of statistical mechanism and use them to explore thermal properties of the solid. The student can also outline the free electron model of metals and the formation of the energy band structure of the crystals and their significance to the electrical properties of materials. He or she is able to explain the basic phenomena related to semiconductors and is able to calculate the charge carrier distributions in them.

Contents:

Crystal structures and cohesion. Waves and defects in crystals. Basic principles of quantum mechanics and thermal properties (statistics). Free electron model of metals, energy bands and Brillouin zones in crystals. Basic phenomena of semiconductors.

Mode of delivery:

Lectures, exercises and assignments.

Learning activities and teaching methods:

Lectures 30 h, and exercises 30 h, assignments 30 h, independent study 45 h.

Target group:

-

Prerequisites and co-requisites:

Required physics and mathematics courses.

Recommended optional programme components:

The student should take the course 766326A Atomifysiikka at same time or beforehand.

Recommended or required reading:

H.M. Rosenberg: The Solid State, Clarendon Press, Oxford, 1988. B. Streetman: Solid State Electronic Devices, Prentice Hall, New Jersey, 1995.

Assessment methods and criteria:

Grade is based on exams and assignments, grading principles will be defined in the beginning of the course.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numeric grading 1-5.

Person responsible:

Juha Hagberg

Working life cooperation:

-

Other information:

-

521302A: Circuit Theory 1, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
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:

Autumn, periods 1-3

Learning outcomes:

After the course the student can

- write and solve the equations describing the operation of a given electrical circuit
- solve the sinusoidal steady-state solution using complex phasor arithmetics
- solve time responses of electric circuits
- simplify electrical circuits e.g. using equivalent circuits

- 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, 22 h exercises, and a simulation exercise (10h)

Target group:

Finnish BSc students.

Prerequisites and co-requisites:

Matrix algebra, complex arithmetics, differential equations.

Recommended optional programme components:

-

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:

-

521306A: Circuit Theory 2, 4 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Rahkonen, Timo Erkki
Opintokohteen kielet: Finnish
Leikkaavuudet:

521303A	Circuit Theory 2	5.0 op

ECTS Credits:

4

Language of instruction:

Finnish. Exams can be arranged in English on demand.

Timing:

Spring, periods 5-6

Learning outcomes:

After the course the student can

- use Laplace transform for solving time and frequency response of electric circuits

- derive continous-time transfer functions., solve their poles and zeros and understand the meaning of those
- draw the pole-zero map and Bode plots of any given transfer function
- 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.

Target group:

Finnish BSc students.

Prerequisites and co-requisites:

Basics of circuit theory, differential equations.

Recommended optional programme components:

-

Recommended or required reading:

Nilsson, Riedel: Electric Circuits (6th or 7th ed., Prentice-Hall 1996), Chapters 12-18.

Assessment methods and criteria:

Course is examined by a final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

Other information:

-

521412A: Digital Techniques 1, 6 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Antti Mäntyniemi
Opintokohteen kielet: Finnish
Leikkaavuudet:

521301A	Digital Techniques 1	8.0 op

ECTS Credits:

6

Language of instruction:

In Finnish.

Timing:

Period 1-3

Learning outcomes:

Learning outcomes: 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. 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. Based on this knowledge, students are able to implement and analyze digital devices consisting of ordinary simple digital components, especially FPGA circuits. 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:

Principles of digital devices, Boolean algebra, number notations, analyze and synthesis of combinatorial circuits, flip-flops, principles of state machine behavior, CPLD- and FPGA-circuits, physical characteristics of CMOS technology.

Mode of delivery:

Classroom

Learning activities and teaching methods:

Lectures 40h/ exercises 20h (group exercises)

Target group:

1st year students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Brown, S., Vranesic, Z. Fundamentals of Digital Logic with VHDL Design, McGraw Hill, 2005, materials in Optima.

Assessment methods and criteria:

Compulsory exercises and exam. Recommended by partial exams.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Exercises: pass/fail. Final grading for the exam 1 – 5.

Person responsible:

Antti Mäntyniemi

Working life cooperation:

-

Other information:

-

521431A: Principles of Electronics Design, 5 op

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

ECTS Credits:

5

Language of instruction:

Finnish.

Timing:

Spring, periods 4-6

Learning outcomes:

On completion of the study module students 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, operational amplifier, 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.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30 h and exercises 20 h.

Target group:

-

Prerequisites and co-requisites:

Circuit Theory I

Recommended optional programme components:

Recommended course Principles of Semiconductor Devices

Recommended or required reading:

Lecture notes, Razavi: Fundamentals of Microelectronics (John Wiley & Sons 2008), chapters 1-8 and 15 partially or Sedra & Smith : Microelectronic Circuits (6th ed.), chapters 1-5 and 14.

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 Häkkinen

Working life cooperation:

-

Other information:

-

521432A: Electronics Design I, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Ilkka Nissinen, Jan Nissinen
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish.

Timing:

Autumn, periods 1-3

Learning outcomes:

On completion of the study module students should be able to recount the principles covering the design of multistage amplifiers, analyze and set the frequency response of a transistor amplifier and make use of feedback to improve the properties of an amplifier in the desired manner. They should also be able to analyze the stability of a given degree of feedback amplification and to dimension an amplifier correctly to ensure stability. Students should similarly be able to describe the principles governing the design of power amplifiers, 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. They should be able to design low-frequency oscillators, to explain the operating principles of radio frequency oscillators and tuned amplifiers and to recount the basic principles governing the functions and properties of emitter-coupled logic.

Contents:

Frequency response of a transistor amplifier, differential amplifier, feedback, stability and nonidealities of a feedback amplifier, comparator, output stages and power amplifiers, applications of operational amplifier, oscillators, tuned amplifiers and ECL logic.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 40 h and exercises 20 h.

Target group:

Not defined.

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, Razavi: Fundamentals of Microelectronics (John Wiley & Sons 2008), chapters 10-13-8 and 14, partially or Sedra & Smith : Microelectronic Circuits (6th ed.), chapters 7,8,9,13 and partially 11 and 12.

Assessment methods and criteria:

Final or 2 mid-term exams.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 1-5.

Person responsible:

Ilkka Nissinen, Jan Nissinen

Working life cooperation:

-

Other information:

-

521267A: Computer Engineering, 4 op

Voimassaolo: 01.08.2005 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Teemu Tokola, Juha Röning
Opintokohteen kielet: Finnish
Leikkaavuudet:

810122P	Computer Architecture	5.0 op

ECTS Credits:

4

Language of instruction:

Finnish.

Timing:

The course unit is held in the spring semester, during periods 4 - 6. It is recommended to complete the course at the beginning of studies.

Learning outcomes:

The aim of the course is to provide basic understanding to the operation of a digital computer, and to provide basic knowledge for programming using a symbolic programming language. After passing the course, student can explain the basic operation principle of a computer, the phases of an instruction execution, and an interrupt mechanism. The student can explain the basic organization of a computer including CPU, ALU, memory, I/O device, bus, and a register. The student can describe some basic operations of a computer using a register transfer language, and explain the role of instruction format as a part of the control logic. The student can perform conversions between number systems such as decimal, binary and hexadecimal systems. The student can use and interpret the basic data representations used in a digital computer such as integers, fixed point numbers, floating point numbers, and ASCII symbols. The student can explain the arithmetic operations performed using two's complement, the basic principles of a RISC architecture, and the connection of these principles to the performance of the computer. The student can explain a typical memory organization and terms like address space, cache memory, and virtual memory. The student can explain the principles of asynchronous communication, and the operation of the assembler. The student can create small programs using an assembly language.

Contents:

Computer organization and architecture, the operation principle of a computer, register transfer language, data types, interrupt, I/O devices, and memory organization. Assembly language and the operation of an assembler.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 30h, exercises 18h, programming exercise 8h, and exam. 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:

Student must have completed the following courses are completed prior to applying for the course: 521412A Digital Techniques I.

Recommended optional programme components:

-

Recommended or required reading:

Mano M., Computer System Architecture. Prentice Hall, Eng-lewood Cliffs, New Jersey 1993.

Patterson D., Hennessy J., Computer Organization and Design. Morgan Kauffman, San Fracisco, CA, 2005.

Assessment methods and criteria:

Exam and programming 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, Teemu Tokola

Working life cooperation:

-

521109A: Electrical Measurement Principles, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Saarela

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Lectures are in Finnish. Laboratory exercises and exams can be done in English.

Timing:

Periods 1-3.

Learning outcomes:

Upon completion of the course, students are be able to measure basic measurements with a ammeter, voltmeter and oscilloscope. They can operate signal and function generators. They can 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 safety regulations.

Mode of delivery:

Pure face-to-face teaching.

Learning activities and teaching methods:

Lectures 20h and laboratory exercises 16 h, independent work 100 h.

Target group:

Course is compulsory for electrical engineering, information engineering and wellness technology students.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Ask the person responsible for English material. (Lectures are based on some chapters of book: W.D. Cooper: Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall, 1990. English labwork material is available.

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:

-

Other information:

-

521337A: Digital Filters, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannuksela, Jari Samuli

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521337A Digital Filters (OPEN UNI) 5.0 op

ECTS Credits:

5

Language of instruction:

Finnish, English study material available

Timing:

Spring, period 5-6.

Learning outcomes:

Upon completing the required coursework, the student is able to specify and design respective frequency selective FIR and IIR filters using the most common methods. He is also 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 filters. Moreover, the student is able to explain the impacts of finite word length in filter design. After the course the 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:

031018P Complex Analysis, 031050A 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:

Jari Hannuksela

Working life cooperation:

None.

521357A: Telecommunication Engineering 1, 3 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Heikki Antero Kärkkäinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521330A Telecommunication Engineering 5.0 op

ECTS Credits:

3

Language of instruction:

Finnish

Timing:

Spring, periods 5-6

Learning outcomes:

After completing the course student can identify operation principles of the most important functional blocks for an analog telecommunication system. Student aslo recognizes various radio signal propagation models. Student understands operation principles of various analog carrier and pulse modulation methods both in time and frequency domains. Student can also analyze the limitations resulting from channel interference and also estimate the influence of non-ideal realizations and operations on system performance. Student can also perform numerical SNR-calculations.

Contents:

Basic blocks of a communication system, radio channel properties from a standpoint of information transmission, linear and non-linear modulations, analog and digital pulse modulations, superheterodyne receiver (mixing), phase-lock loop and its applications, multiplexing methods, comparison of modulation methods without interference, SNR performance analysis of various continuous-wave and pulse modulations and their comparison, influence of a single-tone interference and phase-error, threshold effect, methods to improve system performance.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 10 h

Target group:

2 nd year bachelor’s degree students

Prerequisites and co-requisites:

Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture slides available in Finnish from TTK-OPTIMA system. Slides are based on the coursebooks: R.E. Ziemer & W.H. Tranter: Principles of Communications # Systems, Modulation and Noise, 6 th edition, 2010, John Wiley & Sons, chapters 1, 3 and 7. S.R. Saunders & A. Aragón-Zavala: Antennas and Propagation for Wireless Communication Systems, 2 nd edition, 2007, John Wiley & Sons, selected parts.

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:

Kari Kärkkäinen

Working life cooperation:

-

Other information:

-

521361A: Telecommunication Engineering II, 3 op

Voimassaolo: 01.08.1950 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Heikki Antero Kärkkäinen
Opintokohteen kielet: Finnish
Leikkaavuudet:

521330A	Telecommunication Engineering	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish

Timing:

Fall, periods 2-3

Learning outcomes:

After completing the course student can tell and analyze the essential and optional blocks of a digital communication system both in time and in frequency domain. Student also understands limitations resulting from transmission channel and can propose various methods to combat such effects. Using simple assumptions, student can analyze system performance mathematically and compare various modulation methods from the standpoint point of system resources. Student can evaluate standards and specifications of communication systems. Student can also apply obtained knowledge for practical system and sub-system design.

Contents:

Basic blocks of a digital transmission system, baseband digital transmission, binary and M-ary digital continuous-wave modulations, correlation and matched filter receivers and their bit error probability performance with AWGN channel, effects of band-limiting and multipath propagation and methods to combat against such effects, basics of information theory, basics of source coding and error-correction coding methods.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 10

Target group:

3 rd year bachelor's degree students

Prerequisites and co-requisites:

Signal Analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture slides available in Finnish from TTK-OPTIMA system. Slides are based on the coursebook: R.E. Ziemer & W. H. Tranter: Principles of Communications - Systems, Modulation and Noise, 6th edition, 2010, John Wiley & Sons, selected parts of chapters 8, 9, 10, and 11.

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:

Kari Kärkkäinen

Working life cooperation:

-

Other information:

-

521384A: Basics in Radio Engineering, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Fall, periods 1-2

Learning outcomes:

After completing the course the student can define what radio engineering is and list its separate areas. He /she is also able to describe different terms and applications of radio engineering. Using Maxwell's equations the student can solve the propagation of radio waves in a homogeneous medium, the reflection and transmission at an interface of two lossless media, the power and energy of the electromagnetic fields, as well as, the radio wave propagate on in common transmission lines and waveguides. In addition, he/she is able to apply these solutions to typical problems in radio engineering. The student can utilize the methods based on the Smith chart for the impedance matching of microwave circuits and antennas. He /she can describe the operation of passive transmission line and waveguide devices, resonators and filters, as well as, the operation of the circuits based on the semiconductor devices. In addition, he/she is able to calculate their characteristics with the microwave circuit theory. The student is capable to describe the antenna terms, to classify antenna types and antenna arrays, as well as, to calculate the electromagnetic fields radiated by them. He/she can classify and describe the most significant radio wave propagation mechanisms occurring over the radio links on the Earth's surface, through the troposphere and via the ionosphere. The student is able to summarize the structure of a radio system and to calculate the properties of its blocks. In addition, he/she can design a free-space radio link using the link budget. The

student can identify the biological effects and safety standards of radio waves and can apply them to himself or herself and to other people.

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. Biological effects and safety standards.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures 26 h and exercises 16 h.

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 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:

Markus Berg

Working life cooperation:

-

Other information:

-

521141P: Elementary Programming, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Mika Rautiainen
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay521141P	Elementary Programming (OPEN UNI)	5.0 op

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5

Language of instruction:

Finnish, the course can be completed in English by answering the lecture questions and doing the programming exercises and the final exercise.

Timing:

Fall, periods 1-3.

Learning outcomes:

Upon completing the required coursework, the student is able to explain the basic programming concepts and structures and to solve problems using these concepts and structures. Moreover, the student is able to implement small programs independently.

Contents:

Basic concepts of programming, basic structures of programming languages, solving problems by programming.

Mode of delivery:

Web-based teaching + face-to-face teaching

Learning activities and teaching methods:

Study materials web. 20 h lectures with intergrated exercises; in addition, appr. 10 h voluntary guided practising, the rest as independent work.

Target group:

1 st year students of computer science and engineering and electrical engineering 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:

Will be announced at the beginning of the course.

Assessment methods and criteria:

Students answer questions after each lecture and do the programming exercises and the final exercise. Assessment is based on these three elements; passing the course requires points from each element. More detailed information on assessment can be found from http://www.oulu.fi/cse/studying/courses. Read more about assessment criteria at the University of Oulu webpage.

Grading:

pass7fail.

Person responsible:

Mika Rautiainen

Working life cooperation:

-

521142A: Embedded Systems Programming, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Riekki, Jukka Pekka

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:

5

Language of instruction:

Finnish, the course can be completed in English by answering the lecture questions and by doing the laboratory exercise, the programming exercises and the final exercise.

Timing:

Spring, periods 4-6.

Learning outcomes:

Upon completing the required coursework, the student is able to implement small C programs both in Unix environment and for embedded systems with memory-mapped I/O. Moreover, the student is able to recognize how embedded systems programming differs from programming general-purpose computers.

Contents:

Basics of C, bitwise operations, memory management, memory-mapped I/O devices, hardware registers, interrupts, compiling and linking.

Mode of delivery:

Web-based teaching + face-to-face teaching

Learning activities and teaching methods:

20 h lectures, 3 h laboratory exercise; 10-20 h voluntary guided practising, the rest as independent work alone and in the two-person groups.

Target group:

1st year students of computer science and engineering and electrical engineering and other Students of the University of Oulu.

Prerequisites and co-requisites:

The following courses must be completed prior to applying for the course: 521141P Elementary programming.

Recommended optional programme components:

The course “521267A Computer Engineering” is recommended to be completed simultaneously.

Recommended or required reading:

Will be announced at the beginning of the course.

Assessment methods and criteria:

Students answer questions after each lecture, participate the laboratory exercise, and do the programming exercises and the final exercise. Assessment is based on these three elements; passing the course requires points from each element. More detailed information on assessment can be found from http://www.oulu.fi/cse/studying/courses.
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:

Jukka Riekki

Working life cooperation:

-

A451121: Module Preparing for the Option, Electronics, 20 - 30 op

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

Ei opintojaksokuvauksia.

Compulsory studies

521331A: Filters, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Rahkonen, Timo Erkki

Opintokohteen kielet: Finnish

Leikkaavuudet:

521304A Filters 5.0 op

ECTS Credits:

4

Language of instruction:

Finnish. Exams can be arranged in English on demand.

Timing:

Autumn, periods 3-4. Will be transferred to periods 4-6 in spring 2014.

Learning outcomes:

After the course the student can

- draw a pole-zero map for a given transfer function
- perform impedance and frequency scaling for component values
- choose an appropriate prototype filter and filter degree
- synthesize passive RLC filters
- synthesize active opamp based filters
- can compare various filter technologies
- 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:

Classroom

Learning activities and teaching methods:

25h lectures, 16 h exercises. A design excersice (15h).

Target group:

Finnish students

Prerequisites and co-requisites:

Basics of circuit theory and analog design.

Recommended optional programme components:

Course Digital filters expands the topic into digital domain.

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:

1-5

Person responsible:

Prof. Timo Rahkonen

Working life cooperation:

-

Other information:

-

521218A: Introduction to Microfabrication Techniques, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Teirikangas, Merja Elina

Opintokohteen kielet: Finnish

Leikkaavuudet:

521070A Introduction to Microfabrication Techniques 5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish.

Timing:

Periods 4-6

Learning outcomes:

Upon completing the course the student is able
- to explain properties of micro- and nanoelectronics and micro- and nanomechanics materials, processing of source materials and basics of fabrication methods
- utilize the knowledge given by the course in developing applications to be realized by micro- and nanofabrication methods.

Contents:

Lithography. Film growing methods. Dry and wet etching methods. Bulk and surface micromachining. Materials, devices and fabrication methods of integrated circuits. Considerations of modeling, packaging, scaling and power in miniaturized systems. Application examples.

Mode of delivery:

The course will be implemented as face to face teaching.

Learning activities and teaching methods:

24 hours lectures. Demonstrations and design exercises.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is to familiarize with the courses 521104P Introduction to Materials Physics and 521205A Principles of Semiconductor Devices.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Text book will be shown later.

Assessment methods and criteria:

Final exam and passing both design exercise and demonstration.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Merja Teirikangas

Working life cooperation:

-

Other information:

-

521430A: Electronic Measurement Techniques, 6 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Saarela
Opintokohteen kielet: Finnish
Leikkaavuudet:

521092A	Electronic Measurement Techniques	5.0 op
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

ECTS Credits:

6,0

Language of instruction:

Lectures are in Finnish. Calculation exercises are in Finnish but same material is available in English. Laboratory exercises can be done in English.

Timing:

4-6 (next in 2015)

Learning outcomes:

The goal of the course is to deepen the knowledge of the field of electronic measurement techniques, to become familiar with censoring principles, measurements of amplifier and filter properties, interference problems and common connector and digital interface solutions and the principles of the processing of measurement results.
Learning outcomes: Upon completion of the course, students can plan and implement complicated measurements with oscilloscopes and basic measurements with spectrum analyzers and light detectors. Students can measure common sources of noise and interference and can name means to control them. Students can name methods to realize electrical quantities.

Contents:

Calibration, measurement amplifiers, spectrum analysers and correlation measurements, noise and interference, grounding, CMR and processing of measurement results

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures and laboratory exercises. One or two exams and passed lab exercises.

Target group:

Course is compulsory for electrical engineering, information engineering and wellness technology students.

Prerequisites and co-requisites:

Electrical Measurement Principles, Analogue Electronics I, Digital Techniques I.

Recommended optional programme components:

Replaces course 521171A, 6,5 cr

Recommended or required reading:

Ask the lecturer.

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Juha Saarela

Working life cooperation:

-

Other information:

-

521404A: Digital Techniques 2, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Jukka Lahti
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

After completing this course the student 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.

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:

Finnish BSc students.

Prerequisites and co-requisites:

Digital techniques I.

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

Final exam or term exams, and a design excercise.
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:

-

521433A: Laboratory Exercises on Analogue Electronics, 3 op

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

521307A	Laboratory Exercises on Analogue Electronics	5.0 op

ECTS Credits:

3

Language of instruction:

Finnish, English.

Timing:

1 - 3

Learning outcomes:

On completion of the study module students should be able to design basic electronic structural blocks and verify their functionality in a CAD simulation environment. They should be able independently to realize and test a small-scale design object employing analogue circuit techniques.

Contents:

Passive RC-circuits, diodes and their applications, bipolar junction transistor, MOS-transistors, operational amplifiers and their applications, power amplifiers.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Independent work.

Target group:

-

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:

Principles of Electronics Design and Electronics Design I.

Recommended or required reading:

Not defined.

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:

None.

Other information:

None

A451122: Module Preparing for the Option, Technical Physics, 20 - 30 op

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

Ei opintojaksokuvauksia.

Compulsory studies

766328A: Thermophysics, 6 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

761314A	Thermophysics	5.0 op
766348A	Thermophysics	7.0 op
761102P	Basic Thermodynamics	2.0 op

ECTS Credits:

6 credits

Language of instruction:

Finnish

Timing:

Third autumn semester

Learning outcomes:

The student can explain the basic principles of thermophysics and can derive their consequences in the extent and level of the lectures (see Contents). In addition, he/she can solve problems which require profound understanding of the essential contents of the course.

Contents:

The goal of the course is to explain how the macroscopic thermophysical properties of a system (e.g., equation of state) can be derived from its fundamental microscopic properties (e.g., from the behavior of the molecules). For this purpose, the students are given a physically clear understanding of the basic principles of thermophysics, recognizing the fundamental role of its statistical nature. Topics will include: Basic concepts, The first law, Thermal expansion, heat transfer, and diffusion, The second law, The combined law, Heat engines and refrigerators, Thermodynamic potentials, Phases of matter, Classical ideal gas, Classical and open systems, Quantal ideal gas.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 46 h, 12 exercises (24 h), self-study 90 h

Target group:

Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.

Prerequisites and co-requisites:

No specific prerequisites

Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously

Recommended or required reading:

Textbooks: H. D. Young and R. A. Freedman: University Physics, 13th edition, Pearson Addison-Wesley, 2012, or earlier editions (in part), F. Mandl: Statistical Physics, second edition, John Wiley & Sons Ltd., 1988 (in part).
Lecture notes: Juhani Lounila: 766328A Termofysiikka, Oulun yliopisto, 2013.
Course material availability can be checked here.

Assessment methods and criteria:

Two written intermediate examinations or one final examination
Read more about assessment criteria at the University of Oulu webpage.

Grading:

Numerical grading scale 0-5, where 0 = fail

Person responsible:

Juhani Lounila

Working life cooperation:

No work placement period

Other information:

https://wiki.oulu.fi/display/766328A/

780109P: Basic Principles in Chemistry, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Minna Tiainen
Opintokohteen oppimateriaali:
Petrucci, Ralph H., , 2002
Opintokohteen kielet: Finnish
Leikkaavuudet:

780120P	Basic Principles in Chemistry	5.0 op
ay780117P	General and Inorganic Chemistry A (OPEN UNI)	5.0 op
780115P	General and Inorganic Chemistry II	6.0 op
780114P	General and Inorganic Chemistry I	6.0 op
780113P	Introduction to Chemistry	12.0 op
780101P	Introduction to Physical Chemistry	7.0 op
780101P2	Physical Chemistry I	4.0 op
780107P	Basic Course in Inorganic and Physical Chemistry	7.5 op
780152P	Inorganic and Physical Chemistry I	7.5 op
780153P	General and Inorganic Chemistry	7.5 op
780154P	Basic Inorganic Chemistry	7.5 op

ECTS Credits:

4 credits/107 hours of work

Language of instruction:

Finnish

Timing:

1st autumn

Learning outcomes:

Upon completion of the course, the student will be able to display an understanding of basic chemistry phenomenon; equilibrium of acids and bases, chemical equilibrium, redox reactions and stoichiometry.

Contents:

Introduction to chemistry, stoichiometry, redox reactions, chemical equilibrium, the equilibrium of acid and bases, buffer solutions, titration.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

36 hours of lectures/ self –study 71 hours

Target group:

Biology, Geology, Mechanical Engineering, Process Engineering, Environmental Engineering compulsory. Geography, optional.

Prerequisites and co-requisites:

No specific prerequisites

Recommended optional programme components:

This course has partly the same contents as the courses General and Inorganic Chemistry I and II (780114P and 780115P) or Introduction to Chemistry (780113P) (and the course Introduction to Physical Chemistry). If the student performs also the courses Inorganic Chemistry I and II (780114P and 780115P) or Introduction to Chemistry, this course will be cancelled in his/hers study register.

Recommended or required reading:

Petrucci, R.H., Harwood, W.S., and Herring, F.G.: General Chemistry: Principles and Modern Applications, Prentice Hall, 8th edition (2002) (Chapters 1-6, 10, 16-18) or a newer edition.

Assessment methods and criteria:

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

Grading:

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

Person responsible:

Lecturer Minna Tiainen

Working life cooperation:

No

Other information:

This course is only for students who have chemistry as a minor subject.

521218A: Introduction to Microfabrication Techniques, 4 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Teirikangas, Merja Elina
Opintokohteen kielet: Finnish
Leikkaavuudet:

521070A Introduction to Microfabrication Techniques 5.0 op

ECTS Credits:

4

Language of instruction:

In Finnish.

Timing:

Periods 4-6

Learning outcomes:

Upon completing the course the student is able
- to explain properties of micro- and nanoelectronics and micro- and nanomechanics materials, processing of source materials and basics of fabrication methods
- utilize the knowledge given by the course in developing applications to be realized by micro- and nanofabrication methods.

Contents:

Lithography. Film growing methods. Dry and wet etching methods. Bulk and surface micromachining. Materials, devices and fabrication methods of integrated circuits. Considerations of modeling, packaging, scaling and power in miniaturized systems. Application examples.

Mode of delivery:

The course will be implemented as face to face teaching.

Learning activities and teaching methods:

24 hours lectures. Demonstrations and design exercises.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is to familiarize with the courses 521104P Introduction to Materials Physics and 521205A Principles of Semiconductor Devices.

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Text book will be shown later.

Assessment methods and criteria:

Final exam and passing both design exercise and demonstration.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Merja Teirikangas

Working life cooperation:

-

Other information:

-

521430A: Electronic Measurement Techniques, 6 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha Saarela
Opintokohteen kielet: Finnish

Leikkaavuudet:

521092A	Electronic Measurement Techniques	5.0 op
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

ECTS Credits:

6,0

Language of instruction:

Lectures are in Finnish. Calculation exercises are in Finnish but same material is available in English. Laboratory exercises can be done in English.

Timing:

4-6 (next in 2015)

Learning outcomes:

The goal of the course is to deepen the knowledge of the field of electronic measurement techniques, to become familiar with censoring principles, measurements of amplifier and filter properties, interference problems and common connector and digital interface solutions and the principles of the processing of measurement results.
Learning outcomes: Upon completion of the course, students can plan and implement complicated measurements with oscilloscopes and basic measurements with spectrum analyzers and light detectors. Students can measure common sources of noise and interference and can name means to control them. Students can name methods to realize electrical quantities.

Contents:

Calibration, measurement amplifiers, spectrum analysers and correlation measurements, noise and interference, grounding, CMR and processing of measurement results

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

Lectures and laboratory exercises. One or two exams and passed lab exercises.

Target group:

Course is compulsory for electrical engineering, information engineering and wellness technology students.

Prerequisites and co-requisites:

Electrical Measurement Principles, Analogue Electronics I, Digital Techniques I.

Recommended optional programme components:

Replaces course 521171A, 6,5 cr

Recommended or required reading:

Ask the lecturer.

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Juha Saarela

Working life cooperation:

-

Other information:

-

A451123: Module Preparing for the Option, Telecommunication Engineering, 20 - 40 op

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

Ei opintojaksokuvauksia.

Compulsory studies

521484S: Statistical Signal Processing, 5 op

Voimassaolo: - 31.07.2012
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Heikkilä, Janne Tapani
Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

In Finnish.

Timing:

Periods 4-6.

Learning outcomes:

Upon completion of the course, the student is able to utilize the generic linear model as a representation for parameter estimation. He can apply typical deterministic and random parameter estimation methods for different estimation problems. He is able to determine statistical properties of estimators and make comparisons between them. The student can also form a basic state-variable model and utilize Kalman filtering for state estimation. Moreover, he is able to apply basic methods of detection theory for solving simple detection problems. After the course, the student can implement the learned methods and assess their statistical properties with the Matlab software.

Contents:

1. Introduction, 2. Modeling of estimation problems, 3. Least Squares estimation, 4. BLUE-estimation, 5. Signal detection, 6. ML estimation, 7. MS estimation, 8. MAP estimation, 9. Kalman Filter.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (30 h), exercises (24 h) and Matlab design exercise (10 h).

Target group:

-

Prerequisites and co-requisites:

Matrix Algebra, Probability and Mathematical Statistics

Recommended optional programme components:

Digital Filters, Signal Analysis

Recommended or required reading:

J. Mendel: Lectures in estimation theory for signal processing, communications and control, Prentice-Hall, 1995. M.D. Srinath, P.K. Rajasekaran, R. Viswanathan: Introduction to Statistical Signal Processing with Applications, Prentice-Hall, 1996, Chapter 3. Lecture notes and exercise material.

Assessment methods and criteria:

The course is passed with intermediate exams or final exam and accepted Matlab exercise.

Grading:

Numeric scale 1-5

Person responsible:

Janne Heikkilä

Working life cooperation:

-

Other information:

-

521370A: Laboratory Exercises in Telecommunication Engineering, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha-Pekka Mäkelä

Opintokohteen kielet: Finnish

ECTS Credits:

5

Language of instruction:

Finnish

Timing:

Spring, periods 4-6

Learning outcomes:

Upon completing the required coursework, the student is able to use a spectrum analyzer for basic radio frequency measurements. The student can operate a vector signal analyzer and analyze the obtained results. The course gives skills to measure and analyze basic properties of a radio frequency amplifier and other components used in radio systems. In addition, the student is also capable of building a simple digital communication link and measuring its performance using spectrum and vector signal analyzers.

Contents:

Radio interface and spectrum. Measurements of radio system components. Performance measurements of communication systems. Radio channel measurements.

Mode of delivery:

Independent work.

Learning activities and teaching methods:

Exercises including measurements and documentation of results.

Target group:

3 rd year bachelor’s degree students

Prerequisites and co-requisites:

Telecommunication Engineering I, Telecommunication Engineering II, Basics of Radio Engineering

Recommended optional programme components:

-

Recommended or required reading:

Laboratory exercise manual(s)

Assessment methods and criteria:

Evaluated written reports
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 Mäkelä/Risto Vuohtoniemi

Working life cooperation:

-

Other information:

The course introduces the student to a range of common measurement instruments used in radio and communications engineering. In addition, the course introduces the student to performance measurements and measurement documentation in the field of communication systems.

521316A: Broadband Communications Systems, 4 op

Voimassaolo: 01.08.2006 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Opettajat: Matti Latva-aho
Opintokohteen kielet: Finnish
Leikkaavuudet:

521329A	Hands-on Course in Wireless Communication	5.0 op
521307A	Laboratory Exercises on Analogue Electronics	5.0 op
521316S	Introduction to Broadband Transmission Techniques	5.0 op

ECTS Credits:

4

Language of instruction:

Finnish

Timing:

Spring, periods 4-6

Learning outcomes:

Upon completing the required coursework, student can distinguish the basic transmission technologies used in the most important commercial wireless communication systems. Furthermore, the student can differentiate and compare the key points behind these technologies, why they are used and what are their advantages and disadvantages. Student can explain how the wireless channel impacts the design of the overall system. The most relevant standards are introduced and explained, so that student can attain information from past and especially the forthcoming wireless standards. Student can also observe and explain the performance of these technologies with variable system and channel parameters through the course laboratory exercise.

Contents:

Digital transmission link, wideband radio channels, multiple access techniques, spread spectrum and DS-CDMA techniques, OFDM techniques, UWB techniques, applications and most common standards

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 20 h and the compulsory design work with a simulation program (20 h).

Target group:

3 rd year bachelor's degree students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Defined during the lectures.

Assessment methods and criteria:

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

Grading:

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

Person responsible:

Matti Latva-aho, Petri Luoto

Working life cooperation:

-

Other information:

-

A451124: Module Preparing for the Option, Prerequisite for Physics Teacher Education (obligatory), 20 - 31 op

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

Ei opintojaksokuvauksia.

Compulsory

802357A: Euclidean Spaces, 5 op

Voimassaolo: 01.06.2015 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

802352A Euclidean Topology 4.0 op

Ei opintojaksokuvauksia.

802164P: Series and Integral, 5 op

Voimassaolo: 01.06.2015 -
Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

800318A Integral 5.0 op
802353A Series and Integrals 6.0 op

Ei opintojaksokuvauksia.

802151P: Introduction to mathematical deduction, 5 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay802151P Introduction to mathematical deduction (OPEN UNI) 5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

Finnish

Timing:

First period at the first semester.

Learning outcomes:

After completing the course, student

- is able to use different methods proving techniques
- is able to use basic set theoretic concepts and definitions
- is able to define and apply basic definitions related to functions

Contents:

The course in an introduction to mathematical deduction and introduces different types of proof techniques. The course covers the concepts familiar from upper secondary school studies more profound way. Main concepts in this course are basic set theory and functions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h, exercises 18h

Target group:

Major and minor students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

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

Grading:

Pass/Fail

Person responsible:

Tero Vedenjuoksu

Working life cooperation:

-

Other information:

Course homepage: https://noppa.oulu.fi/noppa/kurssi/802151p/etusivu

806113P: Introduction to Statistics, 5 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Hanna Heikkinen, Läärä Esa
Opintokohteen oppimateriaali:
Wild, Christopher J. , , 2000
Grönroos, Matti (2) , , 2003
Opintokohteen kielet: Finnish
Leikkaavuudet:

806118P	Introduction to Statistics	5.0 op
806119P	A Second Course in Statistics	5.0 op
806116P	Statistics for Economic Sciences	5.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

3rd period. It is recommended to complete the course at the 1st spring semester.

Learning outcomes:

Upon completion of the course, student will be
- able to identify and define the main principles of statistical research, collection of the data and analysis
- able to apply basic methods of descriptive statistics and statistical inference in simple quantitative research using a statistical software
- able to critically evaluate results of the statistical research presented in media
- prepared for teaching statistics in secondary school and high school
- prepared for participating in a group.

Contents:

- the nature and the meaning of statistics
- data and the acquisition of them: observations, variables, measuring and designs of a study
- the descriptive statistics of empirical distributions: tables, graphical presentations and descriptive measures of center, variation and dependence
- the principles and the basic methods of statistical inference: random sample, sample statistics, point estimation, confidence intervals and statistical testing of hypotheses

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 16 h (partly compulsory) / instructed group work (28 h) / independent work 80 h. Group works will be returned. Additional independently implemented learning diary tasks. Independent work contains also preparation for group work and peer assessment.

Target group:

Students of mathematical sciences and other interested students.

Prerequisites and co-requisites:

The recommended prerequisite prior to enrolling for the course is the completion of the courses: 802151P Introduction to mathematical deduction, 802154P Elementary functions, 802155P Continuity and limit ja 801195P Introduction to Probability Theory.

Recommended optional programme components:

After the course, student is able to continue other statistics courses.

Recommended or required reading:

Lecture notes.

Assessment methods and criteria:

This course utilizes continuous assessment. Practical works and learning diaries are assessed weekly. The assessment of the course is based on the learning outcomes of the course. The more detailed assessment criteria is available in the beginning of the course. In addition one compulsory lecture and peer assessment.
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:

Hanna Heikkinen

Working life cooperation:

No

802328A: Basics in Number Theory, 5 op

Voimassaolo: 01.06.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Tapani Matala-aho
Opintokohteen oppimateriaali:
Hardy, G. H., , 1979
Rosen, Kenneth H., , 1993
Opintokohteen kielet: Finnish

ECTS Credits:

5 cr

Language of instruction:

Finnish/English

Timing:

2.-3. year of studies. Timing varies.

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

In our lectures we consider arithmetical properties of the common numbers involved in studing mathematics and in particular number theory. Also the methods will get a special interest. Examples of the numbers under the research will be binomials, continued fractions, sums of powers and some numbers sharing a name with the mathematicians Bernoulli, Euler, Fermat, Fibonacci, Heron, Lucas, Mersenne, Neper, Pythagoras, Stirling, Wilson and Wolstenholme. From the tools we mention congruences of rational numbers and polynomials, difference operators, generating series, irrationality considerations, matrix presentations, recurrences and telescopes.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

36h lectures, 18h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

802354A Lukuteoria ja ryhmät,
802355A Rings, fields and polynomials
802118P Linear algebra I
802119P Linear algebra II
802352A Euclidean topology
802353A Series and integrals

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes,
G.H. Hardy ja E.M. Wright: An Introduction to the Theory of Numbers;
Kenneth H. Rosen: Elementary number theory and its applications.

Assessment methods and criteria:

Mid-term exams or final exam
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Tapani Matala-aho

Working life cooperation:

-

766330A: Structure of matter, 6 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

763343A	Solid state physics	5.0 op
763333A	Structure of matter I	4.0 op
766334A	Structure of matter II	2.0 op

Ei opintojaksokuvauksia.

A451125: Module Preparing for the Option, Prerequisite for Physics Teacher Education (optional), 9 - 30 op

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

Ei opintojaksokuvauksia.

Choose to get total of 180 ECTS to your degree.

802119P: Linear Algebra II, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen oppimateriaali:
Lay, David C. , , 2003
Opintokohteen kielet: Finnish
Leikkaavuudet:

802320A	Linear Algebra	5.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

First year, 4. period

Learning outcomes:

On successful completion of this course, the student will be able to
- basic properties of inner product spaces
- linear mappings, their matrix representation, and eigen values
- determinants and apply them to problems relating to matrices and linear mappings

Contents:

The aim of the course is to provide the student with the knowledge needed in almost all later courses in mathematics: Abstract vector spaces and subspaces, Linear independence and bases, Inner product spaces, Linear mappings, Determinants, Eigenvalues and Eigenvectors, Hermitian matrices and quadratic forms.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

35 h lectures, 21 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

802119P Linear algebra I

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exam or final exam
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Esa Järvenpää

Working life cooperation:

-

801389A: Basic Geometry, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

801399A	Geometry	5.0 op

ECTS Credits:

6 cr

Learning outcomes:

On successful completion of this course, the student will be able to
- prove simple geometric claims
- solve simple geometric problems with the help of ruler and compass
- solve basic applied problems of school geometry

Contents:

School geometry (801389A) The course presents the core material in Finnish junior high school and high school geometry courses. It is mainly meant for those students who study to become mathematics, physics and chemistry teachers. The first part of this course is classic Euclidean plane geometry and the second part is solid geometry. Students become familiar with geometric proof and how to solve simple geometric problems with the help of ruler and compass. Geometric results are used to solve problems. The second part considers spatial geometry and starts with how lines and planes can situate in ordinary three dimensional space. Basic geometric properties of solids like cube, ball and cone are considered and methods how to calculate their surface aries and volumes are presented.

Assessment methods and criteria:

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

Person responsible:

Martti Kumpulainen

800322A: Multidimensional analysis, 8 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Salmi

Opintokohteen kielet: Finnish

Leikkaavuudet:

800328A	Calculus of several variables	5.0 op
802351A	Vector Calculus	5.0 op

ECTS Credits:

8 cr

Language of instruction:

Finnish

Timing:

Second year, periods 1-2

Learning outcomes:

On successful completion of this course, the student will be able to
- differentiate multivariate functions
- apply the derivative to minimization problems
- define and use multidimensional integrals

Contents:

The course deals with multidimensional real calculus.
The course provides an introduction to vector-valued functions of one variable, their derivatives and path integrals.
The central notion of the course is the derivative of vector-valued function of several variables (including the gradient of a real-valued function of several variables). In the course we develop the Riemann integral of a real-valued function of two variables. The course provides basic tools for advanced courses in analysis and for applications (such as physics).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 h lectures, 28 h exercises, 129 h self-study.

Target group:

Major and minor students in mathematics.

Prerequisites and co-requisites:

Linear algebra I
Linear algebra II
Euclidean topology
Series and integrals

Recommended optional programme components:

-

Recommended or required reading:

- Baxandall, Liebeck: Vector calculus, Oxford University Press, 1986.
- lecture notes.

Assessment methods and criteria:

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

Grading:

0-5

Person responsible:

Pekka Salmi.

Working life cooperation:

No

521033A: Engineering Study, Electronics and Communications, 3 - 10 op

Voimassaolo: 01.08.2008 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail

Opettajat: Antti Mäntyniemi
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

900060A: Technical Communication, 2 op

Voimassaolo: 01.08.2005 - 31.07.2021
Opiskelumuoto: Intermediate Studies
Laji: Course
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:
Electrical Engineering, Computer Science and Engineering and Communications Technologies: 2nd year spring term or 3rd year autumn term or 3rd year spring term.
Mechanical Engineering: 3rd year.
Process and Environmental Engineering: 1 st year spring or autumn term.
Learning outcomes:
Upon completion of the course the student should be familiar with the central principles of work and study-related communication, both oral and written, and be able to apply this knowledge in his/her own communication. The student should be able to prepare and give an illustrative and understandable oral presentation on a topic related to his/her own field in a way that suits the audience and the situation. The student should also be able to seek information and report on his/her findings in writing. The student should be able to analyse and assess his/her own writing and the writing of his/her peers. He/she should be able to act in group communication situations in a target-oriented manner. The student should also be able to give and receive constructive criticism.
Contents:
Professional communication skills: team writing, the process of writing and its different stages, distinctive features of formal scientific and professional texts, oral communication, preparing an illustrative presentation, methods of convincing one's audience, giving and receiving constructive criticism, the features of a functioning team, the group process and the roles of team members, negotiations and meeting practices.
Mode of delivery:
Multimodal teaching
Learning activities and teaching methods:
Contact hours ca. 20 h and independent group work or self-study ca. 40 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.

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

761102P: Basic Thermodynamics, 2 op

Opiskelumuoto: Basic Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766348A	Thermophysics	7.0 op
766328A	Thermophysics	6.0 op

ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
Every autumn term
Learning outcomes:
The student will learn to recognize and understand ordinary thermodynamic phenomena taking place around us as well as to take them into account and utilize them, for instance, in designing devices and buildings.
Contents:
We cover the basics of temperature, heat and thermal properties of matter both in macroscopic and microscopic levels. Topics in detail: Temperature, thermometers, heat, thermal properties of matter (e.g. thermal expansion, specific heat, phase changes), equations of state, the laws of thermodynamics, heat engines (e.g. internal-combustion engine), refrigerators, the Carnot cycle, entropy.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 16 h, 4 exercises (8 h), self-study 29 h
Target group:
For the students of the University of Oulu
Prerequisites and co-requisites:
No specific prerequisites
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously

Recommended or required reading:
Young and Freedman; University Physics, Addison Wesley (Edition 10, Chapters 15-18, or Editions 11-13, Chapters 17-20). Similar material can also be found in H. Benson: University physics, Wiley & Sons, New York (Chapters 18-21).
Lecture notes: Basic thermodynamics (in Finnish) by K. Mursula.
Course material availability can be checked here.
Assessment methods and criteria:
2 intermediate examinations (in autumn) or final examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Ville-Veikko Telkki
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761102P/

477622A: Control System Design, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Process and Environmental Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

477603A	Control System Design	4.0 op

Ei opintojaksokuvauksia.

521308S: Electronic Research Exercise, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

521436S	Electronic Research Exercise	3.5 op

Ei opintojaksokuvauksia.

521105A: Electronic components project, 3 op

Voimassaolo: 24.09.2014 - 31.07.2015
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

3
Language of instruction:
Finnish
Timing:
Spring, periods 4-6
Learning outcomes:
-
Contents:
-
Mode of delivery:
-
Learning activities and teaching methods:
-
Target group:
Electrical engineering BSc students
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
-
Grading:
Pass/fail
Person responsible:
Jari Hannu
Working life cooperation:
-
Other information:
-

802352A: Euclidean Topology, 4 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opettajat: Maarit Järvenpää

Opintokohteen kielet: Finnish

Leikkaavuudet:

802357A	Euclidean Spaces	5.0 op
802356A	Metric Topology	5.0 op

ECTS Credits:
4 ECTS credits
Language of instruction:
Finnish
Timing:
First year, 3. period
Learning outcomes:
After the course student is able to
- define elementary topological concepts (open and closed sets, accumulation point, etc)
- handle sequences of real numbers
- proof fundamental theorems related to continuous functions
Contents:
The courses goal is to expand students knowledge and understanding of continuous functions. Course considers basic topology of n-dimensional Euclidean space. Important concepts are, for instance, open and closed sets, compactness and completeness.
Mode of delivery:

Face-to-face teaching
Learning activities and teaching methods:
28h lectures, 14h exercises
Target group:
Major and minor students
Prerequisites and co-requisites:
802154P Elementary functions
802155P Limit and continuity
802156P Derivative
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Midterm exam or final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Maarit Järvenpää
Working life cooperation:
-

801346A: Introduction to Cryptography, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Leikkaavuudet:

802336A Introduction to Cryptography 5.0 op

ECTS Credits:
4 cr
Language of instruction:
Finnish
Timing:
2. year or later, Fall term (1. or 2. period)
Learning outcomes:
After completeing the course, student
- knows the principles of sime traditianl symmetric key methods
- knows how public key methods (RSA, discrete logarithm, knapsack) work
- is familiar with the possibility to use and apply number theory in cryptography
Contents:
The course considers some traditianl symmetric key methods (affine system, matrix cryptography) and three public key methods, namely RSA, discrete logarithm and knapsack.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
27 h lectures, 15 h exercises
Target group:
Major and minor students
Prerequisites and co-requisites:
Compulsory basic and intermediate studies in mathematics.
Recommended or required reading:
Lecture notes
Assessment methods and criteria:
Final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:

1-5
Person responsible:
Tapani Matala-aho

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

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Module of the Option
Laji: Study module
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521288S: Multiprocessor Programming, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

521280S	DSP Laboratory Work	5.0 op

Ei opintojaksokuvauksia.

766334A: Nuclear and particle physics, 2 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

766344A	Nuclear and particle physics	5.0 op
766330A-02	Structure of matter, part 2: Nuclear and particle physics	0.0 op
766330A-01	Structure of matter, part 1: Solid state physics	0.0 op
766330A	Structure of matter	6.0 op

ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
Second spring term
Learning outcomes:
The student can explain the basic principles of nuclear and particle physics and can derive their consequences in the extent and level of the lectures (see Contents). In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The course deals with the structure and properties of nuclei, nuclear forces, nuclear models, radioactivity, nuclear reactions, properties and interactions of fundamental particles, and unified theories of fundamental interactions.
Mode of delivery:

Face-to-face teaching
Learning activities and teaching methods:
Lectures 20 h, exercises 10 h, self-study 23 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
766326A Atomic physics 1
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Textbooks: H. D. Young and R. A. Freedman: University Physics, 13th edition, Pearson Addison-Wesley, 2012, or earlier editions (in part), R. Eisberg and R. Resnick: Quantum physics of atoms, molecules, solids, nuclei, and particles, John Wiley & Sons (in part). Additioanl material available from the web pages of the course.
Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Juhani Lounila
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766334A/

802354A: Number Theory and Groups, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Myllylä

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay802354A	Number Theory and Groups (OPEN UNI)	5.0 op
800333A	Algebra I	8.0 op

ECTS Credits:
5 ECTS credits
Language of instruction:
Finnish
Timing:
1. year, 3. period
Learning outcomes:
After completing the course, student is able to
- derive and proof main results in the course
- use and apply different proof techniques
- recognize algebraic structures and the concepts
- see connections and differences between different algebraic structures

Contents:
The course includes basics in arithmetics and algebraic structures, such as, congruence, residue classes, prime numbres, Euclidean algorithm, the fundamental theorem of arithmetic, Euler-Fermat formula, groups and morphisms. The course gives an understanding of algebraic terms and concepts used in mathematics and physics.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
28h lectures, 14h exercises

Target group:
Major and minor students
Prerequisites and co-requisites:
802151P Introduction to mathematical deduction
Recommended optional programme components:
-
Recommended or required reading:
Lecture notes
Assessment methods and criteria:
Midterm exam or final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Kari Myllylä
Working life cooperation:
-

521025S: Power Electronics, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:
5
Language of instruction:
Finnish.
Timing:
Periods 4-5
Learning outcomes:
On completion of the study module a student is able to discuss and write on the subject by using the terminology in the field of switching power supplies. He or she can analyze the operation of different switching power supplies in continuous and discontinuous conduction mode and in steady state operation. The student is able to design various switching power supplies different dc-dc -applications. The student 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.

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:
-
Prerequisites and co-requisites:
Courses Circuit Theory I-II, Electronics Design I-II or equivalent.
Recommended optional programme components:
-
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.
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:
Person responsible:
Kari Määttä
Working life cooperation:
-
Other information:
-

900082Y: Second Official Language (Finnish), Oral Skills, 1 - 3 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

900081Y: Second Official Language (Finnish), Written Skills, 1 - 2 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory

900081Y-01: Second Official Language (Finnish), Written Skills, 1 - 2 op

Voimassaolo: 01.08.2014 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

900081Y-02: Second Official Language (Finnish), Oral Skills, 1 - 3 op

Voimassaolo: 01.08.2014 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

901049Y: Second Official Language (Swedish), Oral Skills, 1 op

Voimassaolo: 01.08.2014 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
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

Ei opintojaksokuvauksia.

901048Y: Second Official Language (Swedish), Written Skills, 1 op

Voimassaolo: 01.08.2014 -
Opiskelumuoto: Language and Communication Studies
Laji: Course
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

Ei opintojaksokuvauksia.

802353A: Series and Integrals, 6 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Peter Hästö
Opintokohteen kielet: Finnish
Leikkaavuudet:

800318A Integral 5.0 op
802164P Series and Integral 5.0 op

ECTS Credits:
6 ECTS credits
Language of instruction:
Finnish (possible also in English)
Timing:
First year, 4. period
Learning outcomes:
After completing the course, student is able to

- operate with real series
- separate the concept of continuity and uniform continuity
- define and calculate Riemann integrals
- derive and operate function sequences and function series
- calculate derivate and integrate function series

Contents:
The course is a continuum for the courses Limits and continuity and Derivative. Basic topological methods (presented in Euclidean Topology) are heavily used in proofs and methods involving continuous functions. The goal is the same as in the prerequisite courses, that is, to develop mathematical thinking and extend the knowledge of mathematical analysis.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
30h exercises, 14h exercises
Target group:
Major and minor students
Prerequisites and co-requisites:

802154P Elementary functions
802155P Limit and continuity
802156P Derivative
802352A Euclidean topology

Recommended optional programme components:
-
Recommended or required reading:
Lecture notes
Assessment methods and criteria:
Midterm exams or final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Peter Hästö
Working life cooperation:
-

521369A: Simulations and Tools for Telecommunications, 3 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Risto Vuohtoniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521328A Simulations and Tools for Telecommunications 5.0 op

ECTS Credits:
3
Language of instruction:
Finnish
Timing:
Spring, periods 4-5
Learning outcomes:
A student recognizes problems and limitations related to simulations. A student can select a suitable simulation method and knows how to validate the model. Student knows how to generate signals, random numbers and noise as well as fading channels. A student knows how to make Monte-Carlo simulations at the baseband level and can estimate confidence level of simulation results. A student can explain principles of network level simulations. Furthermore, a student knows basics of one or two fundamental simulation programs.
Contents:
Simulation methods, modelling communication systems with simulations, confidence limits of simulation, noise generation and modelling of fading channel. A simple baseband simulation example. Basics of MATLAB and OPNET simulation software (these could vary depending on needs/availability).
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 20 h (including program introductions), and the compulsory antenna design work with an electromagnetic simulation program (15 h).
Target group:
3 rd year bachelor's degree students
Prerequisites and co-requisites:
Telecommunication Engineering II
Recommended optional programme components:
-
Recommended or required reading:
Lecture notes. Selected parts (informed in the notes) of Michel C. Jeruchim, Philip Balaban, and K. Sam Shanmugan, Simulation of Communication Systems, Modeling Methodology and Techniques, 2nd edition.

Plenum Press, 2000. Additional reading: William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.
Assessment methods and criteria:
The course is passed with a final examination and the accepted simulation work report. The final grade is based on exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Risto Vuohtoniemi
Working life cooperation:
-
Other information:
-

521484A: Statistical Signal Processing, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Heikkilä, Janne Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

521348S Statistical Signal Processing 1 5.0 op

ECTS Credits:
5
Language of instruction:
Finnish, Course can be passed in English.
Timing:
Spring, periods 4-6.
Learning outcomes:
Upon completion of the course, the student is able to utilize the generic linear model as a representation for parameter estimation. He can apply typical deterministic and random parameter estimation methods for different estimation problems. He is able to determine statistical properties of estimators and make comparisons between them. The student can also form a basic state-variable model and utilize Kalman filtering for state estimation. Moreover, he is able to apply basic methods of detection theory for solving simple detection problems. After the course, the student can implement the learned methods and assess their statistical properties with the Matlab software.
Contents:
This course provides basic knowledge of statistical signal processing, in particular, estimation theory and its applications in signal processing. Topics: 1. Introduction, 2. Modeling of estimation problems, 3. Least Squares estimation, 4. BLUE-estimation, 5. Signal detection, 6. ML estimation, 7. MS estimation, 8. MAP estimation, 9. Kalman Filter.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures (30 h), exercises (24 h) and Matlab design exercise (10 h). The rest as independent work.
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.
Prerequisites and co-requisites:
031019P Matrix Algebra, 031021P Probability and Mathematical Statistics
Recommended optional programme components:
521337A Digital Filters, 031050A Signal Analysis. These courses provide complementary information on digital signal processing and stochastic signals. The courses are recommended to be studied either in advance or simultaneously.
Recommended or required reading:

J. Mendel: Lectures in estimation theory for signal processing, communications and control, Prentice-Hall, 1995.
M.D. Srinath, P.K. Rajasekaran, R. Viswanathan: Introduction to Statistical Signal Processing with Applications, Prentice-Hall, 1996, Chapter 3. Lecture notes and exercise material.

Assessment methods and criteria:

The course is passed with intermediate exams or final exam and accepted Matlab 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:

Janne Heikkilä

Working life cooperation:

None.