Opasraportti

Electrical Engineering and Wireless Communications Engineering (2011 - 2012)

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

More on studies

Tutkintorakenteet

MSc. Engineering, Electrical Engineering

Tutkintorakenteen tila: published

Lukuvuosi: 2011-12

Lukuvuoden alkamispäivämäärä: 01.08.2011

Option (60 - 80 op)

Compulsory, choose one of the options. Advanced modules are approximately 30 ects in total.

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
      - 521404A: Digital Techniques 2, 5 op
      - 521405A: Electronic System Design, 5 op
      - 521450S: Optoelectronics, 4 op
      - 521335S: Radio Engineering 1, 6 op
      - 521332S: Computer Aided Circuit Design, 4 op
      - 521423S: Embedded System Project, 5 op
      - 470462A: Fundamentals of Control and Systems Engineering III, 5 op
- *Advanced module, electronics design, circuit and system design, compulsory courses*
  - A451271: Advanced Module/ Electronics Design, Circuit and System Design (obligatory), 17 op
    - *Compulsory courses*
      - 521435S: Electronics Design III, 6 op
      - 521445S: Digital Techniques 3, 6 op
      - 521025S: Power Electronics, 5 op
- *Advanced module, circuit and system design, optional courses, module total approx. 30 cr.*
  - A451272: Advanced Module/Electronics Design, Circuit and System Design (optional), 13 op
    - *Optional courses, module approx. 30 credits.*

521410S: Special Course in Electronic Design, 4 - 7 op
521441S: Electronics Design and Construction Exercise, 6,5 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

Advanced module, digital systems design, obligatory courses

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

Compulsory courses

521453A: Operating Systems, 5 op
521457A: Software Engineering, 5 op
521445S: Digital Techniques 3, 6 op
521261A: Computer Networks I, 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

optional courses

521275A: Embedded Software Project, 8 op
521485S: DSP-laboratory Work, 3,5 op
521277A: Embedded Systems, 4 op
521486S: Signal Processing Systems, 4 op
521358S: Application Specific Signal Processors, 4 op
521262S: Computer Networks II, 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
521174S: Measuring and Testing Systems, 4 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 courses

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, 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
521174S: Measuring and Testing Systems, 4 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
465082S: Physical Metallurgy II, 7 op
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
Module total appr. 30 cr
521167S: Testing Techniques of Electronics, 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
521114S: Wireless Measurements, 4 op
521405A: Electronic System Design, 5 op
521441S: Electronics Design and Construction Exercise, 6,5 op

Telecommunication Engineering

H453221: Module of the Option, Telecommunication Engineering, 60 - 80 op
Module of the Option
A451224: Module of the Option, Telecommunication Engineering, 40 - 41 op
Module of the option

031025A: Introduction to Optimization, 5 op
521321S: Elements of Information Theory and Coding, 5 op
521323S: Wireless Communications 2, 5 op
521340S: Communications Networks I, 5 op
521326S: Radio Engineering 1, 5 op
521385S: Mobile Telecommunication Systems, 5 op
Compulsory
521385S-01: Mobile Telecommunications systems, exam, 0 op
521385S-02: Mobile Telecommunication Systems, exercisework, 0 op
521324S: Statistical Signal Processing II, 5 op
521350S: Seminar in Telecommunication and Radio Engineering, 1 op

Advanced module, obligatory courses, 10-36 ECTS cr
A453273: Advanced module, Telecommunication Engineering, 10 - 47 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
521488S: Multimedia Systems, 6 op

Electives
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
521488S: Multimedia Systems, 6 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521261A: Computer Networks I, 5 op
521266S: Distributed Systems, 6 op
521262S: Computer Networks II, 6 op
521265A: Telecommunications Software, 5 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
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

Advanced module wireless communications, compulsory courses
A451285: Advanced Module/Telecommunication Engineering, Wireless Communications (obligatory), 20 op
Compulsory courses
521317S: Wireless Communications 3, 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 3, 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
521358S: Application Specific Signal Processors, 4 op
521386S: Radio Channels, 5 op
031022P: Numerical Analysis, 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

Tutkintorakenteen tila: published

Lukuvuosi: 2011-12

Lukuvuoden alkamispäivämäärä: 01.08.2011

Module of the option (44 op)

All courses are compulsory.

A451225: Module of the Option, Wireless Communications Engineering, 40 - 65 op
Compulsory
031025A: Introduction to Optimization, 5 op
521320S: Wireless Communications 2, 8 op
521340S: Communications Networks I, 5 op
521335S: Radio Engineering 1, 6 op
521333S: Mobile Telecommunication Systems, 5 op
521350S: Seminar in Telecommunication and Radio Engineering, 1 op
521373S: Communication Signal Processing I, 6 op
521315A: Basics of Information Theory, 4 op
521343S: Coding Methods, 4 op

Advanced module (33 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 3, 8 op
521360S: Communication Signal Processing II, 4 op
521380S: Antennas, 4 op
521386S: Radio Channels, 5 op

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

Choose the minimum of 10 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
521488S: Multimedia Systems, 6 op
521318S: Modern Topics in Telecommunications and Radio Engineering, 3 - 7 op
521261A: Computer Networks I, 5 op
521266S: Distributed Systems, 6 op
521262S: Computer Networks II, 6 op
521265A: Telecommunications Software, 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: 2011-12

Lukuvuoden alkamispäivämäärä: 01.08.2011

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
030001P: Orientation Course for New 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
761103P: Electricity and Magnetism, 4 op
766320A: Applied Electromagnetism, 6 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
521170A: Electrical Measurement Principles, 4,5 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
521171A: Electronic Measurement Techniques, 6,5 op
521316A: Broadband Communications Systems, 4 op
521433A: Laboratory Exercises on Analogue Electronics, 3 op
521218A: Introduction to Microelectronics and Micromechanics, 4 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 Microelectronics and Micromechanics, 4 op
521171A: Electronic Measurement Techniques, 6,5 op

Telecommunication Technology

A451123: Module Preparing for the Option, Telecommunication Engineering, 20 - 40 op
Compulsory studies
521484S: Statistical Signal Processing, 5 op
521369A: Simulations and Tools for Telecommunications, 3 op
521370A: Laboratory Exercises in Telecommunication Engineering, 5 op
521331A: Filters, 4 op
521316A: Broadband Communications Systems, 4 op

Teacher

A451124: Module Preparing for the Option, Prerequisite for Physics Teacher Education (obligatory), 20 - 31 op
Compulsory
802352A: Euclidean Topology, 4 op
802353A: Series and Integrals, 6 op
802151P: Introduction to mathematical deduction, 5 op

806113P: Introduction to Statistics, 5 op
802354A: Number Theory and Groups, 5 op
761102P: Basic Thermodynamics, 2 op
766334A: Nuclear and particle physics, 2 op

A451125: Module Preparing for the Option, Prerequisite for Physics Teacher Education (optional), 9 - 30 op

Compulsory studies

802352A: Euclidean Topology, 4 op
802353A: Series and Integrals, 6 op
802151P: Introduction to mathematical deduction, 5 op
806113P: Introduction to Statistics, 5 op
802354A: Number Theory and Groups, 5 op
761102P: Basic Thermodynamics, 2 op
766334A: Nuclear and particle physics, 2 op

Chosen to complete the 180 cr degree

801346A: Introduction to Cryptography, 4 op
802119P: Linear Algebra II, 5 op
801389A: Basic Geometry, 6 op
800322A: Analysis II, 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.

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: Tarmo Ruotsalainen
Opintokohteen kielet: Finnish

Language of instruction:

In Finnish (In English if needed).

Timing:

Period 1-2.

Learning outcomes:

The goal is to reinforce and further develop the student's understanding of concepts of analogue circuit blocks and their application and use in the design of electronic equipment. The course also gives basic skills for the design of integrated building blocks. Noise and modeling of noise in electrical circuits, and the structures and properties of DA/AD converters are covered.
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, analyse and design integrated structural 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 connected with DA and AD conversion and converters and to analyse and outline their main structural principles and 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.

Learning activities and teaching methods:

Lectures, exercises and a small design work. Final exam.

Recommended optional programme components:

Electronics Design I.

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.

521404A: Digital Techniques 2, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannu Heusala

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Period 1-2.

Learning outcomes:

The goal of the cource is to familiarize students to the professional design flow, design methodology and implementaion options of digital integrated circuits.
Osaamistavoitteet: After the cource students are able to design high level architectures of digital systems and blocks of the system implemented by special hardware (ASIC and FPGA). Students are able to ably design methodologies and tools. Design verification and implementation analysis are emphasised. Students can simulate and model (VHDL modelling and VHDL simulation) digital systems and critically revalue the design also from the implementation's point of view.

Contents:

1. Implementation technologies of digital circuits, 2. Description levels of digital systems, 3. VHDL modelling of digital circuits and systems, 4. System level specification and design, 5. Design of ASICs and FPGAs, 6. High level VHDL synthesis, 7. RTL-VHDL synthesis, 8. Planning of production test of digital ASICs.

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

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.
Learning outcomes: On completion of the study module a student is able to explain all the phases of a development project of an electronic device. He or she is able to explain how to protect results obtained during the development process and on the other hand the student is able to explain the restrictions caused by standards and patents of other companies. The 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 nonidealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

Contents:

Electronic product design process, patents, test design, and EMC/LVD standards, Characteristics of ASIC technology and design, Characteristics of highspeed digital design. Reliability engineering. Documentation design

Learning activities and teaching methods:

The course includes 3 h of lectures and 2 h of exercises per week. The course will be passed by means of a final exam.

Recommended optional programme components:

Circuit Theory I-II, Analogue Electronics I-II, Digital Techniques I-II, Filter Theory, Computer engineering, Embedded Systems.

Recommended or required reading:

Handout. Ward & Angus: Electronic Product Design, m Hall&Hall&McCall: Highspeed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques.

521450S: Optoelectronics, 4 op

Voimassaolo: - 31.07.2014

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Kilpelä, Ari Juhani

Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 5-6

Learning outcomes:

To give the basic knowledge of the transmitter and receiver electronics used in optoelectronic applications, and basic theory of optical fibers and their usage in various applications.
Learning outcomes: On completion of the study module students should be able to explain the principles of operation of the photoconductors and photochannels (optic fibres), semiconductor light sources and photodetectors 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 light source control circuits and photodetector preamplifiers and be capable of comparing them in terms of their main performance parameters. They should also be reasonably able to use the main principles of signal processing that are required for the design of optoelectronic measurement applications.

Contents:

Geometrical and physical optics, optical fibers and their properties, sources of radiation (the radiation of black body, LED- and laser structures), photodetectors (photo conductive detector, light multiplier, PIN- and AP-diodes, position sensitive detectors), light source modulation, preamplifiers and their bandwidth/stability/noise analysis, the signal analysis methods used in optoelectonics

Learning activities and teaching methods:

Lectures and exercises. May include a seminar. Final exam.

Recommended optional programme components:

Principles of Semiconductor Devices.

Recommended or required reading:

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

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

Language of instruction:

In Finnish (fall 2010), In English (fall 2011).

Timing:

Period 1-3.

Learning outcomes:

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. 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. 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. Student can also explain the principle of an automatic gain control (AGC). Student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Definitions of noise terms, impedance matching using discrete components, microstrip matching networks, RF transistor amplifier design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Learning activities and teaching methods:

Lectures and exercises in total 4 hours in a week. Design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade the weight for the exam is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

Lecture notes. R. Ludwig & P. Bretchko: RF Circuit Design Theory and Applications, 2000. G. Gonzales: Microwave Transistor Amplifiers Analysis and Design, 1997.

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

Language of instruction:

The course and exercises are held in Finnish.

Timing:

Periods 4-6.

Learning outcomes:

This course explains the operation, limitations and application areas of various types of front-end and back-end CAD tools used for analog and mixed signal design.

Contents:

Circuit simulators. Solving network equations. Principles of AC, DC, transient analyses and steady-state simulation methods. Simulation of noise and distortion. Worst-case and statistical analysis and optimization. Physical design and design verification.

Learning activities and teaching methods:

Lectures 2 hours / week. Simulation exercises and final exam.

Recommended optional programme components:

Knowledge in circuit theory, basic circuit simulations, and analog design.

Recommended or required reading:

Handouts. K. Kundert: Designer's guide to SPICE and Spectre. Kluwer Academics.

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

Learning outcomes:

The objective of this course is to familiarize students to modern embedded system development process with hands on approach.
Learning outcomes: Upon completing the required coursework, the student is able to do an embedded system development process from a requirement specification to a prototype. Based on the requirement specification the student can create a system level design, select components, design a printed circuit board and manufacture it, assemble the board, and design, implement, test and debug software for the system, and finally achieve a result that fulfills the given requirements.

Contents:

Creating a simple prototype level device, based on the Atmel AVR microcontroller. Demonstration of the prototype. Applicable components and tools: avr-gcc, Eagle/Orcad, AVR Studio, JTAG-ICE.

Learning activities and teaching methods:

The course is a project that is made with groups of three students. The proceeding of the project is monitored by meetings with assistants.

Recommended optional programme components:

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

Recommended or required reading:

Assignment, component datasheets, manuals, www-pages.

470462A: Fundamentals of Control and Systems Engineering III, 5 op

Voimassaolo: - 31.12.2010
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Process and Environmental Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Kortela, Urpo, Seppo Honkanen
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Advanced module, electronics design, circuit and system design, compulsory courses

A451271: Advanced Module/ Electronics Design, Circuit and System Design (obligatory), 17 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

521435S: Electronics Design III, 6 op

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

Language of instruction:
In Finnish.
Timing:
Period 3-4.
Learning outcomes:
This course continues themes of Electronics Design II with the goal of extending the understanding and skills of the student in the area of integrated circuits and systems (mainly mixed-mode) in CMOS technology. The emphasis is in highperformance and high-level system building blocks (sampling, filtering, AD/DA conversion, phase/frequency domain signal processing). The analogue/digital boundary with oversampling and __ related conversion techniques is one of the main topics here. All topics covered in this course are highly relevant to modern state-ofthe-art electronics. One of the goals is also to advance the students skills in self learning and ability to follow the development of the technology field.
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 analyse and design differential amplifiers and other structural blocks for implementation in an IC environment. They should be able to explain how an SC 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 structure 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, __-techniques in general and particularly in AD/DA converters, operations with frequency /phase domain signals, design of IC layout.

Learning activities and teaching methods:

Lectures, exercises and an extended laboratory exercise. In the laboratory exercise CAD tools used in IC design and a complete IC design flow become familiar. Lectures and exercises are on periods 3 and 4 and the laboratory exercise on periods 5 and 6. The course may include seminar-type study. The course will be passed by means of a final exam and a passed laboratory exercise.

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. Prerequisites: Filter theory, Electronics Design II, Principles of Microelectronics and Micromechanics (recommended).

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

Language of instruction:

In Finnish.

Timing:

Period 3-4.

Learning outcomes:

The goal of the cource is to familiarize students to the professional design flow, design methodology and implementaion options of digital integrated circuits.
Learning outcomes **:** After the cource students are able to design high level architectures of digital systems and blocks of the system implemented by special hardware (ASIC and FPGA). Students are able to ably design methodologies and tools. Design verification and implementation analysis are emphasised. Students can simulate and model (VHDL modelling and VHDL simulation) digital systems and critically revalue the design also from the implementation's point of view.

Contents:

1. Implementation technologies of digital circuits, 2. Description levels of digital systems, 3. VHDL modelling of digital circuits and systems, 4. System level specification and design, 5. Design of ASICs and FPGAs, 6. High level VHDL synthesis, 7. RTL-VHDL synthesis, 8. Planning of production test of digital ASICs.

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

Language of instruction:

Finnish.

Timing:

Period 4-5.

Learning outcomes:

The course provides the basic knowledge on switched-mode power supplies so that the student recognizes the typical terminology and different topologies as well as can estimate the voltage and current stresses for designing/selecting proper components.
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 operation principle of single-phase ac-dc -converters based on the pulse width modulation.

Contents:

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

Learning activities and teaching methods:

The course includes 3 h of lectures and 2 h of exercises per week. The course is passed by means of a final exam.

Recommended optional programme components:

Circuit Theory I-II, Analogue Electronics I-II.

Recommended or required reading:

R. W. Erickson, D. Maksimovic: Fundamentals of Power Electronics, 2nd ed.Kluwer Academic Publishers, 2004. Chapters 1-3, 5, 6,13; chapters 16-18 to most part.

Advanced module, circuit and system design, optional courses, module total approx. 30 cr.

A451272: Advanced Module/Electronics Design, Circuit and System Design (optional), 13 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 approx. 30 credits.

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

Language of instruction:

The course and exercises are held in Finnish. (In English if the are more than 2 international students).

Timing:

Period 1-2.

Learning outcomes:

The contents of this course vary yearly, containing current topics of electronics design.
Learning outcomes: Varies with the course contents

Contents:

The contents and extent of the course are defined every year by the beginning of the semester. The course may include RFIC design, analysis and linearization techniques of nonlinear circuits, or digital error correction of A/D converters, for example. The weight is mostly planned to be in the analysis of nonlinear and/or time-varying circuits.

Learning activities and teaching methods:

The extent varies, and may contain a design exercise.

Recommended optional programme components:

Knowledge in circuit theory, and analog, digital and RF design is expected.

Recommended or required reading:

The course material is announced yearly.

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

Language of instruction:

Finnish.

Timing:

Period 1-6.

Learning outcomes:

To familiarize the student with independent electrical circuit and system design and with the methods and tools used in the design process. The course prepares the student for the diploma work in the area of circuits and system design.
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. Experienced designers are used as instructors. The task can be carried out by one person or by a team of two persons. The mark will be decided on the basis of the statement of the instructor and the report provided by the student. Starting from spring 2003 an alternative for normal design/contruction work is to take part in a special course, in which a mixed mode analog IC is designed. This design task is executed under supervision in the workstation class and the whole IC design flow and the IC design software are studied. It is possible that the number of the students taking part in the IC design course may be limited on the basis of successful progress in electronics studies.

Recommended optional programme components:

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

521380S: Antennas, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Karhu Seppo

Opintokohteen kielet: English

Leikkaavuudet:

521388S Antennas 5.0 op

Language of instruction:

English.

Timing:

Periods 4-5.

Learning outcomes:

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.
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, microstrip antennas and antenna arrays. The student is also able to design wire antennas, microstrip antennas and antenna arrays for different radio systems. In addition, the student can use electromagnetic simulators to analyze and design antennas.

Contents:

Introduction 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.

Learning activities and teaching methods:

Lectures, exercises and the compulsory antenna design work with an electromagnetic simulation program. 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.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

C. A. Balanis: Antenna Theory, Analysis and Design (Third Edition). John Wiley & Sons, 2005. Chapters 1-6 and 14.

521216S: Microelectronics Packaging Technology and Reliability, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Sami Myllymäki

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Periods 1-3.

Learning outcomes:

The students are introduced to the packaging and interconnection technologies and to the reliability and testing of electronics packaging technology.
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 mechanism's 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 these. Methods of environmental testing, screening and quality control.

Learning activities and teaching methods:

Lectures and literature review. The course is passed by a final exam and an accepted literature review.

Recommended optional programme components:

Introduction to Microelectronics and Micromechanics.

Recommended or required reading:

Lecture notes. Parts form books: Rao R. Tummala: Fundamentals of Microsystems Packaging, Rao R. Tummala, Eugene J. Pymaszewski, Alan G. Klopfenstein: Microelectronics Packaging Handbook II, William D. Brown (toim.): Advanced Electronic Packaging, With Emphasis on Multichip Modules, IEEE, Inc., New York 1999, luvut 11 ja 16, Patrick D.T. O'Connor: Practical Reliability Engineering, John Wiley&Sons, 2002, luvut 8 ja 9 ja Ken Gilleo: Area Array Packaging Handbook: Manufacturing and Assembly, McGraw-Hill 2002.

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 Radio Engineering II 6.0 op

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

The aim is to understand the basic theory and techniques of design in transceivers at the system level. 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. Learning outcomes: After completing the course the student recognizes the blocks of a transmitter and can explain the principle of a transmitter. She/he can classify different architectures used in transmitters and understand the basis for them. Student can define parameters used in the transmitter system level design and can design a transmitter 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. Student can also explain factors, which are important for the selection of DA- and AD-converters. She/he can derive various methods to create the in phase and the quadratute components of a signal. She/he can also explain the principles of frequency synthesis in a transmitter.

Contents:

Designing transceivers at the system level, transceiver architectures, performance characteristics of transceivers, factors which limit the performance of transceivers, nonlinearities, design of RF and IF stages, placement of the A/Dconverter in receivers, frequency synthesis, design and implementation examples.

Learning activities and teaching methods:

Two hours of lectures in a week. Demonstrations (eight hours) and design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade, the weight for the examination is 0.75, and for the design exercise 0.25. Course will be given every second year in even years.

Recommended optional programme components:

Radio Engineering I.

Recommended or required reading:

Lecture notes. Walter Tuttlebee: Software Defined Radio. Enabling Technologies, chapters1-4, 2002. U.L. Rohde, J.C. Whitaker & T.T.N Bucher: Communications Receivers: DSP, Software Radios and Design, 3rd edition, 2001. V. Manassewitsch: Frequency Synthesizers, Theory and Design, 1987.

521172S: EMC Design, 4 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521115S	EMC Design	5.0 op

Language of instruction:

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

Timing:

Period 6.

Learning outcomes:

The special requirements and limitations of EMC design provide directives for the equipment's interference emission and for their ability to operate as intended in environments/circumstances

under interference. This has a great effect on electrical and mechanical design. The course introduces the EMC requirements for electrical equipment as well as methods to achieve them. 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 and shielding. EMC testing laboratories, EMC tests and their background.

Learning activities and teaching methods:

Lectures, exercises and laboratory exercises. Final exam.

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. T. Williams, K. Armstrong: EMC for Systems and Installations. E. L. Bronaugh, W. S. Lambdin: A Handbook Series on Electromagnetic Interference and Compatibility, vol. 6, Electromagnetic Interference Test Methodology and Procedures.

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

Learning outcomes:

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

Contents:

Fabrication stages of VLSI semiconductors. Simulation of semiconductor processes. VLSI semiconductor techniques. GaAs devices and circuits, the new features of hybrid techniques and the trends of microelectronics. Materials and fabrication methods of micromechanics. Design and implementation of micromechanical structures. Actuators for small movements, micro valves, pumps and motors, switches, micro-optics, applications in medical engineering, autonomic microsystems, microrobotics, nanotechniques. Implementation: Lectures and exercises. Final exam.

Recommended optional programme components:

Introduction to Microelectronics and Micromechanics.

Recommended or required reading:

Will be informed during lectures

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 courses

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

Language of instruction:

In Finnish.

Learning outcomes:

The objective of the course is to provide basic knowledge of computer operating system structures and functioning.
Learning outcome: 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:

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

Learning activities and teaching methods:

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. The final grade is based on the final examination and accepted laboratory work.

Recommended optional programme components:

Elementary Programming, Embedded Systems Programming, Computer Engineering

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.

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

Learning outcomes:

The purpose of this course is to give an overview of software development related to real-time systems.

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, followup, quality control, product control, 5. structural analysis and design, 5. software testing methods and strategies, 6. introduction to object-oriented analysis and design.

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.

Recommended optional programme components:

Introduction to Programming

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.

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

Language of instruction:

In Finnish.

Timing:

Period 3-4.

Learning outcomes:

The goal of the cource is to familiarize students to the professional design flow, design methodology and implementaion options of digital integrated circuits.

Learning outcomes **:** After the cource students are able to design high level architectures of digital systems and blocks of the system implemented by special hardware (ASIC and FPGA). Students are able to ably design methodologies and tools. Design verification and implementation analysis are emphasised. Students can simulate and model (VHDL modelling and VHDL simulation) digital systems and critically revalue the design also from the implementation's point of view.

Contents:

1. Implementation technologies of digital circuits, 2. Description levels of digital systems, 3. VHDL modelling of digital circuits and systems, 4. System level specification and design, 5. Design of ASICs and FPGAs, 6. High level VHDL synthesis, 7. RTL-VHDL synthesis, 8. Planning of production test of digital ASICs.

521261A: Computer Networks I, 5 op

Voimassaolo: - 31.07.2012
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Ojala, Timo Kullervo
Opintokohteen kielet: Finnish

Language of instruction:

In Finnish. Materials are in English.

Timing:

Period 5-6.

Learning outcomes:

The course gives a comprehensive description of the fundamentals of

computer networks, using the public Internet and its protocols

and applications as examples

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 computer networking problems, and design and implement a small computer networking application

Contents:

Internet's architecture, most important access networks, TCP/IP protocol stack, the most important Internet applications, Internet security.

Learning activities and teaching methods:

Lectures, exercises, and practical work.

Recommended or required reading:

James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach (5th Edition), Addison-Wesley, 2009.

Lecture slides and exercise materials.

Assessment methods and criteria:

The course is passed with a final exam or with a set of

intermediate exams, together with an approved practical work.

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.

optional courses

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: Juha Röning
Opintokohteen kielet: English

Learning outcomes:

To familiarize students with modern embedded system development with
modern methods and tools.
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 Bachelor's thesis on 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 to form an acceptable Bachelor's thesis.

Contents:

Development tools, practical application programme for an embedded system.

Learning activities and teaching methods:

Pair project with monitoring meetings and a compulsory exercise.

Recommended optional programme components:

Software Engineering, Embedded Systems, Operating Systems.

Recommended or required reading:

Data periodicals, handouts, handbooks.

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.

521277A: Embedded Systems, 4 op

Voimassaolo: 01.08.2011 - 31.07.2013
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Janne Haverinen
Opintokohteen kielet: English

Ei opintojaksokuvauksia.

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

The objective of the course is to provide advanced understanding on the organization of signal processing systems, including the implementations of the most common structural elements and algorithms, and on the use of design tools.
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 (particularly DCT), polyphase filters, 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.

Learning activities and teaching methods:

The course consists of lectures and several design exercises out of which at least five needs to be passed. The final grade is based on the combined points obtained from the exercises and the final exam.

Recommended optional programme components:

Digital Filters, Computer Engineering, Digital Techniques II

Recommended or required reading:

Lecture notes and exercise materials. Material is in English.

521358S: Application Specific Signal Processors, 4 op

Voimassaolo: - 31.07.2012

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Boutellier, Jani Joosefi

Opintokohteen kielet: Finnish

Language of instruction:

English, if one or more international students are present

Timing:

Period 4-5.

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.

Learning activities and teaching methods:

Lectures 10h (participation mandatory). Independent work 98h

Target group:

This is an optional advanced-level course. It is inteded for masters-level students and post-graduate students, especially to those that are specializing into signal processing

Recommended optional programme components:

521267A Computer engineering, 521337A digital filters, programming skills

Recommended or required reading:

Handouts.

Assessment methods and criteria:

Participation in mandatory classes and approved project work.

Grading:

5 - 1 / failed

Person responsible:

Jani Boutellier.

521262S: Computer Networks II, 6 op

Voimassaolo: 01.08.2007 - 31.07.2012

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Ojala, Timo Kullervo
Opintokohteen kielet: English

Language of instruction:
In English.
Timing:
Period 3-4.
Learning outcomes:

The course focuses on advanced issues on computer networking and the Internet.

Learning outcomes:

Upon completing the course the student is able to explain the recent developments in the Internet, solve complicated computer networking problems, and design and implement a computer networking application.

Contents:

Recent developments in Internet architecture, access networks, and Internet protocol stack, multimedia and quality of service,

session management, mobility management.

Learning activities and teaching methods:

Lectures, exercises, and practical work. The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work. The implementation is fully English.

Recommended optional programme components:

Recommended courses include Computer Networks I, Operating Systems, Basics of Digital Communications, Telecommunications Software and Communication Networks I.

Recommended or required reading:

James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down

Approach (5th Edition), Addison-Wesley, 2009.

Assorted Internet standards.

Lecture slides, exercises.

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

Learning outcomes:

The course introduces the student to properties and application areas of functional ceramics that are used in electronics. Besides traditional passive components the application area consists of energy sources based in fuel cells, chemical sensors based in ceramics, high-temperature superconductors, piezoelectric precision actuators, ferroelectric memories, pyroelectric infrared detectors, electro-optical light quides and switches and magnetic microwave and antenna components.
Learning outcomes: Upon completing the course, the student is able to estimate the properties and usability of functional ceramics in different component applications of electronics and can perform theoretical calculatory structural dimensioning for them. The student is able to compare and choose applicable processing methods for the production of abovementioned functional structures. In addition the student is able to interpret new research results of the field and recognizes their application areas.

Contents:

Microstructures and special features of ceramic materials, dielectric-, polarization and electrical conductivity properties and the influence of lattice defects on these properties, fabrication and processing of ceramics, ceramic conductors and insulators, piezoelectric and ferroelectric materials, pyroelectric and electro-optical materials, magnetic materials.

Learning activities and teaching methods:

2 hours of lectures and 2 hours of exercises every week. The course is passed with a final exam

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

Opintojaksossa perehdytään elektroniikassa ja optoelektroniikassa käytettäviin funktionaalisiin materiaaleihin. Tarkoituksena on antaa yleiskäsitys näiden materiaalien pääominaisuuksista ja ilmiöistä, joihin nämä ominaisuudet perustuvat, sekä niiden käytöstä elektroniikassa.
Osaamistavoitteet: Opintojakson suoritettuaan opiskelija osaa selittää perusteet eristeiden käyttäytymisestä tasa- ja vaihtokentässä, magneettisten materiaalien ominaisuuksista sekä magnetismiin liittyvistä käsitteistä, sähkökeraamien ominaisuuksista ja sovelluksista sekä valoa lähettävien ja moduloivien laitteiden materiaaleista. Opiskelija osaa myös arvioida eri materiaalien käytettävyyttä ja soveltuvuutta elektroniikan ja optoelektroniikan laitteisiin.

Contents:

The course treats materials used in electronic circuits, optoelectronics and transducers. Magnetic materials (soft and hard, information storage). Piezo-, pyro- and ferroelectric materials and their applications. Displays and their materials (liquid crystals). Materials for optoelectronic devices.

Learning activities and teaching methods:

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

Recommended optional programme components:

Introduction to Material Physics

Recommended or required reading:

N. Braithwaite and G. Weaver, Electronic Materials, The Open University, Butterworths, London, 1990. Lecture notes.

521216S: Microelectronics Packaging Technology and Reliability, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Sami Myllymäki

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Periods 1-3.

Learning outcomes:

The students are introduced to the packaging and interconnection technologies and to the reliability and testing of electronics packaging technology.
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 mechanism's 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 these. Methods of environmental testing, screening and quality control.

Learning activities and teaching methods:

Lectures and literature review. The course is passed by a final exam and an accepted literature review.

Recommended optional programme components:

Introduction to Microelectronics and Micromechanics.

Recommended or required reading:

Lecture notes. Parts form books: Rao R. Tummala: Fundamentals of Microsystems Packaging, Rao R. Tummala, Eugene J. Pymaszewski, Alan G. Klopfenstein: Microelectronics Packaging Handbook II, William D. Brown (toim.): Advanced Electronic Packaging, With Emphasis on Multichip Modules, IEEE, Inc., New York 1999, luvut 11 ja 16, Patrick D.T. O'Connor: Practical Reliability Engineering, John Wiley&Sons, 2002, luvut 8 ja 9 ja Ken Gilleo: Area Array Packaging Handbook: Manufacturing and Assembly, McGraw-Hill 2002.

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

Language of instruction:

In Finnish (fall 2010), In English (fall 2011).

Timing:

Period 1-3.

Learning outcomes:

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. 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. 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. Student can also explain the principle of an automatic gain control (AGC). Student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Definitions of noise terms, impedance matching using discrete components, microstrip matching networks, RF transistor amplifier design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Learning activities and teaching methods:

Lectures and exercises in total 4 hours in a week. Design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade the weight for the exam is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

Lecture notes. R. Ludwig & P. Bretchko: RF Circuit Design Theory and Applications, 2000. G. Gonzales: Microwave Transistor Amplifiers Analysis and Design, 1997.

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen, Jari Hannu

Opintokohteen kielet: Finnish

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

The course covers common passive components and their measurement techniques used at RF and microwave frequencies. The course provides ability to know components selection principles and ability to conduct measurements related to electromagnetic fields and high frequency circuits.
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.

Learning activities and teaching methods:

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

Recommended optional programme components:

Electronic components, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended or required reading:

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

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tarmo Ruotsalainen

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish (In English if needed).

Timing:

Period 1-2.

Learning outcomes:

The goal is to reinforce and further develop the student's understanding of concepts of analogue circuit blocks and their application and use in the design of electronic equipment. The course also gives basic skills for the design of integrated building blocks. Noise and modeling of noise in electrical circuits, and the structures and properties of DA/AD converters are covered.
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, analyse and design integrated structural 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 connected with DA and AD conversion and converters and to analyse and outline their main structural principles and 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.

Learning activities and teaching methods:

Lectures, exercises and a small design work. Final exam.

Recommended optional programme components:

Electronics Design I.

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.

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

Learning outcomes:

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

Contents:

Fabrication stages of VLSI semiconductors. Simulation of semiconductor processes. VLSI semiconductor techniques. GaAs devices and circuits, the new features of hybrid techniques and the trends of microelectronics. Materials and fabrication methods of micromechanics. Design and implementation of micromechanical structures. Actuators for small movements, micro valves, pumps and motors, switches, micro-optics, applications in medical engineering, autonomic microsystems, microrobotics, nanotechniques. Implementation: Lectures and exercises. Final exam.

Recommended optional programme components:

Introduction to Microelectronics and Micromechanics.

Recommended or required reading:

Will be informed during lectures

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

Language of instruction:

In English.

Timing:

Period 5-6.

Learning outcomes:

The students are introduced to methods and processes of growth of thin films and to methods of research of growth, microstructure, and chemical composition of thin films.
Learning outcomes : Student is able to describe characteristics of materials in thin-film form, main methods of deposition of thin films, main experimental methods of materials characterization (thickness, chemical composition, morphology, crystal and electronic structure), strongly localized research methods, and methods of studies of dynamic properties. Student is able to explain processes of growth of thin films, physical principles and limits of research methods, relationship between measurement results and materials parameters. Student is able to select appropriate research methods and properly apply them.

Contents:

Thin films for electronics. Methods of deposition. Growth processes. Methods of studies of thickness, microstructure, and chemical composition. Methods of x-ray and electron diffraction. X-ray, electron, and ion spectroscopy. Electron, tunnelling, atomic force, and near-field microsopes. Infra-red and Raman spectroscopy.

Learning activities and teaching methods:

Lectures, demonstrations, and calculation exercises. Final exam. The course is provided biannially.

Recommended optional programme components:

Basic physics. Introduction to materials physics

Recommended or required reading:

Selected chapters from M. Ohring: The materials science of thin films, Academic Press, 1992, 2002. Lecture notes.

521203S: Micromodules, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Period 4-6.

Learning outcomes:

The student get acquainted to system level packaging technologies and applications and how these will be developed in the future.
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

Learning activities and teaching methods:

L ectures and a literature review. The course is passed by a final exam and an accepted literature review. The course rank is a weighted average (2 and 1) from exam and literature review .

Recommended optional programme components:

Principles of Microelectronics and Micromechanics, Microelectronics Packaging Technology and Reliability.

Recommended or required reading:

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

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

The course provides knowledge of electrical and optical microsensors, their structure, operation principles, and use in various applications. Course also introduces to design and fabrication of main sensor types for different forms of energy.
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.

Learning activities and teaching methods:

Lectures 2 hours/week and calculation exercises 1 hour/week.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1994.

521217S: Printed Electronics, 4 op

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

521089S Printed Electronics 5.0 op

Ei opintojaksokuvauksia.

521174S: Measuring and Testing Systems, 4 op

Voimassaolo: 01.08.2011 - 31.07.2013
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical and Information Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Matti Kinnunen, Juha Häkkinen
Opintokohteen kielet: Finnish

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
Opettajat: Kilpelä, Ari Juhani
Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 5-6

Learning outcomes:

To give the basic knowledge of the transmitter and receiver electronics used in optoelectronic applications, and basic theory of optical fibers and their usage in various applications.

Learning outcomes: On completion of the study module students should be able to explain the principles of operation of the photoconductors and photochannels (optic fibres), semiconductor light sources and photodetectors 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 light source control circuits and photodetector preamplifiers and be capable of comparing them in terms of their main performance parameters. They should also be reasonably able to use the main principles of signal processing that are required for the design of optoelectronic measurement applications.

Contents:

Geometrical and physical optics, optical fibers and their properties, sources of radiation (the radiation of black body, LED- and laser structures), photodetectors (photo conductive detector, light multiplier, PIN- and AP-diodes, position sensitive detectors), light source modulation, preamplifiers and their bandwidth/stability/noise analysis, the signal analysis methods used in optoelectonics

Learning activities and teaching methods:

Lectures and exercises. May include a seminar. Final exam.

Recommended optional programme components:

Principles of Semiconductor Devices.

Recommended or required reading:

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

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

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.
Learning outcomes: On completion of the study module a student is able to explain all the phases of a development project of an electronic device. He or she is able to explain how to protect results obtained during the development process and on the other hand the student is able to explain the restrictions caused by standards and patents of other companies. The 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 nonidealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

Contents:

Electronic product design process, patents, test design, and EMC/LVD standards, Characteristics of ASIC technology and design, Characteristics of highspeed digital design. Reliability engineering. Documentation design

Learning activities and teaching methods:

The course includes 3 h of lectures and 2 h of exercises per week. The course will be passed by means of a final exam.

Recommended optional programme components:

Circuit Theory I-II, Analogue Electronics I-II, Digital Techniques I-II, Filter Theory, Computer engineering, Embedded Systems.

Recommended or required reading:

Handout. Ward & Angus: Electronic Product Design, m Hall&Hall&McCall: Highspeed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques.

464061A: Techniques of Creative Working, 3 op

Voimassaolo: - 31.07.2021

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Mechanical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Niskanen, Juhani

Opintokohteen kielet: Finnish

Leikkaavuudet:

464104A	Product innovations	5.0 op

Learning outcomes:

The objective of the course for the student to learn to find problems in a familiar environment, analyze them and implement mechanical engineering to solve the problems.
Learning outcomes: Upon completion of the course, the student is able to convert a familiar condition to a problem requiring a technical solution and question existing solutions. The student is able to apply the most important methods of systematic creative working.

Contents:

Analyzing and abstracting of a problem; Connecting a problem to a larger context or its division to minor problems; Applying systematic methods to a defined problem

Learning activities and teaching methods:

The course includes an introductory lesson and guided exercises during lessons. The course also includes a separate group work from a topic that has come up during lessons. This course will have an exam and group work. The final grade is the average of exam and group work. Those who have done the exercises during the lessons are required to answer only half of the questions in the exam.

Recommended or required reading:

Jorma Tuomaala: Luovan työn tekniikka.

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

Voimassaolo: - 31.07.2021

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Mechanical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Karjalainen, Jussi Antero

Opintokohteen kielet: Finnish

Leikkaavuudet:

463105A	Casting techniques	8.0 op

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.

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.

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)-

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

Voimassaolo: 01.08.2007 - 31.07.2021

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department 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

Language of instruction:

Finnish

Learning outcomes:

The aim of this course is for students to gain an understanding of the
basic idea and restrictions of FEM and the preparedness to the use of commercial FE-programs.
Learning outcomes: After this course, the student can explain the basic idea of the FEM. He/she can analyze simple truss- and frame structures and explain the theoretical background of the calculations. In addition, the student can analyze two-dimensional and heat transfer problems by using FEM.

Contents:

The basic idea of FEM and its use in static analyses of bars, beams and plane structures. Some general principles of the use of FEM.

Learning activities and teaching methods:

Lectures and exercises take place during periods 1 and 2. The course can be passed either by completing two mid-term exams or a final exam

Recommended optional programme components:

Strength of Materials I and II.

Recommended or required reading:

Lecture notes (in Finnish), N. Ottosen & H. Petersson: Introduction to the Finite Element Method, NAFEMS: A Finite Element Primer, O. C. Zienkiewcz & R. L. Taylor: The Finite Element Method, 4th ed, Vol. 1: Basic Formulation and Linear Problems.

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 courses

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

Language of instruction:

In English.

Timing:

Period 5-6.

Learning outcomes:

The students are introduced to methods and processes of growth of thin films and to methods of research of growth, microstructure, and chemical composition of thin films.
Learning outcomes : Student is able to describe characteristics of materials in thin-film form, main methods of deposition of thin films, main experimental methods of materials characterization (thickness, chemical composition, morphology, crystal and electronic structure), strongly localized research methods, and methods of studies of dynamic properties. Student is able to explain processes of growth of thin films, physical principles and limits of research methods, relationship between measurement results and materials parameters. Student is able to select appropriate research methods and properly apply them.

Contents:

Thin films for electronics. Methods of deposition. Growth processes. Methods of studies of thickness, microstructure, and chemical composition. Methods of x-ray and electron diffraction. X-ray, electron, and ion spectroscopy. Electron, tunnelling, atomic force, and near-field microsopes. Infra-red and Raman spectroscopy.

Learning activities and teaching methods:

Lectures, demonstrations, and calculation exercises. Final exam. The course is provided biannially.

Recommended optional programme components:

Basic physics. Introduction to materials physics

Recommended or required reading:

Selected chapters from M. Ohring: The materials science of thin films, Academic Press, 1992, 2002. Lecture notes.

763312A: Quantum mechanics I, 10 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763612S Quantum mechanics I 10.0 op

ECTS Credits:

10 credits

Timing:

3. autumn

Learning outcomes:

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 basic principles and postulates of quantum mechanics, which lead to derivation of the Schrödinger equation. As examples 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. The time independent perturbation theory with some examples is introduced.

Learning activities and teaching methods:

Lectures 50 h, 13 exercises. Two written intermediate examinations or one final examination.

Target group:

For all interested in modern, quantum phenomena, compulsory for physicists and theoretical physicists.

Recommended optional programme components:

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

Recommended or required reading:

M. Saarela: Kvanttimekaniikka I (lecture notes 2010), C. Cohen-Tannoudji, L. Diu & F. Laloe: Quantum Mechanics vol. I (1977), J. J. Powell & B. Crasemann: Quantum Mechanics (1961), L.I. Schiff: Quantum Mechanics (1968).

Person responsible:

Mikko Saarela

Other information:

https://wiki.oulu.fi/display/763312A/

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

Language of instruction:

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

Timing:

Period 4-5.

Learning outcomes:

The course provides the basic concepts of x-ray diffraction and spectroscopy applicable to the study of composition, crystal structure, and structure imperfections of materials. In addition, the students are introduced to experimental diffraction work.
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. Student can explain the origin and generation of x-ray radiation, can explain the main x-ray detection technologies, and x-ray measurement techniques. Also, student can explain how to experimentally measure the crystal structure, grain size, and stress state of a material by using x-ray diffraction methods (XRD).

Contents:

Generation 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.

Learning activities and teaching methods:

Lectures and calculation exercises. Three laboratory exercises under instruction of assistant lecturer. Final grade of the course will be a weighted average of theoretical examination (2/3) and laboratory exercises (1/3).

Recommended or required reading:

Lecture notes and B.E.Warren: X-ray Diffraction, Addison-Wesley Publishing Company, Inc., 1969 and some other books informed later.

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

The course provides knowledge of electrical and optical microsensors, their structure, operation principles, and use in various applications. Course also introduces to design and fabrication of main sensor types for different forms of energy.
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.

Learning activities and teaching methods:

Lectures 2 hours/week and calculation exercises 1 hour/week.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1994.

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
Vastuuyksikkö: Mathematics Division
Arvostelu: 1 - 5, pass, fail
Opettajat: Ruotsalainen Keijo
Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 4-6

Learning outcomes:

The objective of the course is to provide the mathematical foundations of numerical methods, to analyze their basic theoretical properties (stability, accuracy and computational complexity), and demonstrate their performances on examples.
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 linearalgebra. Basics of the approximation theory. Numerical quadratures. Numerical methods for ordinary and partial differential equations.

Learning activities and teaching methods:

Lectures 4h/week. Two intermediate exams or one final exam.

Recommended or required reading:

- K. Ruotsalainen, Numeeriset menetelmät (lecture notes in finnish)
- Faires and Burden; Numerical methods
- A. Quarteroni, R. Sacco and F Salieri; Numerical mathematics

Prequisites: Calculus 1, Calculus 2, Matrix algebra and Differential Equations.

761668S: Computational physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

6 credits

Language of instruction:

English

Timing:

Not lectured every year.

Learning outcomes:

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 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.

Learning activities and teaching methods:

Lectures 35 h, 4 practical works.

Target group:

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

Recommended optional programme components:

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

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).

Assessment methods and criteria:

One literary examination.

Person responsible:

Perttu Lantto

Other information:

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

763628S: Condensed matter physics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763636S Condensed matter physics 5.0 op

ECTS Credits:

10 credits

Timing:

4. year

Learning outcomes:

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.

Learning activities and teaching methods:

Lectures 50 h, 12 exercise sessions (24 h). One written examination.

Target group:

Optional. For all interested in theoretical condensed matter physics.

Recommended optional programme components:

763333A, 763312A, 766328A.

Recommended or required reading:

Michael P. Marder: Condensed Matter Physics. N.W. Ashcroft & N.D. Mermin: Solid state Physics.

Person responsible:

Erkki Thuneberg

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: Department of Mechanical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Niskanen, Juhani

Opintokohteen kielet: Finnish

Leikkaavuudet:

464104A Product innovations 5.0 op

Learning outcomes:

The objective of the course for the student to learn to find problems in a familiar environment, analyze them and implement mechanical engineering to solve the problems.
Learning outcomes: Upon completion of the course, the student is able to convert a familiar condition to a problem requiring a technical solution and question existing solutions. The student is able to apply the most important methods of systematic creative working.

Contents:

Analyzing and abstracting of a problem; Connecting a problem to a larger context or its division to minor problems; Applying systematic methods to a defined problem

Learning activities and teaching methods:

The course includes an introductory lesson and guided exercises during lessons. The course also includes a separate group work from a topic that has come up during lessons. This course will have an exam and group work. The final grade is the average of exam and group work. Those who have done the exercises during the lessons are required to answer only half of the questions in the exam.

Recommended or required reading:

Jorma Tuomaala: Luovan työn tekniikka.

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: Tarmo Ruotsalainen

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish (In English if needed).

Timing:

Period 1-2.

Learning outcomes:

The goal is to reinforce and further develop the student's understanding of concepts of analogue circuit blocks and their application and use in the design of electronic equipment. The course also gives basic skills for the design of integrated building blocks. Noise and modeling of noise in electrical circuits, and the structures and properties of DA/AD converters are covered.
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, analyse and design integrated structural 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 connected with DA and AD conversion and converters and to analyse and outline their main structural principles and 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.

Learning activities and teaching methods:

Lectures, exercises and a small design work. Final exam.

Recommended optional programme components:

Electronics Design I.

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.

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

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish. Materials also available in English.

Timing:

Period 1-2.

Learning outcomes:

The objective of the course is to present common practical solutions for electrically measuring physical quantities. This course covers especially sensors and methods used in process industry.
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.

Learning activities and teaching methods:

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

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)

521450S: Optoelectronics, 4 op

Voimassaolo: - 31.07.2014

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Kilpelä, Ari Juhani

Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 5-6

Learning outcomes:

To give the basic knowledge of the transmitter and receiver electronics used in optoelectronic applications, and basic theory of optical fibers and their usage in various applications.
Learning outcomes: On completion of the study module students should be able to explain the principles of operation of the photoconductors and photochannels (optic fibres), semiconductor light sources and photodetectors 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 light source control circuits and photodetector preamplifiers and be capable of comparing them in terms of their main performance parameters. They should also be reasonably able to use the main principles of signal processing that are required for the design of optoelectronic measurement applications.

Contents:

Geometrical and physical optics, optical fibers and their properties, sources of radiation (the radiation of black body, LED- and laser structures), photodetectors (photo conductive detector, light multiplier, PIN- and AP-diodes, position sensitive detectors), light source modulation, preamplifiers and their bandwidth/stability/noise analysis, the signal analysis methods used in optoelectonics

Learning activities and teaching methods:

Lectures and exercises. May include a seminar. Final exam.

Recommended optional programme components:

Principles of Semiconductor Devices.

Recommended or required reading:

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

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

Language of instruction:

In Finnish (fall 2010), In English (fall 2011).

Timing:

Period 1-3.

Learning outcomes:

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. 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. 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. Student can also explain the principle of an automatic gain control (AGC). Student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Definitions of noise terms, impedance matching using discrete components, microstrip matching networks, RF transistor amplifier design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Learning activities and teaching methods:

Lectures and exercises in total 4 hours in a week. Design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade the weight for the exam is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

Lecture notes. R. Ludwig & P. Bretchko: RF Circuit Design Theory and Applications, 2000. G. Gonzales: Microwave Transistor Amplifiers Analysis and Design, 1997.

521216S: Microelectronics Packaging Technology and Reliability, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Sami Myllymäki

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Periods 1-3.

Learning outcomes:

The students are introduced to the packaging and interconnection technologies and to the reliability and testing of electronics packaging technology.
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 mechanism's 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 these. Methods of environmental testing, screening and quality control.

Learning activities and teaching methods:

Lectures and literature review. The course is passed by a final exam and an accepted literature review.

Recommended optional programme components:

Introduction to Microelectronics and Micromechanics.

Recommended or required reading:

Lecture notes. Parts form books: Rao R. Tummala: Fundamentals of Microsystems Packaging, Rao R. Tummala, Eugene J. Pymaszewski, Alan G. Klopfenstein: Microelectronics Packaging Handbook II, William D. Brown (toim.): Advanced Electronic Packaging, With Emphasis on Multichip Modules, IEEE, Inc., New York 1999, luvut 11 ja 16, Patrick D.T. O'Connor: Practical Reliability Engineering, John Wiley&Sons, 2002, luvut 8 ja 9 ja Ken Gilleo: Area Array Packaging Handbook: Manufacturing and Assembly, McGraw-Hill 2002.

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen, Jari Hannu

Opintokohteen kielet: Finnish

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

The course covers common passive components and their measurement techniques used at RF and microwave frequencies. The course provides ability to know components selection principles and ability to conduct measurements related to electromagnetic fields and high frequency circuits.
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.

Learning activities and teaching methods:

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

Recommended optional programme components:

Electronic components, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended or required reading:

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

521174S: Measuring and Testing Systems, 4 op

Voimassaolo: 01.08.2011 - 31.07.2013

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical and Information Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Kinnunen, Juha Häkkinen

Opintokohteen kielet: Finnish

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 Measurements	5.0 op

Language of instruction:

Finnish.

Timing:

Period 6.

Learning outcomes:

The goal of this course is to make the student familiar with the measurements utilizing optoelectronics and optics, measurement principles, sensors and device configurations. 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 or verbal report.

Contents:

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

Learning activities and teaching methods:

Lectures and exercises. Final exam.

Recommended or required reading:

Lecture notes. P.G. Cielo: Optical Techniques for Industrial Inspection, Academic Press, 1988.

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: Hast, Jukka Tapio
Opintokohteen kielet: Finnish
Leikkaavuudet:

521089S Printed Electronics 5.0 op

Ei opintojaksokuvauksia.

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

Opintojaksossa perehdytään elektroniikassa ja optoelektroniikassa käytettäviin funktionaalisiin materiaaleihin. Tarkoituksena on antaa yleiskäsitys näiden materiaalien pääominaisuuksista ja ilmiöistä, joihin nämä ominaisuudet perustuvat, sekä niiden käytöstä elektroniikassa. Osaamistavoitteet: Opintojakson suoritettuaan opiskelija osaa selittää perusteet eristeiden käyttäytymisestä tasa- ja vaihtokentässä, magneettisten materiaalien ominaisuuksista sekä magnetismiin liittyvistä käsitteistä, sähkökeraamien ominaisuuksista ja sovelluksista sekä valoa lähettävien ja moduloivien laitteiden materiaaleista. Opiskelija osaa myös arvioida eri materiaalien käytettävyyttä ja soveltuvuutta elektroniikan ja optoelektroniikan laitteisiin.

Contents:

The course treats materials used in electronic circuits, optoelectronics and transducers. Magnetic materials (soft and hard, information storage). Piezo-, pyro- and ferroelectric materials and their applications. Displays and their materials (liquid crystals). Materials for optoelectronic devices.

Learning activities and teaching methods:

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

Recommended optional programme components:

Introduction to Material Physics

Recommended or required reading:

N. Braithwaite and G. Weaver, Electronic Materials, The Open University, Butterworths, London, 1990. Lecture notes.

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

Language of instruction:

Finnish.

Timing:

Period 1-2.

Learning outcomes:

The goal of this course is to make a student familiar with the facts of geometrical and physical optics, optical components and optical instruments needed to perform optical design.
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 designing and optimizing simple lens systems using optical design software tools. He is able to describe the properties of laser beam and to design lens systems for laser beam modification.

Contents:

Basics of geometrical and physical optics, optical components and instruments. Optical design software tools.

Learning activities and teaching methods:

Lectures, exercises. Final exam.

Recommended or required reading:

Lecture notes, Lectures are based on: F. L. Pedrotti, L. M. Pedrotti, L. S. Pedrotti: Introduction to Optics, 3rd ed. Pearson Education, 2007; Hecht: Optics, 4th ed. Addison-Wesley, 2002; D.C. O'Shea: Elements of Modern Optical Design. John Wiley & Sons, 1985.

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

465082S: Physical Metallurgy II, 7 op

Voimassaolo: - 31.12.2014
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Mechanical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: David Porter
Opintokohteen kielet: Finnish
Leikkaavuudet:

465109S Microstructural changes in metallic alloys 7.0 op
465063S-01 Microstructural changes in metallic alloys, examination 0.0 op
465063S-02 Microstructural changes in metallic alloys, exercises 0.0 op
465063S Microstructural changes in metallic alloys 7.0 op

Language of instruction:

Finnish

Learning outcomes:

The aim of the course focuses on the combination and adaptation of contents of the material from previous science courses into practical and applicable knowledge with an advanced understanding on physical metallurgy.
Learning outcomes: After the course, the student is capable to apply basic principles of thermodynamics and kinetics to phase transformations. He/she is able to estimate the effect of a phase diagram on the microstructure of a metal alloy. On the basis of diffusion theory, the student is able to explain solidification, recrystallization and precipitation of metal alloys, and additionally the phase transformation of steels during austenite dissociation (ferrite, pearlite, bainite, martensite). He/she is also able to explain phase structures and their mechanical properties in steels on the basis of TTT diagrams.

Contents:

Thermodynamics and kinetics of phase transformations in a solid state; Phase diagrams; Diffusion; Solidification; Recrystallization; Precipitation; Martensitic transformation; Pearlite and bainite reactions; TTT diagrams and their applications

Learning activities and teaching methods:

The course consists of lectures and seminars during periods 4 to 6. The final grade is based on the weighed combined points from the final exam or the small exams and the personal seminar work.

Recommended optional programme components:

Materials Engineering I, Introduction to Materials Science

Recommended or required reading:

Lecture booklet (in Finnish)
Additional material: Porter, D. & Easterling, K.: Phase Transformations in Metals, Van Nostrand Reinhold Company: New York, 1981; Honeycombe, R.W.: Steels - Microstructure and Properties.

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

Language of instruction:

In English.

Timing:

Period 5-6.

Learning outcomes:

The students are introduced to methods and processes of growth of thin films and to methods of research of growth, microstructure, and chemical composition of thin films.
Learning outcomes : Student is able to describe characteristics of materials in thin-film form, main methods of deposition of thin films, main experimental methods of materials characterization (thickness, chemical composition, morphology, crystal and electronic structure), strongly localized research methods, and methods of studies of dynamic properties. Student is able to explain processes of growth of thin films, physical principles and limits of research methods, relationship between measurement results and materials parameters. Student is able to select appropriate research methods and properly apply them.

Contents:

Thin films for electronics. Methods of deposition. Growth processes. Methods of studies of thickness, microstructure, and chemical composition. Methods of x-ray and electron diffraction. X-ray, electron, and ion spectroscopy. Electron, tunnelling, atomic force, and near-field microsopes. Infra-red and Raman spectroscopy.

Learning activities and teaching methods:

Lectures, demonstrations, and calculation exercises. Final exam. The course is provided biannially.

Recommended optional programme components:

Basic physics. Introduction to materials physics

Recommended or required reading:

Selected chapters from M. Ohring: The materials science of thin films, Academic Press, 1992, 2002. Lecture notes.

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

The course provides knowledge of electrical and optical microsensors, their structure, operation principles, and use in various applications. Course also introduces to design and fabrication of main sensor types for different forms of energy.
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.

Learning activities and teaching methods:

Lectures 2 hours/week and calculation exercises 1 hour/week.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1994.

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

Ei opintojaksokuvauksia.

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

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.
Learning outcomes: On completion of the study module a student is able to explain all the phases of a development project of an electronic device. He or she is able to explain how to protect results obtained during the development process and on the other hand the student is able to explain the restrictions caused by standards and patents of other companies. The 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 nonidealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

Contents:

Electronic product design process, patents, test design, and EMC/LVD standards, Characteristics of ASIC technology and design, Characteristics of highspeed digital design. Reliability engineering. Documentation design

Learning activities and teaching methods:

The course includes 3 h of lectures and 2 h of exercises per week. The course will be passed by means of a final exam.

Recommended optional programme components:

Circuit Theory I-II, Analogue Electronics I-II, Digital Techniques I-II, Filter Theory, Computer engineering, Embedded Systems.

Recommended or required reading:

Handout. Ward & Angus: Electronic Product Design, m Hall&Hall&McCall: Highspeed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques.

521172S: EMC Design, 4 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521115S EMC Design 5.0 op

Language of instruction:

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

Timing:

Period 6.

Learning outcomes:

The special requirements and limitations of EMC design provide directives for the equipment's interference emission and for their ability to operate as intended in environments/circumstances under interference. This has a great effect on electrical and mechanical design. The course introduces the EMC requirements for electrical equipment as well as methods to achieve them. 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 and shielding. EMC testing laboratories, EMC tests and their background.

Learning activities and teaching methods:

Lectures, exercises and laboratory exercises. Final exam.

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. T. Williams, K. Armstrong: EMC for Systems and Installations. E. L. Bronaugh, W. S. Lambdin: A Handbook Series on Electromagnetic Interference and Compatibility, vol. 6, Electromagnetic Interference Test Methodology and Procedures.

521095S: Advanced Course of Printed Electronics, 3 op

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

521089S Printed Electronics 5.0 op

Ei opintojaksokuvauksia.

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

Voimassaolo: - 31.07.2021
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Mechanical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Karjalainen, Jussi Antero
Opintokohteen kielet: Finnish
Leikkaavuudet:

463105A Casting techniques 8.0 op

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.

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.

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)-

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.

Module total appr. 30 cr

521167S: Testing Techniques of Electronics, 4 op

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

Language of instruction:

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

Timing:

Period 3.

Learning outcomes:

In this course students become familiar with testing methods and testing equipment used in electrical industry.
Learning outcomes: After completing the course the student is able to explain how testing affects the quality and reliability of electrical products. Additionally, the student can estimate how the selected testing techniques and the measurement results generated enable the control of the manufacturing process. The student is able to analyze different kinds of testing strategies, and is able to enhance the testability of electronics through the use of design for testability (DfT). Additionally, the student is able to use different manufacturing testing techniques, such as automatic testing equipment, boundary-scan and built-in-self-test (BIST).

Contents:

Quality and reliability, controlling the manufacturing process using test results, automatic test equipment, test strategies, design for testability, boundary-scan, built-in self-test (BIST).

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:

Lecture notes. T. L. Landers, W. D. Brown, E. W. Fant, E. M. Malstrom, N. M. Schmitt: Electronics Manufacturing Processes. B. Davis: The Economics of Automatic Testing. M.L. Bushnell, V.D. Agrawal: Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits. M. Burns, G. W. Roberts: An Introduction to Mixed-Signal IC Test and Measurement.

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: Juha Häkkinen

Opintokohteen kielet: Finnish

Language of instruction:

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

Timing:

Period 5.

Learning outcomes:

The goal of the course is to deepen the knowledge of life cycle testing of mixed-signal devices.
Learning outcomes: After completing the course the student is able to use production testing techniques from the life-cycle testing and re-usability points of view. The student can compare different testing techniques of analogue, digital and RF-electronics, which have been implemented using either embedded testing methods or external automatic testing equipment. Additionally, the student is able to use DSP-based testing and remote testing, and compare different test interfaces and data busses.

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.

Learning activities and teaching methods:

Lectures and exercises. Final Exam.

Recommended optional programme components:

Electronics Design I, Testing Techniques of Electronics.

Recommended or required reading:

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

521172S: EMC Design, 4 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521115S EMC Design 5.0 op

Language of instruction:

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

Timing:

Period 6.

Learning outcomes:

The special requirements and limitations of EMC design provide directives for the equipment's interference emission and for their ability to operate as intended in environments/circumstances under interference. This has a great effect on electrical and mechanical design. The course introduces the EMC requirements for electrical equipment as well as methods to achieve them. 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 and shielding. EMC testing laboratories, EMC tests and their background.

Learning activities and teaching methods:

Lectures, exercises and laboratory exercises. Final exam.

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. T. Williams, K. Armstrong: EMC for Systems and Installations. E. L. Bronaugh, W. S. Lambdin: A Handbook Series on Electromagnetic Interference and Compatibility, vol. 6, Electromagnetic Interference Test Methodology and Procedures.

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

The course provides knowledge of electrical and optical microsensors, their structure, operation principles, and use in various applications. Course also introduces to design and fabrication of main sensor types for different forms of energy.
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.

Learning activities and teaching methods:

Lectures 2 hours/week and calculation exercises 1 hour/week.

Recommended or required reading:

Julian W. Gardner, Microsensors, Principles and Applications, John Wiley&Sons, 1994.

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

Ei opintojaksokuvauksia.

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

Language of instruction:

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

Timing:

Period 4

Learning outcomes:

The objective of the course is to supply student with basic understanding of methods, standards and components, which are needed in the wireless measurements of industrial, traffic, environmental and healthcare applications.
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.

Learning activities and teaching methods:

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.

Recommended optional programme components:

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

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 literal final exam (70 %) and a contemporary seminar (30 %)

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

Language of instruction:

Finnish.

Timing:

Periods 1-2.

Learning outcomes:

The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.
Learning outcomes: On completion of the study module a student is able to explain all the phases of a development project of an electronic device. He or she is able to explain how to protect results obtained during the development process and on the other hand the student is able to explain the restrictions caused by standards and patents of other companies. The 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 nonidealities of electrical components. After passing the course the student can calculate reliability of an electrical device or system.

Contents:

Electronic product design process, patents, test design, and EMC/LVD standards, Characteristics of ASIC technology and design, Characteristics of highspeed digital design. Reliability engineering. Documentation design

Learning activities and teaching methods:

The course includes 3 h of lectures and 2 h of exercises per week. The course will be passed by means of a final exam.

Recommended optional programme components:

Circuit Theory I-II, Analogue Electronics I-II, Digital Techniques I-II, Filter Theory, Computer engineering, Embedded Systems.

Recommended or required reading:

Handout. Ward & Angus: Electronic Product Design, m Hall&Hall&McCall: Highspeed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques.

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

Language of instruction:

Finnish.

Timing:

Period 1-6.

Learning outcomes:

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

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. Experienced designers are used as instructors. The task can be carried out by one person or by a team of two persons. The mark will be decided on the basis of the statement of the instructor and the report provided by the student. Starting from spring 2003 an alternative for normal design/contruction work is to take part in a special course, in which a mixed mode analog IC is designed. This design task is executed under supervision in the workstation class and the whole IC design flow and the IC design software are studied. It is possible that the number of the students taking part in the IC design course may be limited on the basis of successful progress in electronics studies.

Recommended optional programme components:

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

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.

Module of the Option

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.

Module of the option

031025A: Introduction to Optimization, 5 op

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

Language of instruction:

Finnish. English for the students in the International Master program.

Timing:

Period 1-3

Learning outcomes:

The objective of the course is to provide the mathematical foundations of the optimization methods, to analyze their basic theoretical properties and demonstrate their performances on examples.
Learning outcomes **:** The student learns to solve convex optimization problems with the basic optimization algorithms. He/She is able to form the necessary and sufficient conditions for the optimization problem and is able to form the corresponding dual problem.

Contents:

Linear optimization. Simplex-algorithm. KKT-conditions. Dual problem. Gradient algorithms. Conjugate gradient algorithm. Barrier- and penalty function methods. Implementation: Lectures 3h/week, Exercises 2h/week. Two intermediate exams or one final exam.

Recommended optional programme components:

Calculus 1, Calculus 2, Matrix algebra.

Recommended or required reading:

- K. Ruotsalainen, Optimoinnin perusteet (lecture notes in finnish)
- P. Ciarlet; Introductionto numerical linear algebra and optimization
- M. Bazaraa, H. Sherali, C.M. Shetty; Nonlinear programming

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: Juntti, Markku Johannes, Timo Kokkonen

Opintokohteen kielet: English

Leikkaavuudet:

521323S Wireless Communications 2 5.0 op

Language of instruction:

In English.

Timing:

Period 1-2.

Learning outcomes:

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

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. The student can

estimate the realisability of given design tasks before the execution of the detailed design. What is more, the student can independently search for information and knowledge related to

communication engineering, system design and signal

processing.

Contents:

Basic concepts, data compression, basics of source coding, channel capacity, capacity of a Gaussian channel, maximum entropy method, rate distortion theory, introduction to network information theory.

Learning activities and teaching methods:

Lectures and self-calculated exercises. The course is passed with final examination.

Recommended optional programme components:

Random signals, Telecommunication Engineering II.

Recommended or required reading:

Parts from Thomas M. Cover & Joy A. Thomas, Elements of Information Theory, 2nd ed. John Wiley & Sons, 1991 ISBN: 0-471-06259-6. Lecture notes.

521323S: Wireless Communications 2, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

521395S-01 Wireless Communications I, Exam 0.0 op

521395S Wireless Communications I 5.0 op

521320S Wireless Communications 2 8.0 op

521320S-01 Intermediate exam or final exam, Wireless Communications 2 0.0 op

521320S-02 Exercisework, Wireless Communications 2 0.0 op

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

Language of instruction:

In English.

Timing:

Period 1-3.

Learning outcomes:

The aim is to present the fundamentals of the structure of digital data transmission systems. Operation adapted according to the telephone network also considered. Technical implementation and application of the common data and local networks are discussed.
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 IEEE802.11 systems. The student is able to describe the basic protocol model of the UMTS radio interface and radio access network. The student will achieve skills to describe the main principles of mobility control, network security, crosslayer optimization and routing in ad hoc networks. 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.

Learning activities and teaching methods:

Two hours of lectures in a week. The course is passed with final examination and accepted design exercise. The course is lectured in English.

Recommended or required reading:

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

521326S: Radio Engineering 1, 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:

521326S-01 Radio Engineering 0.0 op

521335S Radio Engineering 1 6.0 op

521335S-01 Radio engineering, partial credit 0.0 op

521335S-02 Radio engineering, partial credit 0.0 op

Ei opintojaksokuvauksia.

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

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

To get the basic understanding of mobile communication systems dimensioning and performance. To learn some of the current and developing mobile communication system standards and to prepare students to understand the structure, functionality and dimensioning of these systems. Learning outcomes: Upon completing the required coursework, the student is able to determine the values of the main parameters of WCDMA physical layer and power control. The student can also determine 3G channel model and derive the CDMA cellular network capacity. In addition, the student can determine the main component used in the CDMA network planning. The course gives skills to describe mobility management, adaptive recourse control and dynamic recourse allocation in CDMA networks.

Contents:

Concept and structure of mobile communications system. Basics of CDMA radio network planning and capacity, channel modeling, distributed transmission power control, mobility management, adaptive recourse control, cooperative transmission, transmission diversity, dynamic recourse allocation. Examples of digital mobile telecommunication systems in practice.

Learning activities and teaching methods:

Two hours of lectures in a week and exercises. The course is passed with final examination and accepted laboratory exercise. The course is lectured in English.

Recommended optional programme components:

Telecommunication Engineering II

Recommended or required reading:

Parts of the following: S. Glisic: Wireless Networks:4G Technologies; S. Glisic: Adaptive WCDMA: Theory and Practice, S. Glisic: Advanced Wireless Communications: 4G Cognitive and Cooperative Technoloques (2 nd ed.), 2007

Compulsory

521385S-01: Mobile Telecommunications systems, exam, 0 op

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

Ei opintojaksokuvauksia.

521385S-02: Mobile Telecommunication Systems, exercisework, 0 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Partial credit
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Juha-Pekka Mäkelä
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

521324S: Statistical Signal Processing II, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English
Leikkaavuudet:

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

Ei opintojaksokuvauksia.

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

Language of instruction:

Finnish/English

Learning outcomes:

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.

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.

Learning activities and teaching methods:

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.

Recommended or required reading:

Instructions for preparing a diploma work in the Department of Electrical Engineering.

Advanced module, obligatory courses, 10-36 ECTS cr

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

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Module
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

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

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 queueing theory giving mathematical tools to apply the theory to practical communication systems.
Learning outcomes: Upon completing the required coursework, the student is able to construct simple theoretical queueing 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 queueing systems. The course gives skills for the student to describe functionalities of a communication network with game theory. 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, queueing systems and their measures of effectiveness, Little's result, blocking in queueing systems, open and closed (Jackson) queueing networks, advanced routing in data networks, multiple access techniques, network information theory, cognitive networks.

Learning activities and teaching methods:

Two hours of lectures in a week and exercises, The course is passed with final examination and accepted design exercise. The course is lectured in English.

Recommended optional programme components:

Communication Networks I, Stochastic Processes

Recommended or required reading:

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

521488S: Multimedia Systems, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

In Finnish.

Timing:

Period 2-3.

Learning outcomes:

The aim of the course is to provide advanced knowledge of multimedia technologies, and applying them in designing and implementing a multimedia system.
Learning objectives: Student can determine specifics of different multimedia elements and can explain basic techniques for presentation of multimedia. Student can describe novel multimedia communication techniques and recognize different functional domains, and how to apply them in the design and implementation of novel multimedia applications and services.

Contents:

key concepts, multimedia elements: image, voice, video, and animation techniques; resource management, real-time multimedia, quality of service, synchronization, multimedia communication techniques, multimedia databases, reference models, standardization, applications, watermarking, design and implementation of multimedia system.

Learning activities and teaching methods:

Lectures and course exercise related to multimedia systems (emphasis either on implementation, research or design). Course is passed with final examination and accepted course exercise. In addition group exam for additional points to exam. Course materials and group work instructions are available at OPTIMA.
Further information: http://www.ee.oulu.fi/research/tklab/courses/521488S/

Recommended optional programme components:

recommended courses include basic courses in computer science and mathematics, Operating systems (521453A), Digital Image Processing (521467S), Computer networks (521476S), Software Engineering (521457A) and Knowledge Engineering (521468S).
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Recommended or required reading:

Multimedia Communications: Applications, Networks, Protocols and Standards. F. Halsall, Addison-Wesley 2001, chapters 1-5. Lecture slides provide appendices and show the focus areas in more detail.
Supportive reading **:** Multimedia: Computing, Communications and Applications. R. Steinmetz and K. Nahrstedt, Prentice Hall 1995, chapters 1-6, 9.1.-9.4, 10.1, 11,12 and 15. Open Distributed Processing and Multimedia. G. Blair and J. Stefani, Addison-Wesley 1998, chapters 2-4 and 8. Principles of Multimedia Database Systems. V. Subrahmanian, Morgan Kaufman 1998, chapters 1,5, 9 and 15. Multimedia: Computing, Communications and Application. R. Steinmetz and K. Nahrstedt, Prentice Hall 1995. Chapters 1-6, 9.1.-9.3, 10.1, 11-13, 15, 17.

Electives

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: Tarmo Ruotsalainen
Opintokohteen kielet: Finnish

Language of instruction:

In Finnish (In English if needed).

Timing:

Period 1-2.

Learning outcomes:

The goal is to reinforce and further develop the student's understanding of concepts of analogue circuit blocks and their application and use in the design of electronic equipment. The course also gives basic skills for the design of integrated building blocks. Noise and modeling of noise in electrical circuits, and the structures and properties of DA/AD converters are covered.
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, analyse and design integrated structural 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 connected with DA and AD conversion and converters and to analyse and outline their main structural principles and 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.

Learning activities and teaching methods:

Lectures, exercises and a small design work. Final exam.

Recommended optional programme components:

Electronics Design I.

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.

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

Language of instruction:

Finnish, English.

Timing:

Period 1-6

Learning outcomes:

Design exercises are used to deepen the understanding of the material presented in Principles of Electronics Design and Analogue Electronics I. Implementation: Independent design exercise, which is checked by CADsimulations and experimentally. Simulations are carried out in PSpice environment
Learning outcomes: On completion of the study module students should be able to design basic electronic structural blocks and verify their functioning in a CAD simulation environment. They should be able independently to realize and test a small-scale design object employing the analogue technique.

Recommended optional programme components:

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

521488S: Multimedia Systems, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

In Finnish.

Timing:

Period 2-3.

Learning outcomes:

The aim of the course is to provide advanced knowledge of multimedia technologies, and applying them in designing and implementing a multimedia system.
Learning objectives: Student can determine specifics of different multimedia elements and can explain basic techniques for presentation of multimedia. Student can describe novel multimedia communication techniques and recognize different functional domains, and how to apply them in the design and implementation of novel multimedia applications and services.

Contents:

key concepts, multimedia elements: image, voice, video, and animation techniques; resource management, real-time multimedia, quality of service, synchronization, multimedia communication techniques, multimedia databases, reference models, standardization, applications, watermarking, design and implementation of multimedia system.

Learning activities and teaching methods:

Lectures and course exercise related to multimedia systems (emphasis either on implementation, research or design). Course is passed with final examination and accepted course exercise. In addition group exam for additional points to exam. Course materials and group work instructions are available at OPTIMA.
Further information: http://www.ee.oulu.fi/research/tklab/courses/521488S/

Recommended optional programme components:

recommended courses include basic courses in computer science and mathematics, Operating systems (521453A), Digital Image Processing (521467S), Computer networks (521476S), Software Engineering (521457A) and Knowledge Engineering (521468S).
.

Recommended or required reading:

Multimedia Communications: Applications, Networks, Protocols and Standards. F. Halsall, Addison-Wesley 2001, chapters 1-5. Lecture slides provide appendices and show the focus areas in more detail.
Supportive reading **:** Multimedia: Computing, Communications and Applications. R. Steinmetz and K. Nahrstedt, Prentice Hall 1995, chapters 1-6, 9.1.-9.4, 10.1, 11,12 and 15. Open Distributed Processing and Multimedia. G. Blair and J. Stefani, Addison-Wesley 1998, chapters 2-4 and 8. Principles of Multimedia Database Systems. V. Subrahmanian, Morgan Kaufman 1998, chapters 1,5, 9 and 15. Multimedia: Computing, Communications and Application. R. Steinmetz and K. Nahrstedt, Prentice Hall 1995. Chapters 1-6, 9.1.-9.3, 10.1, 11-13, 15, 17.

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

Language of instruction:

In English.

Timing:

In periods 1-6.

Learning outcomes:

Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

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

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.

Recommended or required reading:

Will be defined in the beginning of the course.

521261A: Computer Networks I, 5 op

Voimassaolo: - 31.07.2012

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Ojala, Timo Kullervo

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish. Materials are in English.

Timing:

Period 5-6.

Learning outcomes:

The course gives a comprehensive description of the fundamentals of computer networks, using the public Internet and its protocols and applications as examples

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 computer networking problems, and design and implement a small computer networking application

Contents:

Internet's architecture, most important access networks, TCP/IP protocol stack, the most important Internet applications, Internet

security.

Learning activities and teaching methods:

Lectures, exercises, and practical work.

Recommended or required reading:

James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach (5th Edition), Addison-Wesley, 2009.

Lecture slides and exercise materials.

Assessment methods and criteria:

The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work.

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:
Period 5-6.

Learning outcomes:

The course provides the key principles of distributed systems and the major design paradigms used in implementing distributed

systems.

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, communication, naming, synchronization, consistency and replication, fault tolerance, security,

distributed object-based systems, distributed file systems, distributed object-based systems, distributed coordination-based systems

Learning activities and teaching methods:

Lectures, exercises and practical work.

The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work.

Recommended optional programme components:

Computer networks, Operating systems, Software Engineering.

Recommended or required reading:

Andrew S. Tanenbaum and Maarten van Steen, Distributed Systems - Principles and Paradigms, Second Edition, Prentice Hall, 2007.

Lecture slides and exercises.

521262S: Computer Networks II, 6 op

Voimassaolo: 01.08.2007 - 31.07.2012
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Ojala, Timo Kullervo
Opintokohteen kielet: English

Language of instruction:
In English.
Timing:
Period 3-4.
Learning outcomes:

The course focuses on advanced issues on computer networking and the Internet.

Learning outcomes:

Upon completing the course the student is able to explain the recent developments in the Internet, solve complicated computer networking problems, and design and implement a computer networking application.

Contents:

Recent developments in Internet architecture, access networks, and Internet protocol stack, multimedia and quality of service, session management, mobility management.

Learning activities and teaching methods:

Lectures, exercises, and practical work. The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work. The implementation is fully English.

Recommended optional programme components:

Recommended courses include Computer Networks I, Operating Systems, Basics of Digital Communications, Telecommunications Software

and Communication Networks I.

Recommended or required reading:

James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down

Approach (5th Edition), Addison-Wesley, 2009.

Assorted Internet standards.

Lecture slides, exercises.

521265A: Telecommunications Software, 5 op

Voimassaolo: 01.08.2005 - 31.07.2012
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Junzhao Sun
Opintokohteen kielet: English

Learning outcomes:

The course provides systematic knowledge of telecommunication software principles and protocol engineering.
Learning Outcomes: Upon completion of the course, students should be able to:
- create and minimize a finite state machine,
- perform reachability analysis on a communicating finite state machine,
- create and identify behavioral properties of a petri net,
- perform coverability analysis on a petri net,
- describe data using ASN.1,
- encode ASN.1 type declaration to transfer syntax using BER,
- apply graphical SDL to model a protocol,

- generate test sequences for a finite state machine with T-, D-, W-, and U-methods,
- explain the key concepts of conformance testing methodology, and
- apply TTCN-3 core language to describe a test suite.

Contents:

Principles, specification, verification, validation, synthesis, description languages and testing of telecommunication protocols.

Learning activities and teaching methods:

The course comprises of lectures and exercises. The course is passed with a final exam and an approved practical work.

Recommended optional programme components:

Software engineering.

Recommended or required reading:

Gerard J. Holzmann, Design and Validation of Computer Protocols, Prentice-Hall, 1991. Andrew S. Tanenbaum, Computer Networks, 4th edition, Prentice Hall, 2003.

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

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:

Period 5-6.

Learning outcomes:

The course provides the key principles of distributed systems and the major design paradigms used in implementing distributed

systems.

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, communication, naming, synchronization, consistency and replication, fault tolerance, security,

distributed object-based systems, distributed file systems, distributed object-based systems, distributed coordination-based systems

Learning activities and teaching methods:

Lectures, exercises and practical work.

The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work.

Recommended optional programme components:

Computer networks, Operating systems, Software Engineering.

Recommended or required reading:

Andrew S. Tanenbaum and Maarten van Steen, Distributed Systems - Principles and Paradigms, Second Edition, Prentice Hall, 2007.

Lecture slides and exercises.

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

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

Language of instruction:

In English.

Timing:

In periods 1-6.

Learning outcomes:

Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

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

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.

Recommended or required reading:

Will be defined in the beginning of the course.

521387S: Telecommunication Engineering Project, 4 op

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

521322S Telecommunication Engineering Project 5.0 op

Timing:

Period 1-6.

Learning outcomes:

To introduce the student into the design, implementation and/or testing of a certain part of communication system.
Learning outcomes:
After completing the course student can - depending on the work subject - either solve, design, construct, measure, simulate, or analyze limited telecommunication and radio system and sub-system problems. Thus student applies the technical knowledge aquired from advanced cources into practical engineering tasks. In addition, student can document technical and scientific results

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 telecommunication laboratory 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 EE department's diploma thesis must be followed.

Recommended optional programme components:

Depending on the subject matter of exercise: Digital Communications, Digital Signal Processing or Radio Engineering or suitable advanced courses of the telecommunication laboratory.

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:

In Finnish.

Timing:

Periods 2-3.

Learning outcomes:

After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial and satellite channels. He/she understands the composition and importance of the propagation models and can apply them in practice. The emphasis in the course is on mobile communication channels.

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 and multipath propagation. The student can also describe how the radiation properties of different kind of antennas affect a radio channel and how the radio wave propagation impairments on the quality of radio communication can be overcome by using different kind of antennas. 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 radio link, in a fixed satellite link, outdoors (megacell, macrocell and microcell) and indoors (picocell). 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. The student can also measure the characteristics of wideband radio channel using a vector network analyser and report the measurement results.

Contents:

Basics of electromagnetic radiation. Different mechanisms of radiowave propagation: absorption, scattering, reflection, refraction and diffraction. Importance of radiowave propagation in the design of cellular communication systems. Effects of antennas on the radio channel. Principles of propagation modelling. Radiowave propagation phenomena over fixed terrestrial radio links and over fixed satellite links. Radio channel modelling for cellular systems (macrocells and microcells). Radio channels of mobile satellite links (megacells). Multipath propagation and its effects on narrowband and wideband radio channels. Radiowave propagation inside or into buildings (picocells). Simulation of narrowband and wideband radio channels. Mitigation methods of propagation phenomena. Measurement exercise of a wideband indoor radio channel.

Learning activities and teaching methods:

Lectures, exercises and the compulsory radio channel measurement exercise. The course is passed with a final examination and an accepted measurement report. In the final grade, the weight for the examination is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering, Stochastic Processes

Recommended or required reading:

Simon R. Saunders: Antennas and propagation for wireless communication systems. John Wiley & Sons Ltd, 1999, Chapters 1-14. Also ‘Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems, second edition. John Wiley & Sons Ltd, 2007, Chapters 1-15' is suitable for the course book.

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 3, 8 op

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

Language of instruction:

English.

Timing:

Period 4-6.

Learning outcomes:

Target is to deepen the understanding of the fundamental transmission concepts used in broadband systems.

Learning outcomes: Upon completing the required coursework, the student can define the design criteria for CDMA and OFDM based wireless systems. Student can also interpret and explain the different receiver algorithm designs used in these technologies. During the course it is explained how these technologies are deployed in current and future wireless systems. After the course student has understanding on the applicability of these technologies to different types of scenarios and applications. With this knowledge the student can justify why certain solutions will be used or considered for future wireless systems and roughly compare their performance.

Contents:

Broadband channels and their modeling, CDMA techniques and modems, performance of CDMA systems, design of OFDM systems and modems, future mobile technologies.

Learning activities and teaching methods:

lecturers, lab exercise, final exam. Lectured only every second year in English (odd years)

Recommended or required reading:

Wireless communications, A. Molisch, John Wiley & Sons 2005. Introduction to Spread Spectrum Communications,R. L. Peterson, R. E. Ziemer, D. E. Borth, Prentice-Hall, 1995. OFDM for Wireless Multimedia Communications, R. Prasad, and R. Van Nee, Artech House, 2000.

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 Radio Engineering II 6.0 op

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

The aim is to understand the basic theory and techniques of design in transceivers at the system level. 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. Learning outcomes: After completing the course the student recognizes the blocks of a transmitter and can explain the principle of a transmitter. She/he can classify different architectures used in transmitters and understand the basis for them. Student can define parameters used in the transmitter system level design and can design a transmitter 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. Student can also explain factors, which are important for the selection of DA- and AD-converters. She/he can derive various methods to create the in phase and the quadratute components of a signal. She/he can also explain the principles of frequency synthesis in a transmitter.

Contents:

Designing transceivers at the system level, transceiver architectures, performance characteristics of transceivers, factors which limit the performance of transceivers, nonlinearities, design of RF and IF stages, placement of the A/Dconverter in receivers, frequency synthesis, design and implementation examples.

Learning activities and teaching methods:

Two hours of lectures in a week. Demonstrations (eight hours) and design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade, the weight for the examination is 0.75, and for the design exercise 0.25. Course will be given every second year in even years.

Recommended optional programme components:

Radio Engineering I.

Recommended or required reading:

Lecture notes. Walter Tuttlebee: Software Defined Radio. Enabling Technologies, chapters1-4, 2002. U.L. Rohde, J.C. Whitaker & T.T.N Bucher: Communications Receivers: DSP, Software Radios and Design, 3rd edition, 2001. V. Manassewitsch: Frequency Synthesizers, Theory and Design, 1987.

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

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

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 queueing theory giving mathematical tools to apply the theory to practical communication systems.
Learning outcomes: Upon completing the required coursework, the student is able to construct simple theoretical queueing 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 queueing systems. The course gives skills for the student to describe functionalities of a communication network with game theory. 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, queueing systems and their measures of effectiveness, Little's result, blocking in queueing systems, open and closed (Jackson) queueing networks, advanced routing in data networks, multiple access techniques, network information theory, cognitive networks.

Learning activities and teaching methods:

Two hours of lectures in a week and exercises, The course is passed with final examination and accepted design exercise. The course is lectured in English.

Recommended optional programme components:

Communication Networks I, Stochastic Processes

Recommended or required reading:

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

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
Opintokohteen kielet: Finnish

Leikkaavuudet:

521322S Telecommunication Engineering Project 5.0 op

Timing:

Period 1-6.

Learning outcomes:

To introduce the student into the design, implementation and/or testing of a certain part of communication system.
Learning outcomes:
After completing the course student can - depending on the work subject - either solve, design, construct, measure, simulate, or analyze limited telecommunication and radio system and sub-system problems. Thus student applies the technical knowledge aquired from advanced cources into practical engineering tasks. In addition, student can document technical and scientific results

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 telecommunication laboratory 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 EE department's diploma thesis must be followed.

Recommended optional programme components:

Depending on the subject matter of exercise: Digital Communications, Digital Signal Processing or Radio Engineering or suitable advanced courses of the telecommunication laboratory.

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

Language of instruction:

In English.

Timing:

In periods 1-6.

Learning outcomes:

Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

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

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.

Recommended or required reading:

Will be defined in the beginning of the course.

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:

In Finnish.

Timing:

Periods 2-3.

Learning outcomes:

After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial and satellite channels. He/she understands the composition and importance of the propagation models and can apply them in practice. The emphasis in the course is on mobile communication channels.

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 and multipath propagation. The student can also describe how the radiation properties of different kind of antennas affect a radio channel and how the radio wave propagation impairments on the quality of radio communication can be overcome by using different kind of antennas. 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 radio link, in a fixed satellite link, outdoors (megacell, macrocell and microcell) and indoors (picocell). 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. The student can also measure the characteristics of wideband radio channel using a vector network analyser and report the measurement results.

Contents:

Basics of electromagnetic radiation. Different mechanisms of radiowave propagation: absorption, scattering, reflection, refraction and diffraction. Importance of radiowave propagation in the design of cellular communication systems. Effects of antennas on the radio channel. Principles of propagation modelling. Radiowave propagation phenomena over fixed terrestrial radio links and over fixed satellite links. Radio channel modelling for cellular systems (macrocells and microcells). Radio channels of mobile satellite links (megacells). Multipath propagation and its effects on narrowband and wideband radio channels. Radiowave propagation inside or into buildings (picocells). Simulation of narrowband and wideband radio channels. Mitigation methods of propagation phenomena. Measurement exercise of a wideband indoor radio channel.

Learning activities and teaching methods:

Lectures, exercises and the compulsory radio channel measurement exercise. The course is passed with a final examination and an accepted measurement report. In the final grade, the weight for the examination is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering, Stochastic Processes

Recommended or required reading:

Simon R. Saunders: Antennas and propagation for wireless communication systems. John Wiley & Sons Ltd, 1999, Chapters 1-14. Also ‘Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems, second edition. John Wiley & Sons Ltd, 2007, Chapters 1-15' is suitable for the course book.

031022P: Numerical Analysis, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 4-6

Learning outcomes:

The objective of the course is to provide the mathematical foundations of numerical methods, to analyze their basic theoretical properties (stability, accuracy and computational complexity), and demonstrate their performances on examples.
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 linearalgebra. Basics of the approximation theory. Numerical quadratures. Numerical methods for ordinary and partial differential equations.

Learning activities and teaching methods:

Lectures 4h/week. Two intermediate exams or one final exam.

Recommended or required reading:

- K. Ruotsalainen, Numeeriset menetelmät (lecture notes in finnish)
- Faires and Burden; Numerical methods
- A. Quarteroni, R. Sacco and F Salieri; Numerical mathematics

Prequisites: Calculus 1, Calculus 2, Matrix algebra and Differential Equations.

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: Jari Iinatti

Opintokohteen kielet: English

Leikkaavuudet:

521325S Synchronisation for Digital Receivers 5.0 op

Language of instruction:

In English.

Timing:

Period 5-6.

Learning outcomes:

Digital communication knowledge is deepened by applying the statistical signal processing techniques to the design of receiver baseband algorithms. The main goal is to learn the principles which are used to optimise the receiver synchronisation and channel estimation methods based on detection and estimation theory.
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 synchronization algorithms for timing, phase and frequency and for joint estimation. He can derive the performance of the algorithms and comparison methods of them. Student can utilize proper interpolation methods for timing estimation. In addition, she/he can utilize and develope algorithms for fading channels.

Contents:

Synthesis and performance of synchronisation algorithms in AWGN channels, frequency estimation, interpolation in synchronisation, synchronisation and channel estimation in fading channels.

Learning activities and teaching methods:

Lectures and exercises in total 6 hours in two weeks during periods 5-6. The course is given in English. A design exercise by Matlab software. The course is passed with final examination and accepted design exercise. Grade is based on exam. Course will be given every second year in uneven year.

Recommended optional programme components:

Statistical Signal Processing, Wireless Communications II. Recommended: Communication Signal Processing I.

Recommended or required reading:

H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998. (Partly).

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 Radio Engineering II 6.0 op

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

The aim is to understand the basic theory and techniques of design in transceivers at the system level. 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.
Learning outcomes: After completing the course the student recognizes the blocks of a transmitter and can explain the principle of a transmitter. She/he can classify different architectures used in

transmitters and understand the basis for them. Student can define parameters used in the transmitter system level design and can design a transmitter 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. Student can also explain factors, which are important for the selection of DA- and AD-converters. She/he can derive various methods to create the in phase and the quadratute components of a signal. She/he can also explain the principles of frequency synthesis in a transmitter.

Contents:

Designing transceivers at the system level, transceiver architectures, performance characteristics of transceivers, factors which limit the performance of transceivers, nonlinearities, design of RF and IF stages, placement of the A/Dconverter in receivers, frequency synthesis, design and implementation examples.

Learning activities and teaching methods:

Two hours of lectures in a week. Demonstrations (eight hours) and design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade, the weight for the examination is 0.75, and for the design exercise 0.25. Course will be given every second year in even years.

Recommended optional programme components:

Radio Engineering I.

Recommended or required reading:

Lecture notes. Walter Tuttlebee: Software Defined Radio. Enabling Technologies, chapters1-4, 2002. U.L. Rohde, J.C. Whitaker & T.T.N Bucher: Communications Receivers: DSP, Software Radios and Design, 3rd edition, 2001. V. Manassewitsch: Frequency Synthesizers, Theory and Design, 1987.

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: Karhu Seppo
Opintokohteen kielet: English
Leikkaavuudet:

521388S Antennas 5.0 op

Language of instruction:

English.

Timing:

Periods 4-5.

Learning outcomes:

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.
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, microstrip antennas and antenna arrays. The student is also able to design wire antennas, microstrip antennas and antenna arrays for different radio systems. In addition, the student can use electromagnetic simulators to analyze and design antennas.

Contents:

Introduction 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.

Learning activities and teaching methods:

Lectures, exercises and the compulsory antenna design work with an electromagnetic simulation program. 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.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

C. A. Balanis: Antenna Theory, Analysis and Design (Third Edition). John Wiley & Sons, 2005. Chapters 1-6 and 14.

521317S: Wireless Communications 3, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

English.

Timing:

Period 4-6.

Learning outcomes:

Target is to deepen the understanding of the fundamental transmission concepts used in broadband systems.

Learning outcomes: Upon completing the required coursework, the student can define the design criteria for CDMA and OFDM based wireless systems. Student can also interpret and explain the different receiver algorithm designs used in these technologies. During the course it is explained how these technologies are deployed in current and future wireless systems. After the course student has understanding on the applicability of these technologies to different types of scenarios and applications. With this knowledge the student can justify why certain solutions will be used or considered for future wireless systems and roughly compare their performance.

Contents:

Broadband channels and their modeling, CDMA techniques and modems, performance of CDMA systems, design of OFDM systems and modems, future mobile technologies.

Learning activities and teaching methods:

lecturers, lab exercise, final exam. Lectured only every second year in English (odd years)

Recommended or required reading:

Wireless communications, A. Molisch, John Wiley & Sons 2005. Introduction to Spread Spectrum Communications,R. L. Peterson, R. E. Ziemer, D. E. Borth, Prentice-Hall, 1995. OFDM for Wireless Multimedia Communications, R. Prasad, and R. Van Nee, Artech House, 2000.

521443S: Electronics Design II, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Tarmo Ruotsalainen

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish (In English if needed).

Timing:

Period 1-2.

Learning outcomes:

The goal is to reinforce and further develop the student's understanding of concepts of analogue circuit blocks and their application and use in the design of electronic equipment. The course also gives basic skills for the design of integrated building blocks. Noise and modeling of noise in electrical circuits, and the structures and properties of DA/AD converters are covered.
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, analyse and design integrated structural 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 connected with DA and AD conversion and converters and to analyse and outline their main structural principles and 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.

Learning activities and teaching methods:

Lectures, exercises and a small design work. Final exam.

Recommended optional programme components:

Electronics Design I.

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.

521225S: RF Components and Measurements, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Häkkinen, Jari Hannu

Opintokohteen kielet: Finnish

Language of instruction:

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

Timing:

Period 1-3.

Learning outcomes:

The course covers common passive components and their measurement techniques used at RF and microwave frequencies. The course provides ability to know components selection principles and ability to conduct measurements related to electromagnetic fields and high frequency circuits.
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.

Learning activities and teaching methods:

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

Recommended optional programme components:

Electronic components, Electronic Measurement Techniques, Basics of Radio Engineering.

Recommended or required reading:

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

521404A: Digital Techniques 2, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Hannu Heusala

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Period 1-2.

Learning outcomes:

The goal of the cource is to familiarize students to the professional design flow, design methodology and implementaion options of digital integrated circuits.

Osaamistavoitteet: After the cource students are able to design high level architectures of digital systems and blocks of the system implemented by special hardware (ASIC and FPGA). Students are able to ably design methodologies and tools. Design verification and implementation analysis are emphasised. Students can simulate and model (VHDL modelling and VHDL simulation) digital systems and critically revalue the design also from the implementation's point of view.

Contents:

1. Implementation technologies of digital circuits, 2. Description levels of digital systems, 3. VHDL modelling of digital circuits and systems, 4. System level specification and design, 5. Design of ASICs and FPGAs, 6. High level VHDL synthesis, 7. RTL-VHDL synthesis, 8. Planning of production test of digital ASICs.

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

Language of instruction:

In Finnish.

Timing:

Period 3-4.

Learning outcomes:

The goal of the cource is to familiarize students to the professional design flow, design methodology and implementaion options of digital integrated circuits.
Learning outcomes **:** After the cource students are able to design high level architectures of digital systems and blocks of the system implemented by special hardware (ASIC and FPGA). Students are able to ably design methodologies and tools. Design verification and implementation analysis are emphasised. Students can simulate and model (VHDL modelling and VHDL simulation) digital systems and critically revalue the design also from the implementation's point of view.

Contents:

1. Implementation technologies of digital circuits, 2. Description levels of digital systems, 3. VHDL modelling of digital circuits and systems, 4. System level specification and design, 5. Design of ASICs and FPGAs, 6. High level VHDL synthesis, 7. RTL-VHDL synthesis, 8. Planning of production test of digital ASICs.

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

Language of instruction:

In Finnish.

Timing:

Period 1-3.

Learning outcomes:

The objective of the course is to provide advanced understanding on the organization of signal processing systems, including the implementations of the most common structural elements and algorithms, and on the use of design tools.
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 (particularly DCT), polyphase filters, 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.

Learning activities and teaching methods:

The course consists of lectures and several design exercises out of which at least five needs to be passed. The final grade is based on the combined points obtained from the exercises and the final exam.

Recommended optional programme components:

Digital Filters, Computer Engineering, Digital Techniques II

Recommended or required reading:

Lecture notes and exercise materials. Material is in English.

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

Opintokohteen kielet: Finnish

Leikkaavuudet:

521322S Telecommunication Engineering Project 5.0 op

Timing:

Period 1-6.

Learning outcomes:

To introduce the student into the design, implementation and/or testing of a certain part of communication system.
Learning outcomes:
After completing the course student can - depending on the work subject - either solve, design, construct, measure, simulate, or analyze limited telecommunication and radio system and sub-system problems. Thus student applies the technical knowledge aquired from advanced cources into practical engineering tasks. In addition, student can document technical and scientific results

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 telecommunication laboratory 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 EE department's diploma thesis must be followed.

Recommended optional programme components:

Depending on the subject matter of exercise: Digital Communications, Digital Signal Processing or Radio Engineering or suitable advanced courses of the telecommunication laboratory.

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

Language of instruction:

In English.

Timing:

In periods 1-6.

Learning outcomes:

Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

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

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.

Recommended or required reading:

Will be defined in the beginning of the course.

521358S: Application Specific Signal Processors, 4 op

Voimassaolo: - 31.07.2012

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Boutellier, Jani Joosefi

Opintokohteen kielet: Finnish

Language of instruction:

English, if one or more international students are present

Timing:

Period 4-5.

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.

Learning activities and teaching methods:

Lectures 10h (participation mandatory). Independent work 98h

Target group:

This is an optional advanced-level course. It is inteded for masters-level students and post-graduate students, especially to those that are specializing into signal processing

Recommended optional programme components:

521267A Computer engineering, 521337A digital filters, programming skills

Recommended or required reading:

Handouts.

Assessment methods and criteria:

Participation in mandatory classes and approved project work.

Grading:

5 - 1 / failed

Person responsible:

Jani Boutellier.

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:

In Finnish.

Timing:

Periods 2-3.

Learning outcomes:

After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial and satellite channels. He/she understands the composition and importance of the propagation models and can apply them in practice. The emphasis in the course is on mobile communication channels.

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 and multipath propagation. The student can also describe how the radiation properties of different kind of antennas affect a radio channel and how the radio wave propagation impairments on the quality of radio communication can be overcome by using different kind of antennas. 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 radio link, in a fixed satellite link, outdoors (megacell, macrocell and microcell) and indoors (picocell). 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. The student can also measure the characteristics of wideband radio channel using a vector network analyser and report the measurement results.

Contents:

Basics of electromagnetic radiation. Different mechanisms of radiowave propagation: absorption, scattering, reflection, refraction and diffraction. Importance of radiowave propagation in the design of cellular communication systems. Effects of antennas on the radio channel. Principles of propagation modelling. Radiowave propagation phenomena over fixed terrestrial radio links and over fixed satellite links. Radio channel modelling for cellular systems (macrocells and microcells). Radio channels of mobile satellite links (megacells). Multipath propagation and its effects on narrowband and wideband radio channels. Radiowave propagation inside or into buildings (picocells). Simulation of narrowband and wideband radio channels. Mitigation methods of propagation phenomena. Measurement exercise of a wideband indoor radio channel.

Learning activities and teaching methods:

Lectures, exercises and the compulsory radio channel measurement exercise. The course is passed with a final examination and an accepted measurement report. In the final grade, the weight for the examination is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering, Stochastic Processes

Recommended or required reading:

Simon R. Saunders: Antennas and propagation for wireless communication systems. John Wiley & Sons Ltd, 1999, Chapters 1-14. Also ‘Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and

propagation for wireless communication systems, second edition. John Wiley & Sons Ltd, 2007, Chapters 1-15' is suitable for the course book.

031022P: Numerical Analysis, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 4-6

Learning outcomes:

The objective of the course is to provide the mathematical foundations of numerical methods, to analyze their basic theoretical properties (stability, accuracy and computational complexity), and demonstrate their performances on examples.
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 linearalgebra. Basics of the approximation theory. Numerical quadratures. Numerical methods for ordinary and partial differential equations.

Learning activities and teaching methods:

Lectures 4h/week. Two intermediate exams or one final exam.

Recommended or required reading:

- K. Ruotsalainen, Numeeriset menetelmät (lecture notes in finnish)
- Faires and Burden; Numerical methods
- A. Quarteroni, R. Sacco and F Salieri; Numerical mathematics

Prequisites: Calculus 1, Calculus 2, Matrix algebra and Differential Equations.

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

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

Learning outcomes:
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 organising, administration and management of a company and its production.
The student has to observe vigilantly everything connected to working life and to industrial operation in his or her training job and has to develop his professional skill. During the training, the student can make contacts to the industrial establishments which have significance from the point of view of both the choice of the diploma work and a final transition to the working life. Practising abroad is recommended because of, among others, improvement of the language skill and of gaining international experience.
Learning outcomes: After advanced practical training the student can describe one possible future job, or an other 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.
Learning activities and teaching methods:
The students acquire their training job themselves.
Assessment methods and criteria:
For master stage practical training lasting at least two months a training report is required for which an acceptable grade must be obtained. A more exact compilation instruction of the training report is on the WWW pages of the department and on the notice board.

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

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: English

Language of instruction:

Finnish. English for the students in the International Master program.

Timing:

Period 1-3

Learning outcomes:

The objective of the course is to provide the mathematical foundations of the optimization methods, to analyze their basic theoretical properties and demonstrate their performances on examples.
Learning outcomes **:** The student learns to solve convex optimization problems with the basic optimization algorithms. He/She is able to form the necessary and sufficient conditions for the optimization problem and is able to form the corresponding dual problem.

Contents:

Linear optimization. Simplex-algorithm. KKT-conditions. Dual problem. Gradient algorithms. Conjugate gradient algorithm. Barrier- and penalty function methods. Implementation: Lectures 3h /week, Exercises 2h/week. Two intermediate exams or one final exam.

Recommended optional programme components:

Calculus 1, Calculus 2, Matrix algebra.

Recommended or required reading:

- K. Ruotsalainen, Optimoinnin perusteet (lecture notes in finnish)
- P. Ciarlet; Introductionto numerical linear algebra and optimization
- M. Bazaraa, H. Sherali, C.M. Shetty; Nonlinear programming

521320S: Wireless Communications 2, 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

Language of instruction:

In English.

Timing:

Period 1-3.

Learning outcomes:

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. 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 to make the performance comparison of them. Student can explain design methods signals for bandlimited 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 multiantenna 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, multiantenna techniques and channel equalizers in wireless communication.

Learning activities and teaching methods:

Lectures and exercises in total 4 hours in a week during periods 1-3. The course is given in English. 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.

Recommended optional programme components:

Telecommunication Engineering II. Also recommended: Statistical Signal Processing, Radio Communication Channels.

Recommended or required reading:

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

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

Language of instruction:

In English.

Timing:

Period 1-3.

Learning outcomes:

The aim is to present the fundamentals of the structure of digital data transmission systems. Operation adapted according to the telephone network also considered. Technical implementation and application of the common data and local networks are discussed.
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 IEEE802.11 systems. The student is able to describe the basic protocol model of the UMTS radio interface and radio access network. The student will achieve skills to describe the main principles of mobility control, network security, crosslayer optimization and routing in ad hoc networks. 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.

Learning activities and teaching methods:

Two hours of lectures in a week. The course is passed with final examination and accepted design exercise. The course is lectured in English.

Recommended or required reading:

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

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

Language of instruction:

In Finnish (fall 2010), In English (fall 2011).

Timing:

Period 1-3.

Learning outcomes:

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. 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. 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. Student can also explain the principle of an automatic gain control (AGC). Student can classify power amplifiers and can in the basic case design the matching network for a power amplifier.

Contents:

Definitions of noise terms, impedance matching using discrete components, microstrip matching networks, RF transistor amplifier design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.

Learning activities and teaching methods:

Lectures and exercises in total 4 hours in a week. Design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade the weight for the exam is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

Lecture notes. R. Ludwig & P. Bretchko: RF Circuit Design Theory and Applications, 2000. G. Gonzales: Microwave Transistor Amplifiers Analysis and Design, 1997.

521333S: Mobile Telecommunication Systems, 5 op

Voimassaolo: - 31.07.2012
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Savo Glisic, Rapeli, Juha Heikki Antero
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

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

Language of instruction:

Finnish/English

Learning outcomes:

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.

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.

Learning activities and teaching methods:

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.

Recommended or required reading:

Instructions for preparing a diploma work in the Department of Electrical Engineering.

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

Language of instruction:

In English.

Timing:

Period 3-4.

Learning outcomes:

Statistical signal processing knowledge is deepened to adaptive signal processing and spectrum estimation.

Learning outcomes: Upon completing the required coursework, the student is able to use the basic methodology of signal processing to design communication systems and their receivers. He or she will be able to design and implement various equaliser algorithms. The student can design linear filters for statistical signal processing applications.

Contents:

Optimal linear filters, spectrum estimation, iterative matrix algorithms, stochastic gradient algorithms, recursive least squares methods

Learning activities and teaching methods:

Lectures and exercises in total 6 hours in two weeks. The course is passed with final examination.

Recommended optional programme components:

Statistical signal processing, Telecommunication Engineering II.

Recommended or required reading:

Parts from: Simon Haykin: Adaptive Filter Theory, 3rd ed. Prentice Hall, 1996. (989 pages) ISBN: 0-13-322760-X. and P. Stoica & R. Moses: Introduction to Spectral Analysis. Prentice-Hall, 1997 (319 pages) ISBN 0-13-258419-0. H. Meyr, M. Moeneclaey & S. A. Fechtel: Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.

521315A: Basics of Information Theory, 4 op

Voimassaolo: 14.11.2005 - 31.07.2012

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: Finnish

Language of instruction:

In English.

Timing:

Period 1-2.

Learning outcomes:

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

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. The student can

estimate the realisability of given design tasks before

the

execution of the detailed design. What is more, the student can

independently search for information and knowledge related to communication engineering, system design and signal processing.

Contents:

Basic concepts, data compression, basics of source coding, channel capacity, capacity of a Gaussian channel, maximum entropy method, rate distortion theory, introduction to network information theory.

Learning activities and teaching methods:

Lectures and self-calculated exercises. The course is passed with final examination.

Recommended optional programme components:

Random signals, Telecommunication Engineering II.

Recommended or required reading:

Parts from Thomas M. Cover & Joy A. Thomas, Elements of Information Theory, 2nd ed. John Wiley & Sons, 1991 ISBN: 0-471-06259-6. Lecture notes.

521343S: Coding Methods, 4 op

Voimassaolo: - 31.07.2012

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Timo Kokkonen

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish every second year (in uneven years) and in English in every other year (in even years)

Timing:

Period 4-5.

Learning outcomes:

The objective of the course is to teach basic information of information theory and source encoding, and the basics of error-detecting and error-correcting codes that are needed in the design of digital communication systems.

Learning outcomes: Upon completing the required coursework, the student can solve simple problems dealing with information theory and source encoding. He or she is able to explain operating principles of block codes, cyclic codes and convolutional codes. The student can form a coder and decoder for common binary block codes, and is capable of using tables of the codes and shift register when solving problems. He or she can represent operating idea of convolutional encoder as a state machine, the student is able to apply Viterbi algorithm to decoding of convolutional codes, and is capable of specifying principles of turbo coding and coded modulation. Moreover, the student can evaluate error probability of codes and knows practical solutions of codes by name.

Contents:

The basics of information theory, discrete-valued channel models, source encoding methods, 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.

Learning activities and teaching methods:

Lectures and exercises in total 6 hours in a week during periods 4-5. The course is given in Finnish every second year (in uneven years) and in English in every other year (in even years). The course is passed with weekly exams (only during lecture periods) or with final exam.

Recommended optional programme components:

Basics of Digital Communications. Also recommended: Wireless Communications II.

Recommended or required reading:

S. Benedetto and E. Biglieri: Principles of Digital Transmission with Wireless Applications, 1999, chapters 1, 3, 10, and partly chapters 11 and 12.

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

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

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 queueing theory giving mathematical tools to apply the theory to practical communication systems. Learning outcomes: Upon completing the required coursework, the student is able to construct simple theoretical queueing 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 queueing systems. The course gives skills for the student to describe functionalities of a communication network with game theory. 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, queueing systems and their measures of effectiveness, Little's result, blocking in queueing systems, open and closed (Jackson) queueing networks, advanced routing in data networks, multiple access techniques, network information theory, cognitive networks.

Learning activities and teaching methods:

Two hours of lectures in a week and exercises, The course is passed with final examination and accepted design exercise. The course is lectured in English.

Recommended optional programme components:

Communication Networks I, Stochastic Processes

Recommended or required reading:

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

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 Radio Engineering II 6.0 op

Language of instruction:

In English.

Timing:

Period 4-6.

Learning outcomes:

The aim is to understand the basic theory and techniques of design in transceivers at the system level. 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.
Learning outcomes: After completing the course the student recognizes the blocks of a transmitter and can explain the principle of a transmitter. She/he can classify different architectures used in transmitters and understand the basis for them. Student can define parameters used in the transmitter system level design and can design a transmitter 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. Student can also explain factors, which are important for the selection of DA- and AD-converters. She/he can derive various methods to create the in phase and the quadratute components of a signal. She/he can also explain the principles of frequency synthesis in a transmitter.

Contents:

Designing transceivers at the system level, transceiver architectures, performance characteristics of transceivers, factors which limit the performance of transceivers, nonlinearities, design of RF and IF stages, placement of the A/Dconverter in receivers, frequency synthesis, design and implementation examples.

Learning activities and teaching methods:

Two hours of lectures in a week. Demonstrations (eight hours) and design exercise with ADS-simulation software. The course is passed with final examination and accepted design exercise. In the final grade, the weight for the examination is 0.75, and for the design exercise 0.25. Course will be given every second year in even years.

Recommended optional programme components:

Radio Engineering I.

Recommended or required reading:

Lecture notes. Walter Tuttlebee: Software Defined Radio. Enabling Technologies, chapters1-4, 2002. U.L. Rohde, J.C. Whitaker & T.T.N Bucher: Communications Receivers: DSP, Software Radios and Design, 3rd edition, 2001. V. Manassewitsch: Frequency Synthesizers, Theory and Design, 1987.

521317S: Wireless Communications 3, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

English.

Timing:

Period 4-6.

Learning outcomes:

Target is to deepen the understanding of the fundamental transmission concepts used in broadband systems.

Learning outcomes: Upon completing the required coursework, the student can define the design criteria for CDMA and OFDM based wireless systems. Student can also interpret and explain the different receiver algorithm designs used in these technologies. During the course it is explained how these technologies are deployed in current and future wireless systems. After the course student has understanding on the applicability of these technologies to different types of scenarios and applications. With this knowledge the student can justify why certain solutions will be used or considered for future wireless systems and roughly compare their performance.

Contents:

Broadband channels and their modeling, CDMA techniques and modems, performance of CDMA systems, design of OFDM systems and modems, future mobile technologies.

Learning activities and teaching methods:

lecturers, lab exercise, final exam. Lectured only every second year in English (odd years)

Recommended or required reading:

Wireless communications, A. Molisch, John Wiley & Sons 2005. Introduction to Spread Spectrum Communications,R. L. Peterson, R. E. Ziemer, D. E. Borth, Prentice-Hall, 1995. OFDM for Wireless Multimedia Communications, R. Prasad, and R. Van Nee, Artech House, 2000.

521360S: Communication Signal Processing II, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti

Opintokohteen kielet: English

Leikkaavuudet:

521325S	Synchronisation for Digital Receivers	5.0 op

Language of instruction:

In English.

Timing:

Period 5-6.

Learning outcomes:

Digital communication knowledge is deepened by applying the statistical signal processing techniques to the design of receiver baseband algorithms. The main goal is to learn the principles which are used to optimise the receiver synchronisation and channel estimation methods based on detection and estimation theory.
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 synchronization algorithms for timing, phase and frequency and for joint estimation. He can derive the performance of the algorithms and comparison methods of them. Student can utilize proper interpolation methods for timing estimation. In addition, she/he can utilize and develope algorithms for fading channels.

Contents:

Synthesis and performance of synchronisation algorithms in AWGN channels, frequency estimation, interpolation in synchronisation, synchronisation and channel estimation in fading channels.

Learning activities and teaching methods:

Lectures and exercises in total 6 hours in two weeks during periods 5-6. The course is given in English. A design exercise by Matlab software. The course is passed with final examination and accepted design exercise. Grade is based on exam. Course will be given every second year in uneven year.

Recommended optional programme components:

Statistical Signal Processing, Wireless Communications II. Recommended: Communication Signal Processing I.

Recommended or required reading:

H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998. (Partly).

521380S: Antennas, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Karhu Seppo

Opintokohteen kielet: English

Leikkaavuudet:

521388S Antennas 5.0 op

Language of instruction:

English.

Timing:

Periods 4-5.

Learning outcomes:

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.
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, microstrip antennas and antenna arrays. The student is also able to design wire antennas, microstrip antennas and antenna arrays for different radio systems. In addition, the student can use electromagnetic simulators to analyze and design antennas.

Contents:

Introduction 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.

Learning activities and teaching methods:

Lectures, exercises and the compulsory antenna design work with an electromagnetic simulation program. 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.

Recommended optional programme components:

Basics of Radio Engineering.

Recommended or required reading:

C. A. Balanis: Antenna Theory, Analysis and Design (Third Edition). John Wiley & Sons, 2005. Chapters 1-6 and 14.

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:

In Finnish.

Timing:

Periods 2-3.

Learning outcomes:

After having passed the course a student is familiar with the basics of radiowave propagation over terrestrial and satellite channels. He/she understands the composition and importance of the propagation models and can apply them in practice. The emphasis in the course is on mobile communication channels.

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 and multipath propagation. The student can also describe how the radiation properties of different kind of antennas affect a radio channel and how the radio wave propagation impairments on the quality of radio communication can be overcome by using different kind of antennas. 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 radio link, in a fixed satellite link, outdoors (megacell, macrocell and microcell) and indoors (picocell). 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. The student can also measure the characteristics of wideband radio channel using a vector network analyser and report the measurement results.

Contents:

Basics of electromagnetic radiation. Different mechanisms of radiowave propagation: absorption, scattering, reflection, refraction and diffraction. Importance of radiowave propagation in the design of cellular communication systems. Effects of antennas on the radio channel. Principles of propagation modelling. Radiowave propagation phenomena over fixed terrestrial radio links and over fixed satellite links. Radio channel modelling for cellular systems (macrocells and microcells). Radio channels of mobile satellite links (megacells). Multipath propagation and its effects on narrowband and wideband radio channels. Radiowave propagation inside or into buildings (picocells). Simulation of narrowband and wideband radio channels. Mitigation methods of propagation phenomena. Measurement exercise of a wideband indoor radio channel.

Learning activities and teaching methods:

Lectures, exercises and the compulsory radio channel measurement exercise. The course is passed with a final examination and an accepted measurement report. In the final grade, the weight for the examination is 0.75 and for the design exercise 0.25.

Recommended optional programme components:

Basics of Radio Engineering, Stochastic Processes

Recommended or required reading:

Simon R. Saunders: Antennas and propagation for wireless communication systems. John Wiley & Sons Ltd, 1999, Chapters 1-14. Also ‘Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems, second edition. John Wiley & Sons Ltd, 2007, Chapters 1-15' is suitable for the course book.

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: Tarmo Ruotsalainen
Opintokohteen kielet: Finnish

Language of instruction:

In Finnish (In English if needed).

Timing:

Period 1-2.

Learning outcomes:

The goal is to reinforce and further develop the student's understanding of concepts of analogue circuit blocks and their application and use in the design of electronic equipment. The course also gives basic skills for the design of integrated building blocks. Noise and modeling of noise in electrical circuits, and the structures and properties of DA/AD converters are covered.
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, analyse and design integrated structural 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 connected with DA and AD conversion and converters and to analyse and outline their main structural principles and 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.

Learning activities and teaching methods:

Lectures, exercises and a small design work. Final exam.

Recommended optional programme components:

Electronics Design I.

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.

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

Language of instruction:

Finnish, English.

Timing:

Period 1-6

Learning outcomes:

Design exercises are used to deepen the understanding of the material presented in Principles of Electronics Design and Analogue Electronics I. Implementation: Independent design exercise, which is checked by CADsimulations and experimentally. Simulations are carried out in PSpice environment Learning outcomes: On completion of the study module students should be able to design basic electronic structural blocks and verify their functioning in a CAD simulation environment. They should be able independently to realize and test a small-scale design object employing the analogue technique.

Recommended optional programme components:

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

521488S: Multimedia Systems, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:

In Finnish.

Timing:

Period 2-3.

Learning outcomes:

The aim of the course is to provide advanced knowledge of multimedia technologies, and applying them in designing and implementing a multimedia system.
Learning objectives: Student can determine specifics of different multimedia elements and can explain basic techniques for presentation of multimedia. Student can describe novel multimedia communication techniques and recognize different functional domains, and how to apply them in the design and implementation of novel multimedia applications and services.

Contents:

key concepts, multimedia elements: image, voice, video, and animation techniques; resource management, real-time multimedia, quality of service, synchronization, multimedia communication techniques, multimedia databases, reference models, standardization, applications, watermarking, design and implementation of multimedia system.

Learning activities and teaching methods:

Lectures and course exercise related to multimedia systems (emphasis either on implementation, research or design). Course is passed with final examination and accepted course exercise. In addition group exam for additional points to exam. Course materials and group work instructions are available at OPTIMA. Further information: http://www.ee.oulu.fi/research/tklab/courses/521488S/

Recommended optional programme components:

recommended courses include basic courses in computer science and mathematics, Operating systems (521453A), Digital Image Processing (521467S), Computer networks (521476S), Software Engineering (521457A) and Knowledge Engineering (521468S).
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Recommended or required reading:

Multimedia Communications: Applications, Networks, Protocols and Standards. F. Halsall, Addison-Wesley 2001, chapters 1-5. Lecture slides provide appendices and show the focus areas in more detail.
Supportive reading **:** Multimedia: Computing, Communications and Applications. R. Steinmetz and K. Nahrstedt, Prentice Hall 1995, chapters 1-6, 9.1.-9.4, 10.1, 11,12 and 15. Open Distributed Processing and Multimedia. G. Blair and J. Stefani, Addison-Wesley 1998, chapters 2-4 and 8. Principles of Multimedia Database Systems. V. Subrahmanian, Morgan Kaufman 1998, chapters 1,5, 9 and 15. Multimedia: Computing, Communications and Application. R. Steinmetz and K. Nahrstedt, Prentice Hall 1995. Chapters 1-6, 9.1.-9.3, 10.1, 11-13, 15, 17.

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

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Electrical Engineering
Opintokohteen kielet: English
Voidaan suorittaa useasti: Kyllä

Language of instruction:

In English.

Timing:

In periods 1-6.

Learning outcomes:

Depending on each year's topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master's thesis and readiness for performing in front of an audience.

Contents:

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

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.

Recommended or required reading:

Will be defined in the beginning of the course.

521261A: Computer Networks I, 5 op

Voimassaolo: - 31.07.2012
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Ojala, Timo Kullervo

Opintokohteen kielet: Finnish

Language of instruction:
In Finnish. Materials are in English.
Timing:
Period 5-6.
Learning outcomes:

The course gives a comprehensive description of the fundamentals of

computer networks, using the public Internet and its protocols

and applications as examples

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 computer networking problems, and design and implement a

small computer networking application

Contents:

Internet's architecture, most important access networks, TCP/IP protocol stack, the most important Internet applications, Internet security.

Learning activities and teaching methods:

Lectures, exercises, and practical work.

Recommended or required reading:

James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach (5th Edition), Addison-Wesley, 2009.

Lecture slides and exercise materials.

Assessment methods and criteria:

The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work.

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:

Period 5-6.

Learning outcomes:

The course provides the key principles of distributed systems and the major design paradigms used in implementing distributed

systems.

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, communication, naming, synchronization, consistency and replication, fault tolerance, security,

distributed object-based systems, distributed file systems, distributed object-based systems, distributed coordination-based systems

Learning activities and teaching methods:

Lectures, exercises and practical work.

The course is passed with a final exam or with a set of intermediate exams, together with an approved practical work.

Recommended optional programme components:

Computer networks, Operating systems, Software Engineering.

Recommended or required reading:

Andrew S. Tanenbaum and Maarten van Steen, Distributed Systems - Principles and Paradigms, Second Edition, Prentice Hall, 2007.

Lecture slides and exercises.

521262S: Computer Networks II, 6 op

Voimassaolo: 01.08.2007 - 31.07.2012
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Computer Science and Engineering
Arvostelu: 1 - 5, pass, fail
Opettajat: Ojala, Timo Kullervo
Opintokohteen kielet: English

Language of instruction:
In English.
Timing:
Period 3-4.
Learning outcomes:

The course focuses on advanced issues on computer networking and the Internet.

Learning outcomes:

Upon completing the course the student is able to explain the recent developments in the Internet, solve complicated computer networking problems, and design and implement a computer networking application.

Contents:

Recent developments in Internet architecture, access networks, and Internet protocol stack, multimedia and quality of service, session management, mobility management.

Learning activities and teaching methods:

Lectures, exercises, and practical work. The course is passed with a final exam or with a set of intermediate exams, together with

an approved practical work. The implementation is fully English.

Recommended optional programme components:

Recommended courses include Computer Networks I, Operating Systems, Basics of Digital Communications, Telecommunications Software and Communication Networks I.

Recommended or required reading:

James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach (5th Edition), Addison-Wesley, 2009.

Assorted Internet standards.

Lecture slides, exercises.

521265A: Telecommunications Software, 5 op

Voimassaolo: 01.08.2005 - 31.07.2012

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Junzhao Sun

Opintokohteen kielet: English

Learning outcomes:

The course provides systematic knowledge of telecommunication software principles and protocol engineering.
Learning Outcomes: Upon completion of the course, students should be able to:
- create and minimize a finite state machine,
- perform reachability analysis on a communicating finite state machine,
- create and identify behavioral properties of a petri net,
- perform coverability analysis on a petri net,
- describe data using ASN.1,
- encode ASN.1 type declaration to transfer syntax using BER,
- apply graphical SDL to model a protocol,
- generate test sequences for a finite state machine with T-, D-, W-, and U-methods,
- explain the key concepts of conformance testing methodology, and
- apply TTCN-3 core language to describe a test suite.

Contents:

Principles, specification, verification, validation, synthesis, description languages and testing of telecommunication protocols.

Learning activities and teaching methods:

The course comprises of lectures and exercises. The course is passed with a final exam and an approved practical work.

Recommended optional programme components:

Software engineering.

Recommended or required reading:

Gerard J. Holzmann, Design and Validation of Computer Protocols, Prentice-Hall, 1991. Andrew S. Tanenbaum, Computer Networks, 4th edition, Prentice Hall, 2003.

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

Opettajat: Jukka Lahti

Opintokohteen kielet: Finnish

Leikkaavuudet:

521026S	Advanced practical training	5.0 op

Learning outcomes:
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 organising, administration and management of a company and its production.
The student has to observe vigilantly everything connected to working life and to industrial operation in his or her training job and has to develop his professional skill. During the training, the student can make contacts to the industrial establishments which have significance from the point of view of both the choice of the diploma work and a final transition to the working life. Practising abroad is recommended because of, among others, improvement of the language skill and of gaining international experience.
Learning outcomes: After advanced practical training the student can describe one possible future job, or an other 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.
Learning activities and teaching methods:
The students acquire their training job themselves.
Assessment methods and criteria:
For master stage practical training lasting at least two months a training report is required for which an acceptable grade must be obtained. A more exact compilation instruction of the training report is on the WWW pages of the department and on the notice board.

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
Vastuuyksikkö: Language Centre
Opintokohteen kielet: Swedish
Leikkaavuudet:

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

Ei opintojaksokuvauksia.

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

Voimassaolo: 01.08.1995 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Language Centre
Opintokohteen kielet: Finnish

Choice of foreign language

902011P: Technical English 3, 6 op

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

Proficiency level:
CEFR B2 - C1
Language of instruction:
English
Target group:
Students of all Engineering Departments (902011P Tekniikan englanti 3)
Students of the Department of Architecture (902011P Tekniikan englanti 3)
Person responsible:
Each department in the Technical Faculty has its own Language Centre contact teacher for questions about English studies.
Other information:
See the Language Centre Study Guide, English, TTK

903012P: Technical German 3, 6 op

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

Ei opintojaksokuvauksia.

Compulsory to all

030001P: Orientation Course for New Students, 1 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Faculty of Technology
Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

477000P Planning of Studies and Career 1.0 op

ECTS Credits:

1 crecit.

Language of instruction:

Finnish.

Timing:

1-3 period.

Learning outcomes:

Upon completion of the course, students will be familiar with the university and the structure of the degree programme. They will be able to gain the tools they need for their studies and the planning of them. Learning outcome: After the course the student is able to recognize his/her own study environment and can make use of the student services of the university. The course provides with skills to draft individual study plan and gives information about different methods of studying. The student can describe some specific professional aspects in the field of architecture or engineering and he/she is also able to use the facilities of academic libraries.

Contents:

Introduction to studies. Overview of the services offered by the university, student organizations and the Finnish social system (f.eg. student financial aid, academic sports services, student health services). Introduction to the University and the Faculty and their administration, degrees and studies at the Faculty of Technology. Overview of the professional aspects in the fields of engineering and architecture and job prospects. Introduction to the methods of studying and to the skills in gaining the tools needed for planning of the studies. Overview of library services, Oula - library catalogue and Nelli - e-resources.

Learning activities and teaching methods:

1. Orientation day for all new students organized by the Faculty of Technology. 2. Orientation to the degree programmes organized by the departments. 3. Student tutoring during the autumn term. Groups are formed during the degree programme orientation. 4. Information on areas of specialization within the degree programmes (during the 2 nd or 3 rd year). 5. Orientation (2 hours) to the library and Oula - library catalogue and Nelli - e-resources at the Science and Technology Library Tellus. Participation in orientations 1, 2 and 5 and min. 5 student tutorials are required for completion of the course.

Grading:

Pass/fail.

Person responsible:

Chief academic officer of the faculty, study advisors of the departments, library.

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 credit.

Language of instruction:

Finnish/English

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.

Learning activities and teaching methods:

The course involves training sessions (8h), web-based learning materials, exercises in the Optima learning environment and a final assignment on a topic of the student's own choice.

Recommended or required reading:

Web-based learning material from Toolbox of Reseach (https://wiki.oulu.fi/display/tor/1.1+Finding+scientific+information)

Assessment methods and criteria:

Passing the course requires participation in the training sessions and successful completion of the course assignments.

Grading:

pass/fail

Person responsible:

Science and Technology Library Tellus, tellustieto (at) oulu.fi http://www.kirjasto.oulu.fi/index.php?id=738

Other information:

http://www.kirjasto.oulu.fi/index.php?id=738

031010P: Calculus I, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Ilkka Lusikka

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031010P	Calculus I (OPEN UNI)	5.0 op

ECTS Credits:

5 cp

Language of instruction:

Finnish

Timing:

Period 1-3

Learning outcomes:

The course gives the basics of vector algebra, analytic geometry, elementary functions and differential and integral calculus of real valued functions of one variable. 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.

Learning activities and teaching methods:

Term course. Lectures 5 h/week.

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).

031011P: Calculus II, 6 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

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

Language of instruction:

Finnish

Timing:

Period 4-6

Learning outcomes:

The course gives the basics of theory of series and differential and integral calculus of real and vector valued functions of several variables.
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.

Learning activities and teaching methods:

Term course. Lectures 5 h/week.

Recommended optional programme components:

Calculus I.

Recommended or required reading:

Kreyszig, E.: Advanced Engineering Mathematics; Grossmann, S.I.: Multivariable Calculus, Linear Algebra and Differential Equations.

031019P: Matrix Algebra, 3,5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Peltola

Opintokohteen kielet: Finnish

Leikkaavuudet:

031078P Matrix Algebra 5.0 op

Language of instruction:

Finnish

Timing:

Period 1-3

Learning outcomes:

The course gives the elementary theory of linear equations, matrices and vector spaces. The eigenvalues and eigenvectors with applications are introduced.
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 _nd 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 linaer 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.

Learning activities and teaching methods:

Term course. Lectures 4 h/week. Two examinations or final examination.

Recommended or required reading:

Grossman, S.I. : Elementary Linear Algebra.

031017P: Differential Equations, 4 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Hamina, Martti Aulis

Opintokohteen kielet: Finnish

Leikkaavuudet:

800320A	Differential equations	5.0 op
031076P	Differential Equations	5.0 op

Language of instruction:

Finnish

Timing:

Period 4-6

Learning outcomes:

The students learn the concepts concerning differential equations and get the ability to read associated literature. The students will achieve adequate mathematical skills for treating differential equations. They can identify simple analytically solvable differential equations and they can solve these by using various methods.
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:

Principles of mathematical modelling. Ordinary differential equations of first and higher order. Laplace transform with applications to differential equations.

Learning activities and teaching methods:

Lectures 3h/week. Two intermediate exams or one final exam.

Recommended optional programme components:

Calculus I.

Recommended or required reading:

Lecture notes in Finnish. Kreyszig. E., Advanced Engineering Mathematics

031021P: Probability and Mathematical Statistics, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Kemppainen

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031021P Probability and Mathematical Statistics (OPEN UNI) 5.0 op

Language of instruction:

Finnish

Timing:

Period 4-6

Learning outcomes:

The course provides the student the fundamental knowledge of the basic concepts of probability, random variables, management of statistical material, hypothesis testing and estimation methods. Learning outcomes **:** After completing the course the student is able to use the basic concepts of probability and most important random variables and is also able to apply these to calculate probabilities and expected values. The student is also able to analyze statistical material by calculating confidence intervals, formulating and testing hypotheses and by performing maximum likelihood estimations.

Contents:

Basic concepts of probability, conditional probability, discrete and continuous random variables and their distributions, expectation and variance, joint distributions, central limit theorem, elements of statistics, interval of confidence, hypothesis testing, maximum likelihood estimation.

Learning activities and teaching methods:

Term course. Lectures 4 h/week. Two examinations or a final examination.

Recommended optional programme components:

Calculus I and Calculus II.

Recommended or required reading:

Milton J.S. and Arnold J.C.: Introduction to Probability and Statistics, McGraw-Hill (1992).

031018P: Complex Analysis, 4 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Mathematics Division

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: Finnish

Leikkaavuudet:

031077P Complex analysis 5.0 op

Language of instruction:

Finnish

Timing:

Period 1-2

Learning outcomes:

The objective of the course is to supply the student with basic understanding of the use of complex numbers and complex functions in various applications of technics, especially in signal processing.
Learning outcomes **:** Upon completing the required coursework, the student is able to apply complex numbers and functions to modeling, solving and analysing of problems arising in technics, especially in signal processing. The student also knows how to use mapping properties and differential and integral calculus of complex functions in applications of technics .

Contents:

Complex numbers, complex exponential function and discrete linear system, mapping properties of complex functions, differential calculus, conformal mapping, integral calculus, Cauchy formula, residue, residue calculus, Möbius transformation, applications to signal processing.

Learning activities and teaching methods:

Term course. Lectures 4 h/week. Two intermediate exams or a final examination.

Recommended optional programme components:

Calculus I.

Recommended or required reading:

Lecture notes and exercise materials. Kreyszig, E.: Advanced Engineering Mathematics; Spiegel **:** Complex Variables; Lang: Complex Analysis.

031050A: Signal Analysis, 4 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Mathematics Division
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

031080A Signal Analysis 5.0 op

Ei opintojaksokuvauksia.

761101P: Basic Mechanics, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Physics
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, also the 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.

Learning activities and teaching methods:

Lectures 32 h, 8 exercises (16 h).

Target group:

Secondary subject students.

Recommended optional programme components:

Knowledge of vector calculus and basics of differential and integral calculus would be desirable.

Recommended or required reading:

Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 12th edition, 2008, chapters 1-14. Also 11th and 10th 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.

Grading:

Scale 1-5 / fail

Person responsible:

Anita Aikio

Other information:

https://wiki.oulu.fi/display/761101P/

761103P: Electricity and Magnetism, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

761119P	Electromagnetism 1	5.0 op
761119P-01	Electromagnetism 1, lectures and exam	0.0 op
761119P-02	Electromagnetism 1, lab. exercises	0.0 op
761113P-01	Electricity and magnetism, lectures and exam	0.0 op
761113P-02	Electricity and magnetism, lab. exercises	0.0 op
761113P	Electricity and magnetism	5.0 op
766319A	Electromagnetism	7.0 op

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:

Spring

Learning outcomes:

Learning outcomes: The student is able to describe the basic concepts of electricity and magnetism and to apply those when solving the problems related to electromagnetism.

Contents:

Electromagnetic interaction is one of the four fundamental interactions in physics and many phenomena like light, radio waves, electric current, magnetism and formation of solid matter are based on electromagnetism. The current technological development is largely based on applications of electromagnetism in energy production and transfer, telecommunications and information technology. Contents in brief: Coulomb's law. Electric field and potential. Gauss's law. Capacitors and dielectrics. Electric current, resistors, electromotive force and DC circuits. Magnetic field, motion of a charged particle in electric and magnetic fields, and applications. Ampère's law and Biot-Savart law. Electromagnetic induction and Faraday's law. Inductance and inductors. R-L-C circuits, alternating current and AC circuits.

Learning activities and teaching methods:

Lectures 32 h, 6 exercises (12 h).

Target group:

Secondary subject students.

Recommended optional programme components:

Knowledge of vector calculus and basics of differential and integral calculus are needed.

Recommended or required reading:

Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 12th edition, 2008, chapters 21-31. Also 11th and 10th editions can be used.
Lecture material: Finnish lecture material will be available on the web page of the course.

Assessment methods and criteria:

Four mini examinations and end examination or final examination.

Person responsible:

Anita Aikio

Other information:

https://wiki.oulu.fi/display/761103P/

766320A: Applied Electromagnetism, 6 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

766325A	Electromagnetism (TTK)	4.0 op
761398A	Theory of Electricity	6.0 op

ECTS Credits:

6 credits

Timing:

Second autumn

Learning outcomes:

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 starting from Maxwell's equations. He can apply the theory to electrostatics, magnetostatics, induction phenomena and electromagnetic radiation.

Contents:

This lecture course consists of electromagnetic field theory and its applications. The course contains three parts: a) lectures, problem classes of field theory and four mini exams and one end exam b) home problems c) project with a report. Each part must be passed at an acceptable level. The marks of the whole course are given by a weighted average of the marks of parts a), b) and c) with weights 50 %, 25 % and 25 %, respectively.
a) Lectures of field theory and problem classes
The field theory starts with Maxwell’s equations and their experimental justification. They are then used in deriving the electrostatics, stationary currents, magnetostatics, theory of dynamic electromagnetic fields and the propagation of electromagnetic waves in space. This theory makes the foundation of all electrical technology, but it is essential especially in understanding the working of antennas, transfer lines and wave guides. The problems given to students are brief and consist of simple cases which can be solved using the theory.
b) Home problems
These problems are more extensive than those on problem classes and solving them requires more profound reasoning. Each person will receive 6 problems to be solved.
c) Project
The project works are meant to act as concrete examples of electromagnetic phenomena. No detailed instructions are given, but the task is described in a loose way. The project group has to invent the experimental arrangement by themselves using the available tools. The group will also write a project report.

Learning activities and teaching methods:

Lectures 36 h, exercises 24 h, four mini examinations and one end examination or one final examination. Home problems. Project.

Target group:

Students in electrical engineering.

Recommended optional programme components:

Courses 761103P, 031011P

Recommended or required reading:

T. Nygrén: Soveltava sähkömagnetiikka (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).

Grading:

Each part must be passed.

Person responsible:

Tuomo Nygrén

Other information:

https://wiki.oulu.fi/display/766320A/

766326A: Atomic physics 1, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

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.

Learning activities and teaching methods:

Lectures 46 h, exercises 24 h.

Target group:

Compulsory

Recommended optional programme components:

Follow-up courses: Advanced courses in atomic and molecular spectroscopy.

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.

Grading:

Scale 1 - 5 / fail

Person responsible:

Sami Heinäsmäki

Other information:

https://wiki.oulu.fi/display/766326A/

766329A: Wave motion and optics, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

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

Timing:

Firts spring

Learning outcomes:

In natural sciences different types of waves (ripples on a pond, musical sounds, seismic waves from earth quake, light, radio waves and so on) play important role. The objective of this course is to study the theory of wave motion. Important part is given to the wave nature of light and principles of optics.

Contents:

General principles of wave motion, sound, light, electromagnetic waves, production and measurement of light, gepmetric optics, optical instruments, wave equation, superposition of waves , interference, interferometry, polarization, Fraunhofer diffraction, diffraction grating, laser basics.

Learning activities and teaching methods:

Lectures 46 h, exercises 24 h.

Target group:

Compulsory.

Recommended or required reading:

Pedrotti, F.L., Pedrotti, L. S.: Introduction to optics, Englewood Cliffs, Prentice-Hall and others.
Course material availability can be checked here.

Assessment methods and criteria:

Two written intermediate examinations or one final examination.

Grading:

Scale 1 - 5 / fail

Person responsible:

Seppo Alanko

Other information:

https://wiki.oulu.fi/display/766329A/

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

521205A: Principles of Semiconductor Devices, 4,5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Marina Tjunina

Opintokohteen kielet: Finnish

Leikkaavuudet:

521071A Principles of Semiconductor Devices 5.0 op

Language of instruction:

In Finnish.

Timing:

Period 3-4.

Learning outcomes:

The students are introduced to principles of operation and characteristics of semiconductor devices.
Learning outcomes: Student is able to describe main characteristics of semiconductor materials and junctions, main types of semiconductor devices, their design and main operational characteristics. Student is able to explain physical principles of operation of idealized devices. Student is able to estimate main parameters of idealized devices.

Contents:

Semiconductor pn-junctions, metal-semiconductor junctions, heterojunctions. Diodes. Bipolar junction transistors. Field effect transistors. Semiconductor lasers. Switching devices.

Learning activities and teaching methods:

Lectures and calculation exercises. Final exam.

Recommended optional programme components:

Basic physics. Introduction to materials physics. Electronic components.

Recommended or required reading:

Selected chapters from Streetman, B.: Solid State Electronic Devices, Prentice-Hall, New Jersey, 2000. Lecture notes.

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

Language of instruction:

In Finnish.

Timing:

Period 1-2.

Learning outcomes:

The students are introduced to the physical principles of electronic and atomic phenomena existing in electronic materials and components. The connections to the general principles of solid state physics are emphasized in the consideration of the phenomena.
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.

Learning activities and teaching methods:

Lectures and exercises.

Recommended optional programme components:

Basic physics and mathematics

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.

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

Language of instruction:

The course and exercises are held in Finnish.

Timing:

Period 5-6.

Learning outcomes:

In this course the student learns to analyse simple DC, AC, and transient circuits. The course gives necessary basic knowledge for all analogue electronics courses (Basics of Electronic Design, Electronics Design I - III, Analog Filters).
Learning Outcomes: After completing the course the student can write and solve a system of equations describing the behaviour of electric circuits, use complex phasor arithmetics to solve the response of circuits driven by sinusoidal signals, solve time responses of circuits, simplify circuit by employing equivalent circuits and series and parallel combinations, and run simple circuit simulations and understands the differences and limitations of different types of analyses.

Contents:

Electric quantities, circuit laws, systematic writing and solving of circuit equations using nodal and mesh analysis, time and frequency response, phasor calculation. Basics of circuit simulation.

Learning activities and teaching methods:

6 hours lectures and exercises per week. Basic circuit simulation exercises. The course is passed by a final exam and the simulation exercises (contact the lecturer for exam in English).

Recommended optional programme components:

Matrix Algebra, Differential Equations.

Recommended or required reading:

Handouts. The same topics are covered in Nilsson, Riedel: Electric Circuits (6th ed., Prentice-Hall 1996), chapters 1-11.

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

Language of instruction:

The course and exercises are held in Finnish.

Timing:

Period 1-3.

Learning outcomes:

This course gives basic knowledge about the analysis and modelling of electrical circuits. After passing this course the student is capable of analyzing frequency responses of circuits implemented using lumped circuit elements.
Learning outcomes: After completing the course the student can use Laplace transform for solving transient and steady-state responses, can derive the transfer function of a continuous-time system, solve its poles and zeros, and understand their meaning, can draw the pole-zero map and Bode plots of a given transfer function, can construct and use a 2-port parameter presentation of a circuit, and understands the principles of circuit synthesis and limitations of linear circuit analysis.

Contents:

Use of Laplace transformation in circuit analysis. Properties of network functions, concept of poles and zeros. Pole-zero plot, Bode amplitude and phase plots. Behavioral modeling of electric circuits. One and two-port parameter presentations. Basics of network synthesis.

Learning activities and teaching methods:

This course includes 4 hours of lectures and exercises per week. The course is passed by a final exam.

Recommended optional programme components:

Circuit Theory I, Calculus I - II, Differential Equations.

Recommended or required reading:

Handouts. Nilsson, Riedel: Electric Circuits (6th or 7th ed., Prentice-Hall 1996), chapters 12-18.

521412A: Digital Techniques 1, 6 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical and Information Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti Mäntyniemi

Opintokohteen kielet: Finnish

Leikkaavuudet:

521301A Digital Techniques 1 8.0 op

Language of instruction:

In Finnish.

Timing:

Period 5-6.

Learning outcomes:

After having completed the coursest student are expected to understand functional principles, implementation options, and logic design principles of the most usual digital equipmet.
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:

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.

Learning activities and teaching methods:

Kurssissa tutustutaan luennoilla ja harjoituksissa konkreettisten esimerkkien kautta nykyaikaisten digitaalieteknisten laitteiden toimintaan ja rakenteeseen. Kurssiin sisältyy luennot ja laskuharjoitukset. Opintojakso suoritetaan loppukokeella. Kurssiin liittyy Ohjelmoitava elektroniikka -kurssi, jolle osallistuminen edellyttää Digitaalitekniikka I -kurssin sisällön hallintaa.

Recommended or required reading:

Brown, S., Vranesic, Z. Fundamentals of Digital Logic with VHDL Design, McGraw Hill, 2005

521431A: Principles of Electronics Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Kostamovaara

Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 1-3.

Learning outcomes:

To give the students all the basic information that all electrical engineers needs about circuit techniques of analogue electronics and internal structure of digital circuits.

Contents:

Analogue and digital circuits, basic amplifier related concepts, operational amplifier, diodes and diode circuits, single stage bipolar- and MOS-transistor amplifiers and how to bias them, small signal modeling and analyzing ac-properties of the amplifiers, internal structures of digital circuits (mainly CMOS), the principles of AD/DA -conversion and principles of VLSI-technology.

Learning activities and teaching methods:

Lectures and exercises. Final exam.

Recommended optional programme components:

Basic knowledge in Circuit Theory (Circuit Theory I). Also, understanding the basic operation of semiconductors helps (Principles of Semiconductor Devices).

Recommended or required reading:

Handout. Sedra, Smith: Microelectronic Circuits (4th edition), chapters 1, 3-5, 10.9, 13 and 14. OR Hambley: Electronics (2nd edition), chapters 1, 2, 3, 4, 5; 6 partially and some parts of other chapters.

521432A: Electronics Design I, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Language of instruction:

Finnish.

Timing:

Period 4-5.

Learning outcomes:

To give the student the basic information about analogue electronics design. The course is continuation to Principles of Electronics Design.
Learning outcomes: On completion of the study module students should be able to recount the principles governing the design of multistage amplifiers, analyse 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 analyse 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 structural blocks 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 resonance amplifiers and to recount the basic principles governing the functions and properties of emitter-coupled logic.

Contents:

Frequency response of transistor amplifier, differential amplifier, feedback, stability and nonidealities of feedback amplifier, comparator, output stages and power amplifiers, application of operational amplifier, oscillators, tuned amplifiers and ECLlogic. Implementation: Lectures and exercises. This course is required when participating in Laboratory Exercises on Analogue Electronics. Final exam.

Recommended optional programme components:

Circuit Theory II, Principles of Electronics Design, Principles of Semiconductor Devices.

Recommended or required reading:

Handout. Sedra, Smith: Microelectronic Circuits (4th edition), Chapters 2, 6-12. OR Hambley: Electronics (2nd edition), chapter 2; chapters 7 - 12 to most part.

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: Janne Haverinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

810122P	Computer Architecture	5.0 op

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. Learning objectives: 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.

Learning activities and teaching methods:

Lectures, programming exercise, and exam.

Recommended optional programme components:

Digital Techniques I

Recommended or required reading:

Mano M., Computer System Architecture. Prentice Hall, Englewood Cliffs, New Jersey 1993; Patterson D., Hennessy J., Computer Organization and Design. Morgan Kauffman, San Fracisco, CA, 2005.

521170A: Electrical Measurement Principles, 4,5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Saarela

Opintokohteen kielet: Finnish

Language of instruction:

Lectures are in Finnish. Laboratory exercises can be done in English.

Timing:

Periods 4-6.

Learning outcomes:

The goal of this course is to give the theoretical and practical basis on electrical measuring techniques and to give basic knowledge to later studies. The course will also provide knowledge to use of general electrical measurement equipment.
Learning outcomes: Upon completion of the course, students are be able to measure basic measurements with a ammeter, voltmeter and oscilloscope. 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.

Learning activities and teaching methods:

Lectures and laboratory exercises. One or two exams and passed lab exercises.

Recommended optional programme components:

Calculus I and II, Physics S.

Recommended or required reading:

A.D. Helfrich, W.D. Cooper: Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall, 1990., material from Optima.

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

Language of instruction:

In Finnish.

Timing:

Period 5-6.

Learning outcomes:

The objective of the course is to supply the student with basic understanding of digital signal processing and applications.
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. Introduction, 2. Discrete transforms, 3. Correlation and convolution, 4. Digital filter design, 5. FIR filter design, 6. IIR filter design, 7. Finite word length effects, 8. Multi-rate signal processing, 9. Adaptive filtering.

Learning activities and teaching methods:

The course is based on lectures and design exercises. The design exercises familiarize the students with the methods of digital signal processing using the Matlab software package. The course can be passed either with week exams or a final exam. In addition, the exercises need to be returned and accepted.

Recommended optional programme components:

Signals and systems, complex analysis.

Recommended or required reading:

Lecture notes and exercise materials. Material is in Finnish. Some material is in English.

Course book: Ifeachor, E., Jervis, B.: Digital Signal Processing, A Practical Approach, Second Edition, Prentice Hall, 2002.

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

Opintokohteen kielet: Finnish

Leikkaavuudet:

521330A Telecommunication Engineering 5.0 op

Language of instruction:

In Finnish.

Timing:

Periods 2-3.

Learning outcomes:

To learn the basic principles of analog amplitude, phase and frequency modulation methods, their implementation methods, and to compare their performance under the influence of noise and single-tone interference. The course aids to understand digital communication systems that are based on discrete message signals.
Learning outcomes:
After completing the course student can identify operation principles of the most important functional blocks for an analog telecommunication system. Student also can tell operation principles of various analog carrier- and pulsemodulation 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-, etc. calculations.

Contents:

Basic blocks of a communication system, linear and angle modulations, phase-lock loop and its applications, analog and digital pulse modulations, 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.

Learning activities and teaching methods:

Lectures and exercises. A final exam concludes the course.

Recommended optional programme components:

Signals and Systems, Stochastic Processes.

Recommended or required reading:

R.E. Ziemer & W.H. Tranter: Principles of Communications # Systems, Modulation and Noise, 5th edition, 2002, John Wiley & Sons, chapter 1 partly, all of ch 3 and ch 6 partly.

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

Language of instruction:

In Finnish.

Timing:

Period 3-4.

Learning outcomes:

To learn the basics of digital transmission systems that are based on amplitude, phase and frequency modulation of a discrete-valued symbol sequence, the influence of transmission channel on system performance, the basics of information and coding theory.
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 can tell the limitations resulting from transmission channel and can tell various methods to combat such effects. Using simple assumptions, student can analyze system performance mathematically and compare various modulation methods from the viewpoint 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, digital continuous-wave modulations (ASK, MPSK, MFSK), correlation and matched filter receivers, receiver structures and their bit error probability performance with AWGN channel, effect of band-limiting and multipath propagation, basics of information theory, discrete channel models, entropies, source coding, channel capacity, basics of error-correction coding methods.

Learning activities and teaching methods:

Lectures and exercises. A final exam concludes the course.

Recommended optional programme components:

Stochastic Processes

Recommended or required reading:

R.E. Ziemer & W. H. Tranter: Principles of Communications - Systems, Modulation and Noise, 5th edition, 2002, John Wiley & Sons, chapter 7, partially chapters 8 and 10

521384A: Basics in Radio Engineering, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Karhu Seppo

Opintokohteen kielet: Finnish

Language of instruction:

In Finnish.

Timing:

Periods 1-2.

Learning outcomes:

The aim is to give elementary knowledge about and to introduce some basic scientific tools needed in radio engineering.

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 homogenic 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 propagaton 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.

Learning activities and teaching methods:

Lectures and exercises. Exam.

Recommended optional programme components:

Elementary knowledge of the electromagnetic theory.

Recommended or required reading:

In Finnish: Antti Räisänen & Arto Lehto: Radiotekniikan perusteet. Otatieto, 2007. 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.

521141P: Elementary Programming, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Computer Science and Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Riekki, Jukka Pekka

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521141P	Elementary Programming (OPEN UNI)	5.0 op

Voidaan suorittaa useasti: Kyllä

Language of instruction:

Finnish.

Timing:

Period 1-3.

Learning outcomes:

Learning outcomes: Upon completing the required coursework, the student is able to recognize the basic programming concepts and structures. Moreover, the student is able to implement small programs.

Contents:

History of programming, basic concepts of programming, basic structures of programming languages, solving problems by programming

Learning activities and teaching methods:

Lectures, many programming exercises

Recommended or required reading:

Will be announced later

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

Language of instruction:

Finnish.

Timing:

Period 4-6.

Learning outcomes:

Learning outcomes: Upon completing the required coursework, the student is able to implement small C programs both in PC 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

Learning activities and teaching methods:

Lectures, many programming exercises

Recommended optional programme components:

Elementary programming

Recommended or required reading:

Will be announced later

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

Language of instruction:

The course and exercises are held in Finnish

Timing:

Period 3-4.

Learning outcomes:

Learning Outcomes: After completing the course the student can construct a needed pole-zero map for a given frequency response, can perform frequency and impedance scaling, can choose an appropriate prototype filter and solve the required order of the filter. Further, he can synthesize simple passive and active filters, and understands the principles for optimising the dynamic range of active filters, and understands the basic limitations of various filter implementation technologies.

Contents:

Prototype filters (Butterworth, Chebychev, Bessel etc.), frequency transforms and impedance conversions. Implementations using lumped and distributed circuits. Active filters. Sensitivity analysis and optimizing the dynamic range of filter stages.

Learning activities and teaching methods:

Lectures and exercises together 5 hours per week. Design exercise and final exam.

Recommended optional programme components:

Knowledge in circuit theory and analog design.

Recommended or required reading:

Handouts. van Valkenburg: Analog Filter Design, chapters 1-14, 18, 20 Holt-Saunders 1982, OR Schauman, van Valkenburg: Design of Analog Filters, chapters 1-13, Oxford University Press 2001.

521171A: Electronic Measurement Techniques, 6,5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical and Information Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Saarela

Opintokohteen kielet: Finnish

Leikkaavuudet:

521092A	Electronic Measurement Techniques	5.0 op
521430A	Electronic Measurement Techniques	6.0 op

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:

Periods 1-3.

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

Learning activities and teaching methods:

Lectures and laboratory exercises. One or two exams and passed lab exercises.

Recommended optional programme components:

Electrical Measurement Principles, Analogue Electronics I, Digital Techniques I.

Recommended or required reading:

Ask the lecturer.

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

Language of instruction:

English

Timing:

Periods 1-3

Learning outcomes:

The target is to introduce the key transmission technologies used in modern broadband wireless systems and to introduce the most common wireless standards.

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:

Wideband radio channels, multiple access techniques, spread spectrum and DS-CDMA techniques, OFDM techniques,UWB techniques, positioning, applications and most common standards.

Learning activities and teaching methods:

Lecturers, lab exercise, final exam

Recommended or required reading:

Defined during the lectures

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

Language of instruction:

Finnish, English.

Timing:

Period 1-6

Learning outcomes:

Design exercises are used to deepen the understanding of the material presented in Principles of Electronics Design and Analogue Electronics I. Implementation: Independent design exercise, which is checked by CADsimulations and experimentally. Simulations are carried out in PSpice environment Learning outcomes: On completion of the study module students should be able to design basic electronic structural blocks and verify their functioning in a CAD simulation environment. They should be able independently to realize and test a small-scale design object employing the analogue technique.

Recommended optional programme components:

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

521218A: Introduction to Microelectronics and Micromechanics, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti Uusimäki

Opintokohteen kielet: Finnish

Leikkaavuudet:

521070A Introduction to Microfabrication Techniques 5.0 op

Language of instruction:

In Finnish.

Timing:

Peroid 4-6.

Learning outcomes:

The student is introduced to the fabrication methods of integrated circuits (IC) and structures of micromechanics.
Learning outcomes **:** After completing the course the student has an extensive knowledge of different fabrication methods of microelectronics and micromechanics. The student knows the required properties of semiconducting materials, the processing of the source material and basic principles of the semiconductor wafer fabrication. The student is able to apply her/his knowledge of the fabrication of semiconductor components. The student has also an understanding of the micromechanics processing methods and thick-film circuit design and fabrication.

Contents:

Integrated circuits: materials, methods, components and circuit technologies. Thick film hybrid techniques. Fabrication of micromechanical structures. Application examples

Learning activities and teaching methods:

Lectures and demonstration including design work. Final exam.

Recommended or required reading:

Lecture notes. D.V. Morgan, K. Board: An Introduction to Semiconductor Microtechnology, John Wiley & Sons, New York 1990/1995.

Assessment methods and criteria:

Final exam, design exercise and demonstration.

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
Vastuuyksikkö: Department of Physics
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 term

Learning outcomes:

The student can explain the basic principles of thermophysics and can derive their consequences in the extent and level of the lectures. 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 and heat transfer, 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.

Learning activities and teaching methods:

Lectures 46 h, exercises 24 h.

Recommended or required reading:

Textbooks: H. D. Young and R. A. Freedman: University Physics, 12th edition, Pearson Addison-Wesley, 2008 (in part), F. Mandl: Statistical Physics, second edition, John Wiley & Sons Ltd., 1988 (in part).
Lecture notes: Juhani Lounila: 766328A Termofysiikka, Oulun yliopisto, 2010.
Course material availability can be checked here.

Assessment methods and criteria:

Two written intermediate examinations or one final examination.

Grading:

Scale 1-5 / fail

Person responsible:

Juhani Lounila

Other information:

https://wiki.oulu.fi/display/766328A/

780109P: Basic Principles in Chemistry, 4 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Chemistry
Arvostelu: 1 - 5, pass, fail
Opettajat: Minna Tiainen
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

Language of instruction:

Finnish

Timing:

1st autumn

Learning outcomes:

Upon completion the student should 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.

Learning activities and teaching methods:

36 hours of lectures

Target group:

Biology, Geology, Mechanical Engineering, Process Engineering, compulsory.
Geography, optional.

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) or a newer edition.

Assessment methods and criteria:

Final examination

Grading:

1-5/fail

Person responsible:

Lecturer Minna Tiainen

Other information:

This course is only for students who have chemistry as a minor subject.
This course has partly the same contents as the course Introduction to Chemistry (780113P) (and the course Introduction to Physical Chemistry). If a student performs also the course Introduction to Chemistry, this course will be cancelled in his/hers study register.

521218A: Introduction to Microelectronics and Micromechanics, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Antti Uusimäki

Opintokohteen kielet: Finnish

Leikkaavuudet:

521070A	Introduction to Microfabrication Techniques	5.0 op

Language of instruction:

In Finnish.

Timing:

Peroid 4-6.

Learning outcomes:

The student is introduced to the fabrication methods of integrated circuits (IC) and structures of micromechanics.
Learning outcomes **:** After completing the course the student has an extensive knowledge of different fabrication methods of microelectronics and micromechanics. The student knows the required properties of semiconducting materials, the processing of the source material and basic principles of the semiconductor wafer fabrication. The student is able to apply her/his knowledge of the fabrication of semiconductor components. The student has also an understanding of the micromechanics processing methods and thick-film circuit design and fabrication.

Contents:

Integrated circuits: materials, methods, components and circuit technologies. Thick film hybrid techniques. Fabrication of micromechanical structures. Application examples

Learning activities and teaching methods:

Lectures and demonstration including design work. Final exam.

Recommended or required reading:

Lecture notes. D.V. Morgan, K. Board: An Introduction to Semiconductor Microtechnology, John Wiley & Sons, New York 1990/1995.

Assessment methods and criteria:

Final exam, design exercise and demonstration.

521171A: Electronic Measurement Techniques, 6,5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Electrical and Information Engineering

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Saarela

Opintokohteen kielet: Finnish

Leikkaavuudet:

521092A	Electronic Measurement Techniques	5.0 op
521430A	Electronic Measurement Techniques	6.0 op

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:

Periods 1-3.

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

Learning activities and teaching methods:

Lectures and laboratory exercises. One or two exams and passed lab exercises.

Recommended optional programme components:

Electrical Measurement Principles, Analogue Electronics I, Digital Techniques I.

Recommended or required reading:

Ask the lecturer.

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

Language of instruction:

In Finnish.

Timing:

Periods 4-6.

Learning outcomes:

This course provides basic knowledge of statistical signal processing, in particular, estimation theory and its applications in signal processing.
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.

Learning activities and teaching methods:

Lectures, exercises and Matlab design exercise. The course is passed with final exam and accepted Matlab exercise

Recommended optional programme components:

Algebra, Statistics, Signals and Systems.

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.

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

Language of instruction:

Lectures are in Finnish. The course book and lecture notes are in English. If the teacher in English speaking, also the lectures are in English.

Timing:

Periods 5-6.

Learning outcomes:

The goal is to familiarize the students with simulation of communication systems, protocols, algorithms and transceiver RF/IF-blocks. The course gives answers to questions why, when and how to simulate. In addition to simulation principles also communication system simulations especially in the baseband level are considered as well as brief overview to simulations in the network level and RF/IF parts.

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 recognizes common communications and RF/IF 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. The common simulation packages communication and RF systems are presented.

Learning activities and teaching methods:

Lectures 2 hours per week (including program introductions) and a compulsory design exercise.

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 final examination and acceptably passed design exercise.

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

Language of instruction:

Finnish.

Timing:

Period 4-6.

Learning outcomes:

The course introduces the student to different measurements and measurement documentation in the field of communication systems. The measurements give information about communication system components, operational principles and performance. A range of common communications system measurement instruments are studied and used in the laboratory exercises.
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 for 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. Implementation: Laboratory exercises. Exercises include both measurements and documentation. The grade is given according to the written reports.

Recommended optional programme components:

Telecommunication Engineering I, Telecommunication Engineering II , Basics of Radio Engineering, Radio Communication Channels, Communication Networks I, Wireless Communications I

Recommended or required reading:

Laboratory exercise manual(s).

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

Language of instruction:

The course and exercises are held in Finnish

Timing:

Period 3-4.

Learning outcomes:

Learning Outcomes: After completing the course the student can construct a needed pole-zero map for a given frequency response, can perform frequency and impedance scaling, can choose an appropriate prototype filter and solve the required order of the filter. Further, he can synthesize simple passive and active filters, and understands the principles for optimising the dynamic range of active filters, and understands the basic limitations of various filter implementation technologies.

Contents:

Prototype filters (Butterworth, Chebychev, Bessel etc.), frequency transforms and impedance conversions. Implementations using lumped and distributed circuits. Active filters. Sensitivity analysis and optimizing the dynamic range of filter stages.

Learning activities and teaching methods:

Lectures and exercises together 5 hours per week. Design exercise and final exam.

Recommended optional programme components:

Knowledge in circuit theory and analog design.

Recommended or required reading:

Handouts. van Valkenburg: Analog Filter Design, chapters 1-14, 18, 20 Holt-Saunders 1982, OR Schauman, van Valkenburg: Design of Analog Filters, chapters 1-13, Oxford University Press 2001.

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

Language of instruction:

English

Timing:

Periods 1-3

Learning outcomes:

The target is to introduce the key transmission technologies used in modern broadband wireless systems and to introduce the most common wireless standards.

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:

Wideband radio channels, multiple access techniques, spread spectrum and DS-CDMA techniques, OFDM techniques,UWB techniques, positioning, applications and most common standards.

Learning activities and teaching methods:

Lecturers, lab exercise, final exam

Recommended or required reading:

Defined during the lectures

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

802352A: Euclidean Topology, 4 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Mathematical Sciences

Arvostelu: 1 - 5, pass, fail

Opettajat: Maarit Järvenpää

Opintokohteen kielet: Finnish

Leikkaavuudet:

802357A Euclidean Spaces 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

Target group:

Major and minor students

Prerequisites and co-requisites:

Introduction to mathematical deduction
Elementary functions
Limit and continuity
Derivative

Assessment methods and criteria:

Midterm exam or final exam

Grading:

1-5

Person responsible:

Maarit Järvenpää

Working life cooperation:

No

802353A: Series and Integrals, 6 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Mathematical Sciences

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
Mode of delivery:
Face-to-face teaching
Target group:
Major and minor students
Prerequisites and co-requisites:
80xxxxP Elementary functions
80xxxxP Limit and continuity
80xxxxP Derivative
802352A Euclidean topology

Recommended or required reading:
Lecture notes
Assessment methods and criteria:
Midterm exams or final exam
Grading:
1-5
Person responsible:
Peter Hästö
Working life cooperation:
No

802151P: Introduction to mathematical deduction, 5 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h, exercises 18h

Target group:

Major and minor students

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Maarit Järvenpää

Working life cooperation:

No

806113P: Introduction to Statistics, 5 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
Arvostelu: 1 - 5, pass, fail
Opettajat: 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:

First year, 3. period

Learning outcomes:

On successful completion of this course, the student will be able to
- present the dataset by using graphics, tables and statistics
- apply appropriate statistical techniques for analyzing solutions to simple real-world problems
- interpret listing of some statistical software

Contents:

The course presents probabilistic techniques for studying uncertainty, and to illustrate how such techniques can be applied to make statistical analysis and interpretation of data in simple one variable settings. Topics include descriptive statistics, basics of probability theory, random variables and their distributions, sampling distributions, estimation, confidence intervals, and hypothesis testing. One aim is also to get basic knowledge from some statistical software.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

32 h lectures, 24 h exercises from which 16 h are normal exercises and 8 h computer exercises.

Target group:

Major and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction
801195P Introduction to probability theory
802118P Linear algebra I

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

802354A: Number Theory and Groups, 5 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
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

Mode of delivery:

Face-to-face teaching

Target group:

Major and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exam or final exam

Grading:

1-5

Person responsible:

Kari Myllylä

Working life cooperation:

No

761102P: Basic Thermodynamics, 2 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Physics
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 Fall 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.

Learning activities and teaching methods:

Lectures 16 h, 4 exercises (8 h).

Target group:

For students with physics as a minor subject.

Recommended or required reading:

Young and Freedman; University Physics, Addison Wesley (Edition 10, Chapters 15-18, or Editions 11-12, 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 Fall) or final examination.

Grading:

Scale 1-5 / fail

Person responsible:

Ville-Veikko Telkki

Other information:

https://wiki.oulu.fi/display/761102P/

766334A: Nuclear and particle physics, 2 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

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:

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. 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.

Learning activities and teaching methods:

Lectures 20 h, exercises 10 h.

Recommended optional programme components:

766326A Atomic physics 1.

Recommended or required reading:

Textbooks: H. D. Young and R. A. Freedman: University Physics, 12th edition, Pearson Addison-Wesley, 2008 (in part), R. Eisberg and R. Resnick: Quantum physics of atoms, molecules, solids, nuclei, and particles, John Wiley & Sons (in part).

Assessment methods and criteria:

One written examination.

Person responsible:

Juhani Lounila

Other information:

https://wiki.oulu.fi/display/766334A/

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.

Compulsory studies

802352A: Euclidean Topology, 4 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
Arvostelu: 1 - 5, pass, fail
Opettajat: Maarit Järvenpää
Opintokohteen kielet: Finnish
Leikkaavuudet:

802357A Euclidean Spaces 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

Target group:

Major and minor students

Prerequisites and co-requisites:

Introduction to mathematical deduction
Elementary functions
Limit and continuity
Derivative

Assessment methods and criteria:

Midterm exam or final exam

Grading:

1-5

Person responsible:

Maarit Järvenpää

Working life cooperation:

No

802353A: Series and Integrals, 6 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
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

Mode of delivery:

Face-to-face teaching

Target group:

Major and minor students

Prerequisites and co-requisites:

80xxxxP Elementary functions
80xxxxP Limit and continuity
80xxxxP Derivative
802352A Euclidean topology

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exams or final exam

Grading:

1-5

Person responsible:

Peter Hästö

Working life cooperation:

No

802151P: Introduction to mathematical deduction, 5 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h, exercises 18h

Target group:

Major and minor students

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Maarit Järvenpää

Working life cooperation:

No

806113P: Introduction to Statistics, 5 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Mathematical Sciences

Arvostelu: 1 - 5, pass, fail

Opettajat: 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:

First year, 3. period

Learning outcomes:

On successful completion of this course, the student will be able to
- present the dataset by using graphics, tables and statistics
- apply appropriate statistical techniques for analyzing solutions to simple real-world problems
- interpret listing of some statistical software

Contents:

The course presents probabilistic techniques for studying uncertainty, and to illustrate how such techniques can be applied to make statistical analysis and interpretation of data in simple one variable settings. Topics include descriptive statistics, basics of probability theory, random variables and their distributions, sampling distributions, estimation, confidence intervals, and hypothesis testing. One aim is also to get basic knowledge from some statistical software.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

32 h lectures, 24 h exercises from which 16 h are normal exercises and 8 h computer exercises.

Target group:

Major and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction
801195P Introduction to probability theory
802118P Linear algebra I

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

802354A: Number Theory and Groups, 5 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
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

Mode of delivery:

Face-to-face teaching

Target group:

Major and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exam or final exam

Grading:

1-5

Person responsible:

Kari Myllylä

Working life cooperation:

No

761102P: Basic Thermodynamics, 2 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Physics
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 Fall 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.

Learning activities and teaching methods:

Lectures 16 h, 4 exercises (8 h).

Target group:

For students with physics as a minor subject.

Recommended or required reading:

Young and Freedman; University Physics, Addison Wesley (Edition 10, Chapters 15-18, or Editions 11-12, 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 Fall) or final examination.

Grading:

Scale 1-5 / fail

Person responsible:

Ville-Veikko Telkki

Other information:

https://wiki.oulu.fi/display/761102P/

766334A: Nuclear and particle physics, 2 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
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:

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. 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.

Learning activities and teaching methods:

Lectures 20 h, exercises 10 h.

Recommended optional programme components:

766326A Atomic physics 1.

Recommended or required reading:

Textbooks: H. D. Young and R. A. Freedman: University Physics, 12th edition, Pearson Addison-Wesley, 2008 (in part), R. Eisberg and R. Resnick: Quantum physics of atoms, molecules, solids, nuclei, and particles, John Wiley & Sons (in part).

Assessment methods and criteria:

One written examination.

Person responsible:

Juhani Lounila

Other information:

https://wiki.oulu.fi/display/766334A/

Chosen to complete the 180 cr degree

801346A: Introduction to Cryptography, 4 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

802336A Introduction to Cryptography 5.0 op

ECTS Credits:

4 cr

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.

Person responsible:

Keijo Väänänen

802119P: Linear Algebra II, 5 op

Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Mathematical Sciences
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 or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exam or final exam

Grading:

1-5

Person responsible:

Esa Järvenpää

Working life cooperation:

No

801389A: Basic Geometry, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Mathematical Sciences

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.

800322A: Analysis II, 8 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Mathematical Sciences

Arvostelu: 1 - 5, pass, fail

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 topology of R^n is reviewed, after which differential and integral calculus is derived for vector-valued functions of multiple arguments are derived.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 h lectures, 28 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Linear algebra I
Linear algebra II
Euclidean topology
Series and integrals

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exams or final exam

Grading:

1-5

Person responsible:

Maarit Järvenpää

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
Vastuuyksikkö: Language Centre
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

Ei opintojaksokuvauksia.