INTERNATIONAL MASTER’S DEGREE PROGRAMME IN WIRELESS COMMUNICATIONS ENGINEERING (WCE)

DESCRIPTION OF COURSES

WCE Study Group 2013-2015

I. Studies of Basic Module

031025A Introduction to Optimization
Optimoinnin perusteet
ECTS credits: 5
Language of instruction: English
Timing: Fall semester, periods 1-2
Objective: The course gives the basics of theory of the optimization methods and how they are used in engineering applications.
Learning outcomes: After completing the course the student is able to solve optimization convex optimization problems with the basic optimization algorithms. The student is also able to form the necessary and sufficient conditions for the optimality.
Contents: Linear optimization, Simplex-algorithm, nonlinear optimization, KKT-conditions, duality, conjugate gradient method, penalty and barrier function methods
Mode of delivery: Face-to-face teaching
Learning activities and teaching methods: Lectures 40 h / Group work 20 h.
Target group: Students in Wireless Communication Engineering programme
Prerequisites and co-requisites: The recommended prerequisite is the completion of the courses Calculus I and II, Matrix algebra
Study materials: P. Ciarlet; Introduction to numerical linear algebra and optimization, M. Bazaraa, H. Sherali, C.M. Shetty; Nonlinear programming
Assessment methods and criteria: Intermediate exams or a final exam.
Grading: Numerical grading scale 1-5.
Person responsible: Keijo Ruotsalainen

521321S Elements of Information Theory and Coding
Informaatioteorian ja koodauksen perusteet
ECTS credits: 5
Language of instruction: English
Timing: Fall, periods 1-3

Objective: To learn the information theory as a discipline and its most important applications in information technology in general and in communications engineering in particular as well as the basics of forward error control coding.

Learning outcomes: Upon completing the required coursework, the student is able to use the basic methodology of information theory to calculate the capacity bounds of communication and data compression systems. He can estimate the feasibility of given design tasks before the execution of the detailed design. What is more, she can independently search for information and knowledge related to communication engineering, system design and signal processing. The student understands the operating principles of block codes, cyclic codes and convolutional codes. He can form an encoder and decoder for common binary block codes, and is capable of using tables of the codes and shift register when solving problems. She can represent the operating idea of a convolutional encoder as a state machine, the student is able to apply the Viterbi algorithm to decoding of convolutional codes, and is capable of specifying principles of turbo coding and coded modulation. Moreover, he can evaluate error probability of codes and knows practical solutions of codes by name.

Contents: Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, rate distortion theory, introduction to network information theory, block codes, cyclic codes, burst error correcting codes, error correcting capability of block codes, convolutional codes, Viterbi algorithm, concatenated codes, and introduction to turbo coding and to coded modulation.

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 40 h, exercises 20 h

Target group: 1st year M.Sc. and WCE students

Prerequisites and co-requisites: Signal Analysis, Telecommunication Engineering II

Recommended optional programme components: Wireless Com-munications II


Assessment methods and criteria: The course is passed with weekly exams (only during lecture periods) or with final exam.

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

Person responsible: Markku Juntti/Timo Kokkonen
Learning activities and teaching methods: Lectures 30 h, exercises 16 h and the compulsory design work with a simulation program (16 h)

Target group: 1st year M.Sc. and WCE students

Prerequisites and co-requisites: Telecommunication Engineering II, Wireless Communications I and II

Study materials: The course material will be defined in the beginning of the course.

Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. Grade is based on the exam.

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

Person responsible: Marcos Katz

521320S Wireless Communications I

Langatontietoliikenne I

ECTS credits: 8

Language of instruction: English

Timing: Fall, periods 1-3

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

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

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

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 40 h, exercises 20 h and the compulsory antenna design work with a simulation program (20 h)

Target group: 1st year M.Sc. and WCE students

Prerequisites and co-requisites: Telecommunication Engineering II, Wireless Communications I

Recommended optional programme components: Recommended: Statistical Signal Processing


Assessment methods and criteria: The course is passed with final examination (during lecture periods possibility to pass with intermediate exams) and accepted design exercise. Grade is based on exam.

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

Person responsible: Jari Iinatti
**521340S  Communication Networks I**  
Tietoliikenneverkot I  

ECTS credits: 5  
Language of instruction: English  
Timing: Fall, periods 1-3  

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

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

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

Mode of delivery: Face-to-face teaching  

Learning activities and teaching methods: Lectures 30 h and the compulsory design work with a simulation program (15 h).  

Target group: 1st year M.Sc. and WCE students  


Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. The final grade is based on examination.  

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

Person responsible: Savo Glisic

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**521373S  Communication Signal Processing I**  
Tietoliikennesignaalinkäsittely I  

ECTS credits: 6  
Language of instruction: English  
Timing: Fall, periods 4-5  

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

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

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

Mode of delivery: Face-to-face teaching  

Learning activities and teaching methods: Lectures 30 h, exercises 16 h and the compulsory antenna design work with a simulation program (16 h).  

Target group: 1st year M.Sc. and WCE students
Prerequisites and co-requisites: Statistical signal processing, Telecommunication Engineering II, Wireless Communications II


Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.

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

Person responsible: Markku Juntti

521335S Radio Engineering I
Radiotekniikka I

ECTS credits: 6
Language of instruction: English
Timing: Fall, periods 1-3

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

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.

Mode of delivery: Face-to-face teaching

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.

Target group: 1st and 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: Basics of Radio Engineering.


Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.

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

Person responsible: Risto Vuoltoniemi

521350S Seminar in Telecommunication and Radio Engineering
Tietoliikenne- ja radiotekniikan seminaari

ECTS credits: 1
Language of instruction: English
Timing: Fall & Spring, periods 1-6
Objective: The aim is to familiarize the students to the diploma work requirements. The students get practice in preparing and giving an oral presentation. At the same time they learn about current research and development projects going on in the university and in the industry.

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

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

Mode of delivery: Seminar presentations

Learning activities and teaching methods: Seminar sessions when necessary during the whole year.

Target group: 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: None

Recommended optional programme components: No

Study materials: Instructions for preparing a diploma work in the Department

Assessment methods and criteria: The student is required to participate in at least 4 seminars. In one of those, the student has to give an oral presentation of his/her diploma work. Presentations are given in English. Seminars are given during the whole year when necessary.

Grading: The course unit utilizes grading passed.

Person responsible: Jari Iinatti

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2. Studies of Advanced Module

521377S Communication Networks II

Tietoliikenneverkot II

ECTS credits: 7

Language of instruction: English

Timing: Spring, periods 4-6

Objective: The aim is to help the student to understand the basic principles of networking by providing a balance between the description of existing networks and the development of analytical tools. The descriptive material is used to illustrate the underlying concepts, and the analytical material is used to generate a deeper and more precise understanding of the concepts. The course presents the basic principles of queuing theory giving mathematical tools to apply the theory to practical communication systems.

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

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

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 30 h, exercises 30 h and the compulsory design work with a simulation program (15 h).

Target group: 1st year M.Sc. and WCE students.
Prerequisites and co-requisites: Communication Networks I


Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. The final grade is based on examination.

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

Person responsible: Savo Glisic

521375S  Radio Engineering II
Radiotekniikka II

ECTS credits: 5

Language of instruction: English

Timing: Spring, periods 4-6

Objective: 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 transceiver and can explain the principle of a transceiver. She/he can classify different architectures used in transceivers and understand the basis for them. The student can define parameters used in the transceiver system level design and can design a transceiver at the system level so that the requirements for the system are fulfilled. She/he can explain nonlinear distortion and can design the automatic gain control in the system level. The student can also explain factors, which are important for the selection of D/A- and A/D-converters. She/he can derive various methods to create the in phase and the quadrature components of a signal. The student can also explain the principles of frequency synthesis in a transceiver.

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.

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 30 h, exercises 24 h. Design exercise with ADS simulation software. 18 h during period 3.

Target group: 1st and 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: Radio Engineering I


Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Course will be given every second year in even years.

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

Person responsible: Risto Vuoltoniemi

521317S  Wireless Communications II
Langaton tietoliikenne II

ECTS credits: 8

Language of instruction: English

Timing: Spring, periods 4-6
Objective: Target is to deepen the understanding of the fundamental transmission concepts used in broadband wireless and in particular mobile 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.

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 45 h, exercises 25 h and the compulsory design work with a simulation program (25 h)

Target group: 1st and 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: Wireless Communications II


Assessment methods and criteria: The course is passed with a final examination and the accepted simulation work report. The final grade based on exam. Course will be given every second year in odd years.

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

Person responsible: Antti Tölli

521360S Communication Signal Processing II

Tietoliikennesignaalinkäsittely II

ECTS credits: 4

Language of instruction: English

Timing: Fall, periods 2-3

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

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

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

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 20 h and exercises 25 h out of which some are Matlab based problems.

Target group: 1st and 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: Statistical Signal Processing, Wireless Communications II.
**Recommended optional programme components**: Recommended: Communication Signal Processing I


**Assessment methods and criteria**: The course is passed with final examination and by solving homework problems. Grade is based on exam. Course will be given every second year in odd years.

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

**Person responsible**: Markku Juntti

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**521380S Antennas**

**Antennit**

**ECTS credits**: 4

**Language of instruction**: English

**Timing**: Spring 2014, periods 4-6

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

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


**Mode of delivery**: Face-to-face teaching

**Learning activities and teaching methods**: Lectures 24 h, exercises 16 h and the compulsory antenna design work with an electromagnetic simulation program (14 h).

**Target group**: 1st and 2nd year M.Sc. and WCE students

**Prerequisites and co-requisites**: Basics of Radio Engineering


**Assessment methods and criteria**: The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25. Course will be given every second year in even years.

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

**Person responsible**: Markus Berg

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**521386S Radio Channels**

**Radiokanavat**

**ECTS credits**: 5
**Language of instruction:** English

**Timing:** Spring 2015, periods 4-6

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

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


**Mode of delivery:** Face-to-face teaching

**Learning activities and teaching methods:** Lectures 26 h and exercises 20 h

**Target group:** 1st and 2nd year M.Sc. and WCE students

**Prerequisites and co-requisites:** Basics of Radio Engineering, Signal Analysis

**Recommended optional programme components:** No


**Assessment methods and criteria:** The course is passed with a final examination and the accepted simulation work report. Course will be given every second year in odd years.

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

**Person responsible:** Markus Berg

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3. Studies of Optional Module (Elective Studies)

**521318S Modern Topics in Telecommunications and Radio Engineering**

**Tietoliikenne- ja radiotekniikan ajankohtaisia aiheita**

**ECTS credits:** 3-7

**Language of instruction:** English

**Timing:** Fall & Spring, periods 1-6
Objective: Depending on each year’s topic, the course gives either an overview or deepens knowledge of actual topics and applications on radio techniques and telecommunications. The course comprises varying topical subjects, applications, research areas. Depending on the subject, the course may comprise a seminar of essays that practices a student for spontaneously acquiring information, improves readiness for making a master’s thesis and readiness for performing in front of an audience.

**Learning outcomes:** After completing the course the student understand and is able to analyze basic principles of the topic which has been presented in the course. The final outcomes will be defined based on the contents.

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

**Mode of delivery:** Face-to-face teaching

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

**Target group:** 1st and 2nd year M.Sc. and WCE students

**Prerequisites and co-requisites:** Will be defined based on the contents.

**Study materials:** Will be defined in the beginning of the course.

**Assessment methods and criteria:** Depends on the working methods.

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

**Person responsible:** Matti Latva-aho

**521225S RF Components and Measurements**

**RF komponentit ja mittaukset**

**ECTS credits:** 5

**Language of instruction:** Finnish. English, if there are at least 3 international students in class.

**Timing:** Fall, periods 1-3

**Learning outcomes:** After completing the course the student has knowledge of the behavior of passive components at RF frequencies, knows the fabrication methods of components and is also able to apply the knowledge to practical applications. The student also knows the operating principles of transfer lines, antennas and filters and of their design. The student can apply the fundamentals of RF and microwave techniques to measurements, is able to make the measurements of RF components, has knowledge of the operating principles of RF region measurement equipment and is able to compare the usability of different measurement techniques in different measurement situations. In addition the student knows how to perform typical measurements of RF region magnitudes (power, frequency, impedance and noise).

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

**Mode of delivery:** Face-to-face teaching, independent design exercises

**Learning activities and teaching methods:** Lectures 24h/calculation exercises 12h/laboratory exercises 12h/design exercises 12h

**Target group:** 1st and 2nd year M.Sc. and WCE students

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


**Assessment methods and criteria:** Final exam and design exercises. Read more about assessment criteria at the University of Oulu webpage.
Grading: The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible: Jari Hannu and Matti Kinnunen

521443S  Electronics Design II
Elektriikkasuunnittelu II

ECTS credits: 5
Language of instruction: Finnish/English
Timing: Fall, periods 1-2

Learning outcomes: On completion of the study module students should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies, analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits, and estimate and minimize the effects of noise on these. They should also be able to explain the terminology used with DA and AD conversion and converters and to analyze and outline their main architectural principles and also to evaluate their characteristics.

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

Mode of delivery: Face-to-face teaching

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

Target group: 1st and 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: Principles of electronics design, Electronics design I


Assessment methods and criteria: The course unit is passed by a final exam and a passed design work.

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

Person responsible: Juha Kostamovaara

521433A  Laboratory Exercises on Analogue Electronics
Analogiatekniikan työt

ECTS credits: 3
Language of instruction: English/Finnish
Timing: Fall & Spring, periods 1-6

Objective: Design exercises to deepen the understanding of the material presented in Principles of Electronics Design and Analogue Electronics I.

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

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

Mode of delivery: A design work supervised by a course instructor

Learning activities and teaching methods:
Target group: 1st and 2nd year M.Sc. and WCE students

Prerequisites and co-requisites: Student must participate to courses Principles of Electronics Design and Electronics Design I, or he/she must have passed these courses of similar to those courses earlier.

Assessment methods and criteria: Teacher accepts student’s design work and measurement results in laboratory.

Grading: The course unit utilizes verbal grading scale pass or fail

Person responsible: Kari Määttä

521273S  Biosignal Processing
Biosignalinkäsittely

ECTS credits: 5

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

Timing: Fall, periods 2-3.

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


Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 10 hours (5 times 2 hours) and laboratory work 20 hours (10 times 2 hours), written exam.

Prerequisites and co-requisites: The basic engineering math courses, digital filtering, programming skills.

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

Supportive reading: 

Assessment methods and criteria: Laboratory work is supervised by assistants who also check that the task assignments are completed properly. The course ends with a written exam.

Grading: Numerical grading of the accepted exam is in the range 1-5.

Person responsible: Tapio Seppänen

521478S  Digital Video Processing
Digitaalinen videon käsitteley

ECTS credits: 5

Language of instruction: English

Timing: Fall, periods 2-3.

Objective: In this course students become familiar with basics of video processing and communications. The emphasis is in video representation and coding.

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


**Mode of delivery**: Face-to-face teaching

**Learning activities and teaching methods**: Lectures (24 h), exercises (10 h) and Matlab design exercise (10 h).

**Prerequisites and co-requisites**: Digital Image Processing, Digital Filters.

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

**Assessment methods and criteria**: The course is passed with final exam and accepted Matlab exercise.

**Grading**: Numerical grading scale 1-5.

**Person responsible**: Janne Heikkilä
Objective: The aim of the course is to provide advanced knowledge of multimedia technologies, and apply them in designing and implementing a multimedia system.

Learning outcomes: 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 systems, applications and services.

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

Mode of delivery: Lectures, course exercise with supervision and seminars.

Learning activities and teaching methods: Lectures (20 h) and course exercise (40 h), rest is independent work. Course is passed with final examination and accepted course exercise. Additional points to exam can be gained from two group exams. Course exercise is graded as part of the total grade. Course materials and group work instructions are available at OPTIMA. More information:

http://www.ee.oulu.fi/research/tklab/courses/521488S/

Target group: 4th and 5th year M.Sc. level students.

Prerequisites and co-requisites: Recommended courses include basic courses in computer science and mathematics, Operating systems (521453A), Digital Image Processing (521467S), Computer networks I and II (521261A and 521262S) and Software Engineering (521457A)


Assessment methods and criteria: Final exam, accepted course exercise.

Grading: Numerical grading scale 1-5.

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

Mode of delivery: Lectures, independent work, group work.

Learning activities and teaching methods: The course consists of lectures (30 h) and design exercises.

Prerequisites and co-requisites: 521337A Digital Filters, 521267A Computer Engineering

Study materials: Lecture notes and exercise materials. Material is in English.

Assessment methods and criteria: Final exam and approved design exercises.

Grading: Numerical grading scale 1-5.

Person responsible: Jari Hannuksela
entities and match the processor performance and the application requirements. The student applies the TTA codesign environment and Altera's FPGA tools to synthesize a system.

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

Mode of delivery: Lectures, independent work, group work

Learning activities and teaching methods: Lectures 12h (participation mandatory). Instructed labs 12h. Independent work 111h.

Target group: This is an advanced-level course intended for masters-level students and post-graduate students, especially to those who are specializing into signal processing.

Prerequisites and co-requisites: 521267A Computer engineering, 521337A digital filters, programming skills

Study materials: Handouts

Assessment methods and criteria: Participation in mandatory classes and approved project work.

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

Person responsible: Jani Boutellier
521266S  Distributed Systems
Hajautetut järjestelmät

ECTS credits: 6
Language of instruction: English.
Timing: Spring, periods 4-5.
Objective: The course provides introduction to the key principles of distributed systems and their application in major design paradigms of 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 web-based systems, distributed coordination-based systems.

Mode of delivery: Face-to-face teaching.

Learning activities and teaching methods: Lectures 30 h / exercises 26 h / project work 50 h / self-study 54 h. Project work is completed as group work.

Target group: M.Sc. students (computer science and engineering).


Assessment methods and criteria: The course uses continuous assessment so that there are 3 intermediate exams. Alternatively, the course can also be passed with a final exam. The course includes a mandatory project work.

Grading: The course uses numerical scale 1-5.

Person responsible: Timo Ojala.

521466S  Machine Vision
Konenäkö

ECTS credits: 5
Language of instruction: English
Timing: Spring, periods 5-6

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


Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures (30 h), exercises (15 h) and Matlab design exercise (10 h).

Prerequisites and co-requisites: Digital Image Processing

Supportive reading: 

Assessment methods and criteria: The course is passed with final exam and accepted Matlab exercise.

Grading: Numerical grading scale 1-5.

Person responsible: Janne Heikkilä

521147S Mobile and Social Computing
Mobiili- ja sosiaalinen laskenta

ECTS credits: 5

Language of instruction: English

Timing: Spring, periods 4-5

Objective: To give students an overview of the mobile social application domain, conceptualize the fundamental aspects of this domain, and provide practical experience in building such applications.

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

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

Mode of delivery: Face to face teaching

Learning activities and teaching methods: Lectures, exercises, and practical work. The course is passed with an approved practical work. The implementation is fully English.

Recommended optional programme components: No prior courses are required.

Study materials: All necessary material will be provided by the instructor.

Assessment methods and criteria: The assessment is project-based. Students have to complete two group-based activities throughout the semester: build a mobile application (50%), build an online social application (50%). Passing criteria: both elements (mobile application, social application) must be completed, each receiving more than 50% of the available points.

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

Person responsible: Vassilis Kostakos

521497S Pattern Recognition and Neural Networks
Hahmontunnistus ja neuroverkot

ECTS credits: 5

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

Timing: Spring, periods 5-6.

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

Mode of delivery: Face-to-face teaching

Learning activities and teaching methods: Lectures 10 hours (5 times 2 hours) and laboratory work 20 hours (10 times 2 hours), written exam.

Prerequisites and co-requisites: The basic engineering math courses, programming skills.


Assessment methods and criteria: Programming work and calculation exercises are supervised by assistants who also check that the task assignments are completed properly. The course has a written exam.

Grading: Numerical grading of the accepted exam is in the range 1-5.

Person responsible: Tapio Seppänen

521260S Programmable Web Project

Ohjelmoitava web

ECTS credits: 5

Language of instruction: English

Timing: Spring, periods 4-6

Objective: The objective of the course is to supply the student with basic understanding of RESTful Web Services and related technologies.

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

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

Mode of delivery: web-based teaching + face-to-face teaching

Learning activities and teaching methods: Lectures 6 h / Laboratory work 15 h / The rest as self-study and group work. Each group implements programs and writes a report.

Target group: M.Sc. level students of Computer Science and Engineering; other students are accepted if there is space in the classes.

Prerequisites and co-requisites: Elementary programming

Recommended optional programme components:

Study materials: Will be announced at the first lecture

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

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

Person responsible: Jukka Riekki

521479S Software Project

Ohjelmistoprojekti

ECTS Credits: 7

Language of Instruction: Finnish/English, material available in English

Timing: Spring, periods 4-6
Learning outcomes: After completing the course, students have demonstrated their capabilities to design, develop and test real-life software. Further, they have shown their proficiency in professionally documenting their work during the assignment.

Contents: Phases of software engineering process: requirement gathering, analysis, design, implementation, testing, (maintenance). Project-work, starting a project, project management, working with external parties, project documentation. Project related implementation techniques and tools, software documentation.

Mode of delivery: Working methods: The course is done in groups of 3-4 students. The clients are typically various companies and societies. Project progress is supervised in formal reviews, where the project teams present their work as it reaches the milestones: the software requirement specification, the project plan, the software design specification, an operational prototype demonstration, the test documentation, and finally the functional software demonstration and release. In addition to formal reviews the project work is coordinated with steering group meetings. The work environment and development tools vary between projects. The number of students that can attend the course is limited.

Prerequisites and co-requisites: 521457A Software Engineering, 521453A Operating Systems, 521482A Programming Exercise and varying project related background reading.


Assessment methods and criteria: Lectures 10 h, design project in period 4-6 180 h. Project work and documentation.

Grading: Numerical grading scale 0-5. 0 means failed performance.

Person responsible: Juha Röning

521280S  DSP-laboratory Work
DSP-työt

ECTS credits: 5

Language of instruction: English

Timing: Periods 2-6 (from November to May)

Objective: 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 designing, implementing and testing signal processing algorithms.

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

Mode of delivery: Starting lectures and independent exercises

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

Target group: Students interested in signal processing, processor architectures, embedded systems programming.

Prerequisites and co-requisites: Digital filters, computer engineering, programming skills.

Recommended optional programme components: Signal processing systems

Study materials: Exercise instruction booklet, processor handbooks and development environment handbooks. All material is in English.

Assessment methods and criteria: The exercises will be passed or failed according to the functionality and overall quality.

Grading: Numerical grading scale 1-5; zero stands for a fail.
Person responsible: Miguel Bordallo López

900017Y  Survival Finnish Course  
   Suomen kielen johdantokurssi

ECTS credits: 2
Proficiency level: A1, according to the Common European Framework
Required proficiency level: No previous Finnish studies.
Timing: The course is offered in autumn terms and spring terms.
Learning outcomes: By the end of the course the student can understand and use some very common everyday expressions and phrases, and s/he can locate informational content in simple texts and messages. The student also knows the basic characteristics of Finnish language and Finnish communication styles.

Contents: This is an introductory course which aims to help students to cope with the most common everyday situations in Finnish. During the course, students learn some useful everyday phrases, some general features of the vocabulary and grammar, and the main principles of pronunciation.

The topics and communicative situations covered in the course are: general information about the Finnish language, some politeness phrases (how to greet people, thank and apologize), introducing oneself, giving and asking for basic personal information, numbers, some time expressions (how to tell and ask the time, days of the week, time of day), food, drink and asking about prices.

The structures studied are: personal pronouns and their possessive forms, forming affirmative, negative and interrogative sentences, the conjugation of some verbs, the basics of the partitive singular and some local cases for answering the ‘where’-question.

Working methods: Lessons twice a week (24 h) and self study (26 h).
Target group: International degree and post-graduate degree students of the University.
Study materials: Will be provided during the course.
Accessment methods: Regular and active participation in the weekly lessons (twice a week), homework assignments and written exam at the end of the course will be observed in assessment.
Grading: Grading scale is 1-5.
Contact teacher: Marja Pohjola-Effe
Other information: Sign-up in WebOodi or by emailing the teacher. The lessons will be held twice a week during a 6-week period. Exact times and room will be informed on the page: http://webcgi.oulu.fi/kielikeskus/index.php?a=oe&s=fffCourses.html&v=fff
Teaching language: Finnish and English

900013Y  Beginners' Finnish Course 1  
   Suomen kielen peruskurssi 1

ECTS credits: 2
Proficiency level: A1, according to the Common European Framework
Required proficiency level: Completion of the Survival Finnish course (900017Y) or the equivalent language skills.
Timing: The course is offered in autumn terms and spring terms.
Learning outcomes: By the end of the course the student can understand and use some familiar and common everyday expressions relating to her/himself and everyday situations. S/he can interact in a simple way provided the other person talks slowly and clearly and is willing to help. The student is able to read short simple texts and messages dealing with familiar topics. S/he also deepens her/his understanding of the Finnish language and communication styles.
Contents: This is a lower elementary course which aims to help students to learn communication skills in ordinary everyday situations. During the course, students broaden their vocabulary and knowledge of grammar and principles of pronunciation. They also practise to understand easy Finnish talk about everyday subjects, and reading and writing short and simple texts/messages.

The topics and communicative situations covered in the course are: talking about oneself, one’s family, studies and daily routines, as well as asking about these things from other person, expressing opinions, describing people and things, talking about weather and seasons, the names of the months and colours.

The structures studied are: verb types, basics of the change of the consonants k, p and t in verbs and nouns, the genitive and partitive cases, possessive structure, some declension types for nouns (word types) and the basics of the local cases.

Working methods: Lessons twice a week (26 h) and self study (24 h).

Target group: International degree and post-graduate degree students of the University.

Study materials: Gehring, S. & Heinzmann, S.: Suomen mestari 1 (chapters 3–5)

Assessment methods: Regular and active participation in the weekly lessons (twice a week), homework assignments and written exam at the end of the course will be observed in assessment.

Grading: Grading scale is 1-5.

Other information: Sign-up in WebOodi or by emailing the teacher. The course will start right after the Survival Finnish course. The lessons will be held twice a week during a 6-week period. Exact times and room will be informed on the page: http://webcgi.oulu.fi/kielikeskus/index.php?a=oe&s=fflCourses.html&v=ffl

Contact teacher: Marja Pohjola-Effe

Teaching language: As much Finnish as possible; English will be used as a help language.

900053Y Beginners' Finnish Course 2
Suomen kielen peruskurssi 2

ECTS credits: 4

Proficiency level: A2, according to the Common European Framework

Required proficiency level: Completion of the Beginners' Finnish course 1 (900013Y) or the equivalent language skills.

Timing: The course is offered in spring terms.

Learning outcomes: By the end of the course the student can understand and use some very common everyday expressions and sentences. S/he can communicate in easy and routine tasks requiring a simple and direct exchange of information on familiar everyday matters. The student understands different kinds of short texts. S/he can for example locate important information in them. In addition, s/he has acquired more detailed knowledge of the language and culture.

Contents: This is a post-elementary course. During the course students learn more about communication in ordinary everyday situations in Finnish. They also extend their vocabulary and knowledge of grammar. Students practise understanding simple Finnish talk and short texts.

The topics and communicative situations covered in the course are: asking for and giving directions, asking for help/favours, carrying out transactions in shops and restaurants, making appointments, talking about the past, asking for and expressing opinions and feelings, accommodation, travelling, vehicles, work, professions, food, drink and parties.

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

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

Target group: International degree and post-graduate degree students of the University.

Study material: Gehring, S. & Heinzmann, S.: Suomen mestari 1 (chapters 6–9)
Assessment methods: Regular and active participation in the weekly lessons (twice a week), homework assignments and written midterm and final exams will be observed in assessment.

Grading: Grading scale is 1-5.

Other information: Sign-up in WebOodi or by emailing the contact teacher. The lessons will be held twice a week during a 13-week period. Exact times and room will be informed on the page: http://webcgi.oulu.fi/kielikeskus/index.php?a=oe&s=fffCourses.html&v=fff

Contact teacher: Marja Pohjola-Effe

Teaching language: As much Finnish as possible; English will be used as a help language.

4. Other Obligatory Studies

521016A Advanced Practical Training
Syventävä harjoittelu

ECTS credits: 3

Language of instruction: English/Finnish

Timing: Recommended timing between first and second study year of M.Sc. studies

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.

Objectives: 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 activities and teaching methods: At least two months of full-time training in industry or research laboratory. The students acquire their training job themselves.

Target group: 1st and 2nd year M.Sc. and WCE students

Assessment methods and criteria: Training report including cover/front page must be submitted to training coordinator Jukka Lahti. Instructions to prepare training report can be found from: http://www.ee.oulu.fi/En/Students/InternationalStudents/TrainingReport

Grading: Accepted/rejected

Person responsible: Jukka Lahti