Opasraportti

ITEE - Courses in English for exchange students (2018 - 2019)

Courses in English for exchange students at the Faculty of Information Technology and Electrical Engineering (ITEE)

This Course Catalogue lists courses taught in English that are available for exchange students at ITEE during academic year 2018-19.

When preparing your study plan, please use the information provided under the **Courses** tab in this catalogue. Read carefully the information of each course you wish to take (e.g. timing, target group, course content, required exams and assignments, preceding studies, additional information etc.).

Please note that if you wish to take courses offered by other faculties, you should contact the appropriate coordinator.

The available Finnish language courses

For information about the exchange application process please see www.oulu.fi/university/studentexchange. All exchange applicants must submit their exchange application through SoleMOVE by the deadline given, proposed study plan is attached to the on-line application.

Accepted exchange students are required to register to all courses. Course registration takes place once you have received your University of Oulu login information, this takes place close to the start of your exchange period. When registering you will be able to find detailed information on teaching and schedule under **Instruction** tab.

Teaching periods for 2018-19
Autumn term 2018
Period 1: Sept 3 - Oct 26, 2018
Period 2: Oct 29 – Dec 21, 2018

Spring term 2019
Period 3: Jan 7 – March 8, 2019
Period 4: March 11 – May 10, 2019

For arrival and orientation dates see www.oulu.fi/university/studentexchange/academic-calender

Further information on application process and services for incoming exchange students:

www.oulu.fi/university/studentexchange

international.office(at)oulu.fi

Faculty of Information Technology and Electrical Engineering information: http://www.oulu.fi/eeng/node/12575

- Communications Engineering: http://www.oulu.fi/dce/
- Computer Science and Engineering: http://www.oulu.fi/cse
- Electrical Engineering: http://www.oulu.fi/eeng/
- Information Processing Science: http://www.oulu.fi/ips/

Any questions on courses at ITEE should be addressed to: *international.itee@oulu.fi*:

Virpi Parkkila

Heli Alatalo

Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

521285S: Affective Computing, 5 op
521281S: Application Specific Signal Processors, 5 op
521151A: Applied Computing Project I, 10 op
521152S: Applied Computing Project II, 10 op
521495A: Artificial Intelligence, 5 op
811395A: Basics of Databases, 5 op
521283S: Big Data Processing and Applications, 5 op
521284S: Biomedical Engineering Project, 5 op
521093S: Biomedical Instrumentation, 5 op
521240S: Biophotonics and Biomedical Optics, 5 op
521273S: Biosignal Processing I, 5 op
521282S: Biosignal Processing II, 5 op
521316S: Broadband Communications Systems, 5 op
813316A: Business Process Modeling, 5 op
521324S: Communication Signal Processing I, 5 op
521325S: Communication Signal Processing II, 5 op
521340S: Communications Networks I, 5 op
521377S: Communications Networks II, 7 op
521140S: Computer Graphics, 5 op
521155S: Computer Security, 5 op
521467A: Digital Image Processing, 5 op
521290S: Distributed Systems, 5 op
521073S: Electroceramics and Intelligent Materials, 5 op
521405A: Electronic System Design, 5 op
521401S: Electronics Design II, 6 op
521321S: Elements of Information Theory and Coding, 5 op
815303A: Embedded Software Development Environments, 5 op
813626S: Emerging Technologies and Issues, 5 op
811600S: Emerging Trends in Software Engineering, 5 op
812351A: Enterprise Systems, 5 op
521145A: Human-Computer Interaction, 5 op
812651S: ICT and Behaviour Change, 5 op
817604S: ICT and Organizational Change, 5 op
813625S: Information Systems Theory, 5 op
812331A: Interaction Design, 5 op
521043S: Internet of Things, 5 op
521242A: Introduction to Biomedical Engineering, 5 op
031025A: Introduction to Optimization, 5 op
521157A: Introduction to Social Network Analysis, 5 op
521289S: Machine Learning, 5 op
521096S: Measurement Systems, 5 op
521074S: Microelectronics and Micromechanics, 5 op
521215S: Microelectronics project, 5 op
521072S: Microsensors, 5 op
521045S: Mobile Computing, 5 op

521385S: Mobile Telecommunication Systems, 5 op
521161S: Multi-Modal Data Fusion, 5 op
521288S: Multiprocessor Programming, 5 op
521158S: Natural Language Processing and Text Mining, 5 op
815657S: Open Source Software Development, 5 op
521094S: Optoelectronic Sensors of Future, 5 op
521159P: Principles of Digital Fabrication, 5 op
521089S: Printed Electronics, 5 op
521386S: Radio Channels, 5 op
521326S: Radio Engineering 1, 5 op
521327S: Radio Engineering II, 6 op
815305A: Real Time Distributed Software Development, 5 op
813621S: Research Methods, 5 op
521124S: Sensors and Measuring Techniques, 5 op
521279S: Signal Processing Systems, 5 op
521044A: Social Computing, 5 op
813620S: Software Business Management, 5 op
815662S: Software Engineering Management, Measurement and Improvement, 5 op
815663S: Software Engineering Research, 5 op
817614S: Software Factory Project, 10 op
815312A: Software Production and Maintenance, 5 op
521479S: Software Project, 7 op
815311A: Software Quality and Testing, 5 op
521348S: Statistical Signal Processing, 5 op
817603S: System Design Methods for Information Systems, 5 op
521156S: Towards Data Mining, 5 op
521154S: UBISS - International UBI Summer School, 5 op
521148S: Ubiquitous Computing Fundamentals, 5 op
812671S: Usability Testing, 5 op
521323S: Wireless Communications I, 5 op
521097S: Wireless Measurements, 5 op
521080S: X-ray Diffraction, 5 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

521285S: Affective Computing, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Guoying Zhao
Opintokohteen kielet: English

ECTS Credits:
5 ECTS cr
Language of instruction:
English
Timing:
Fall, periods 1

Learning outcomes:
After completing the course, student
1. is able to explain the emotion theory and modeling
2. is able to implement algorithms for emotion recognition from visual and audio signals or the fusion of multi-modalities
3. has the ideas of wide applications of affective computing
Contents:
The history and evolution of affective computing; psychological study about emotion theory and modeling; emotion recognition from different modalities: facial expression, speech, EEG; crowdsourcing study; synthesis of emotional behaviors; emotion applications.
Mode of delivery:
Face to face teaching
Learning activities and teaching methods:
The course consists of lectures and exercises. The final grade is based on the points from exam while there are several mandatory exercises.
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.
Prerequisites and co-requisites:
A prior programming knowledge, possibly the bachelor level mathematical studies and/or some lower level intermediate studies (e.g. computer engineering or artificial intelligence courses). The recommended optional studies include the advanced level studies e.g. the pattern recognition and neural networks and/or computer vision courses.
Recommended optional programme components:
-
Recommended or required reading:
All necessary material will be provided by the instructor.
Assessment methods and criteria:
The assessment of the course is based on the exam (100%) with mandatory exercises.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5; zero stands for a fail.
Person responsible:
Guoying Zhao, Henglin Shi, Yante Li
Working life cooperation:
-

521281S: Application Specific Signal Processors, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Olli Silven

Opintokohteen kielet: English

ECTS Credits:
5 ECTS cr
Language of instruction:
In English.
Timing:
Autumn, period 1.
Learning outcomes:
After completing the course, student
1. Can distinguish the main types of signal processors

2. Can design basic customized transport triggered architecture processors

3. Is capable of assembling a signal processor out of basic entities

4. Can match the processor performance and the application requirements

5. Applies the TTA codesign environment and Altera's FPGA tools to synthesize a system
Contents:
Examples of modern signal processing applications, main types of signal processors, parallel signal processing, transport triggered architectures, algorithm-architecture matching, TCE design environment and Altera FPGA tools.
Mode of delivery:
Lectures, independent work, group work.
Learning activities and teaching methods:
Lectures 12h (participation mandatory); Instructed labs 12h. Independent work 111h
Target group:
Computer Science and Engineering students + other Students of the University of Oulu. This is an advanced-level course intended for masters-level students and post-graduate students, especially to those who are specializing into signal processing.
Prerequisites and co-requisites:
521267A Computer Engineering or 521286A Computer Systems (8 ECTS cr) or 521287A Introduction to Computer Systems (5 ECTS cr) and 521337A digital filters, programming skills
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Handouts.
Assessment methods and criteria:
Participation in mandatory classes and approved project work.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5; zero stands for a fail.
Person responsible:
Mehdi Safarpour
Working life cooperation:
No.

521151A: Applied Computing Project I, 10 op

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Denzil Teixeira Ferreira, Matti Pouke

Opintokohteen kielet: English

Leikkaavuudet:

521041A	Applied Computing Project I	8.0 op

ECTS Credits:
10 ECTS cr
Language of instruction:
In English.
Timing:
Autumn and spring, periods 1-4.
Learning outcomes:
1. has basic understanding on how to collaboratively design a small-scale software project,

2. has basic understanding on how to implement and evaluate a small-scale software project,

3. is able to extensively document a small-scale software project,

4. is able to present and "pitch" a project work, i.e. give a good, concise presentation of the work
Contents:
Project work that is typically executed in groups of 3-5 students. Note: the project work cannot be done alone.
Mode of delivery:

3-4 lectures to introduce and conclude the course and project works, collaborative project work for a "client" (teaching assistants and/or industry representatives)
Learning activities and teaching methods:
Practical work in project teams. The course is passed with an approved project work. The implementation is fully in English.
Target group:
3rd year Computer Science and Engineering B.Sc. students and other Students of the University of Oulu.
Prerequisites and co-requisites:
While no specific courses are not required, elementary programming and design skills are desired.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
For additional reading (not mandatory): Dix, Finlay, Abowd & Beale: Human-Computer Interaction (http://www.hcibook.com); Rogers, Sharp & Preece: Interaction Design: Beyond Human-Computer Interaction (http://www.id-book.com).
Assessment methods and criteria:
The course uses continuous assessment so that the project work is assessed in stages: design (20% of total grade), implementation (40%), evaluation (20%), and final report (20%). Passing criteria: all stages (design, implementation, evaluation, report) must be completed with an approved grade. Read more about assessment criteria at the University of Oulu webpage.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5; zero stands for a fail.
Person responsible:
Matti Pouke, Denzil Ferreira
Working life cooperation:
No
Other information:
-

521152S: Applied Computing Project II, 10 op

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Simo Hosio

Opintokohteen kielet: English

ECTS Credits:
10 ECTS cr
Language of instruction:
English.
Timing:
Autumn and Spring, periods 1-4.
Learning outcomes:
1. has advanced understanding on how to collaboratively design a medium-scale software project,

2. has advanced understanding on how to implement and evaluate a medium-scale software project,

3. is able to extensively document a medium-scale software project,

4. has advanced skills in presenting and pitching a project work, i.e. give a good, concise presentation of the work,
Contents:
Project work that is typically executed in groups of 3-5 students. Note: the project work cannot be done alone.
Mode of delivery:
3-4 lectures to introduce and conclude the course and project works, collaborative project work for a "client" (teaching assistants and/or industry representatives).
Learning activities and teaching methods:

Practical work in project teams. The course is passed with an approved project work. The implementation is fully in English.
Target group:
Computer Science and Engineering MSc students and other Students of the University of Oulu.
Prerequisites and co-requisites:
While no specific courses are not required, programming and design skills are desired.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
For additional reading (not mandatory): Dix, Finlay, Abowd & Beale: Human-Computer Interaction (http://www.hcibook.com); Rogers, Sharp & Preece: Interaction Design: Beyond Human-Computer Interaction (http://www.id-book.com).
Assessment methods and criteria:
The course uses continuous assessment so that the project work is assessed in stages: design (20% of total grade), implementation (40%), evaluation (20%), and final report (20%). Passing criteria: all stages (design, implementation, evaluation, report) must be completed with an approved grade.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5; zero stands for a fail.
Person responsible:
Simo Hosio
Working life cooperation:
No

521495A: Artificial Intelligence, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Abdenour Hadid

Opintokohteen kielet: English

Leikkaavuudet:

ay521495A	Artificial Intellig (OPEN UNI)	5.0 op

ECTS Credits:
5 ECTS cr
Language of instruction:
English
Timing:
Period 3.
Learning outcomes:
1. is able to identify the types of problems that can be solved using methods of artificial intelligence.
2. knows the basic concepts of intelligent agents, the common search methods used in artificial intelligence, logic based reasoning and applying planning techniques to problems of artificial intelligence.
3. can also apply simple methods to reasoning under uncertainty and machine learning from observation.
4. In addition the student will be able to implement the most common search methods.
Contents:
1) Introduction, 2) Rational (Intelligent) Agents and Uninformed Search, 3) Informed Search, 4) Programming Project 1 (Pacman 1), 5) Adversarial Search (Games), 6) Programming Project 2 (Pacman 2), 7) Uncertainty and Utilities, 8) Markov Decision Processes, 9) Reinforcement Learning, 10) Bayesian Networks, 11) Machine Learning (learning from Observation), 12) Advanced Applications, 13) Conclusions
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
28 hours of lectures and a programming exercise (approximately 25 hours) during period 3, the rest as independent work.
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.

Prerequisites and co-requisites:
Programming skills.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
The course material is based on the Artificial Intelligence course of Berkely University and the book "Artificial Intelligence, A Modern Approach" by Russell & Norvig.
1) http://ai.berkeley.edu/home.html
2) Russell S., Norvig P.: Artificial Intelligence, A Modern Approach, Second Edition, Prentice Hall, 2003.
Assessment methods and criteria:
The course is passed with a final exam and a passed programming exercise.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5 / fail.
Person responsible:
Abdenour Hadid (Lecturer)
Mohammad Tavakolian (Assistant)
Working life cooperation:
-
Other information:
-

811395A: Basics of Databases, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Iisakka, Juha Veikko

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits / 133 hours of work.

Language of instruction:
Finnish. If at least four non-Finnish students take the course, an English exercise group will be organised.
Timing:
The course is held in the spring semester, during period 3. It is recommended to complete the course in the 1st spring semester.
Learning outcomes:
After completing the course, students will understand what the databases are and what are their relevance to information systems. They know the concept model for building databases, design a relational database with a good quality and make queries. Students understand the transactions, schedules, serialiseability and recovery options.
.
Contents:
Conceptual modelling (ER- and EER-diagrams), relational model (theory, databases, query techniques and normalization), transactions.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 45 h (in Finnish), compulsory exercises 24 h, reading 20 h, exams 21 h and self-studying 23 h.
Target group:
BSc students.

Prerequisites and co-requisites:
The student knows basics of programming.
Recommended or required reading:
Silberschatz, Korth & Sudarshan: Database system concepts. Elmasri & Navathe: Fundamentals of database systems.

Assessment methods and criteria:
The course is divided to five parts. All parts must be passed in a year. Students must show they achieve at least half of required knowledge of each part.

Grading:
Numerical scale 1-5 or fail.
Person responsible:
Juha Iisakka

521283S: Big Data Processing and Applications, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ekaterina Gilman, Susanna Pirttikangas

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits
Language of instruction:
English
Timing:
Period IV. It is recommended that the course is taken on the fourth year Spring.
Learning outcomes:
Upon completion of the course, the student :

1. is able to explain the big data phenomenon, its challenges and opportunities.
2. is able to explain the requirements and common principles for data intensive systems design and implementation, and evaluate the benefits, risks and restrictions of available solutions.
3. can explain the principles of big data management and processing technologies and utilize them on a basic level.

Contents:
General introduction into big data, namely: big data fundatmenals, data storage, batch and stream data processing, data analysis, privacy and security, big data use cases.
Mode of delivery:
Face-to-face teaching, independent and group work
Learning activities and teaching methods:
Lectures, exercises, seminars, independent and group work
Target group:
M.Sc. students (computer science and engineering) and other Students of the University of Oulu
Prerequisites and co-requisites:
The Bachelor level studies of Computer science and engineering study programmes or respective knowledge.
Recommended optional programme components:
Finishing 521290S Distributed Systems, 521497S Pattern recognition and neural networks, and 521286A Computer Systems is beneficial.
Recommended or required reading:
Lecture slides and exercise material will be provided. Each lecture will include the refernce list for recommended reading. Instructions to necessary installations will be given.
Assessment methods and criteria:
This course assesses students continuously by the completion of exercises, seminar presentations and short reports on a selected topic (group work), and answering two quizzes during the course. To pass the course, it is enough to get 50% of available points. No exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Ekaterina Gilman
Working life cooperation:
The course includes also invited lectures from industry.

521284S: Biomedical Engineering Project, 5 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Tapio Seppänen
Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits
Language of instruction:
English.
Timing:
As part of the master level studies, in any period suitable to the student.
Learning outcomes:
1. has develop skills for being initiative, creativity, application of theoretical knowledge, programming and cooperation.
Contents:
A small-scale research work in an active research group. Topics will be selected from the needs of present research activities in the site of work and the interests of student. Main emphasis is on the development and application of methods and algorithms for biomedical data processing. Often the work includes programming with Matlab, C or Java languages.
Mode of delivery:
Self-study under supervision.
Learning activities and teaching methods:
First the research group is studied to get understanding of what are its goals. Detailed task description is written with the advisor. Typically, the work includes study of theoretical background information, programming, testing and simulations, and documentation. Task assignments can be applied at any time all year round.
Target group:
Master-level students that are interested in biomedical engineering. Students of the University of Oulu.
Prerequisites and co-requisites:
The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Courses such as Biosignal processing I and II, Biomedical image processing and Machine learning are recommended. Programming skills, especially the Matlab.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Literature and scientific articles depending on the task assignment.
Assessment methods and criteria:
Course assessment is based on the technical report.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Tapio Seppänen
Working life cooperation:
No

521093S: Biomedical Instrumentation, 5 op

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

Opettajat: Igor Meglinski

Opintokohteen kielet: Finnish

Leikkaavuudet:

521107S Biomedical Instrumentation 6.0 op

ECTS Credits:
5
Language of instruction:
English.
Timing:
Period 3.
Learning outcomes:
After the course the student is capable to explain principles, applications and design of medical instruments most commonly used in hospitals. He/she can describe the electrical safety aspects of medical instruments and can present the physiological effects of electric current on humans. In addition the student is able to explain medical instrumentation development process and the factors affecting it. He/she also recognizes typical measurands and measuring spans and is able to plan and design a biosignal amplifier.

Contents:
Diagnostic instruments (common theories for medical devices, measurement quantities, sensors, amplifiers and registering instruments). Bioelectrical measurements (EKG, EEG, EMG, EOG, ERG), blood pressure and flow meters, respiration studies, measurements in a clinical laboratory, introduction to medical imaging methods and instruments, ear measurements, heart pacing and defibrillators, physical therapy devices, intensive care and operating room devices and electrical safety aspects.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures/exercises 42 h and self-study 100 h.
Target group:
Students interested in biomedical measurements.
Prerequisites and co-requisites:
None
Recommended optional programme components:
Course replaces earlier courses Biomedical measurements and Biomedical instrumentation.

Recommended or required reading:
R. S. Khandpur: Biomedical Instrumentation, Technology and Applications, McGraw-Hill, 2005 and J. G. Webster: Medical Instrumentation, Application and Design, 4th edition, John Wiley & Sons, 2010.
Assessment methods and criteria:
The course is passed by the final exam or optionally with the assignments/test agreed at the first lecture.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1 - 5.
Person responsible:
Igor Meglinski
Working life cooperation:
No.

521240S: Biophotonics and Biomedical Optics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Igor Meglinski

Opintokohteen kielet: Finnish

ECTS Credits:

5
Language of instruction:
English
Timing:
Period 2
Learning outcomes:
On successful completion of the course, students will be able to categorize the basic principles of modern optical and laser-based diagnostic modalities and instruments used in advanced biomedical research and clinical medicine. They will be able to demonstrate detailed understanding and evaluate the key biophotonics techniques underlying day-to-day clinical diagnostic and therapies and industrial applications in pharmacy, health care and cosmetic products. They can operate with the selected techniques of their choice.
Contents:
The course includes in-depth coverage of state-of-the-art optical imaging and spectroscopy systems for advanced biomedical research and clinical diagnosis, fundamental properties of light such as coherence, polarization, angular momentum, details of light interaction with tissue, and modern imaging system. Coherent Optical Tomography (OCT), Laser Doppler Flowmetry, Laser Speckle Imaging (LSI), Photo-Acoustic Tomography (PAT), Tissue polarimetry; Optical and Near-Infra-Red Spectroscopy (NIRS), Confocal and Fluorescence Microscopies; Tissue Optics: Light/matter interactions, index of refraction, reflection, optical clearing, absorption, Mie scattering, Rayleigh scattering, Monte Carlo modelling.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures/exercises 42 h and self-study 100 h.
Target group:
Students interested in biomedical measurements.
Prerequisites and co-requisites:
None.
Recommended optional programme components:
A new course
Recommended or required reading:
V.V Tuchin: Handbook of Optical Biomedical Diagnostics, SPIE Press, 2002; V.V Tuchin: Handbook of Coherent Domain Optical Methods, Springer, 2nd edition, 2013. D.A Boas, C. Pitris, N. Ramanujam, Handbook of Biomedical Optics, CRC Press, 2011.
Assessment methods and criteria:
The course is passed by the final exam and with the assignments.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1 - 5
Person responsible:
Igor Meglinski
Working life cooperation:
No.

521273S: Biosignal Processing I, 5 op

Voimassaolo: 01.08.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Seppänen

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits / 50 hours of work
Language of instruction:
English. Examination can be taken in English or Finnish.
Timing:
The course unit is held in the autumn semester, during period 2. It is recommended to complete the course at the end of studies.
Learning outcomes:

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

Contents:
Biomedical signals. Digital filtering. Analysis in time-domain and frequency domain. Nonstationarity. Event detection. Signal characterization.

Mode of delivery:
Face-to-face teaching and guided laboratory work.

Learning activities and teaching methods:
Lectures 10h, Laboratory work 20h, Self-study 20h, written examination.

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

Prerequisites and co-requisites:
The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Programming skills, especially basics of the Matlab. Basic knowledge of digital signal processing.

Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading:
The course is based on selected chapters of the book "Biomedical Signal Analysis", R.M Rangayyan, 2nd edition (2015). + Lecture slides + Task assignment specific material.

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

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

Person responsible:
Tapio Seppänen

Working life cooperation:
No.

521282S: Biosignal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jukka Kortelainen

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
5 ECTS cr

Language of instruction:
Lectures and laboratory works are given in English. The examination can be taken in Finnish or English.

Timing:
Period 4

Learning outcomes:
After completing the course, student
1. knows the special characteristics of neural signals and the typical signal processing methods related to them

2. can solve advanced problems related to the neural signal analysis

Contents:
Introduction to neural signals, artifact removal, anesthesia and natural sleep, topographic analysis and source localization, epilepsy, evoked potentials.

Mode of delivery:

Face-to-face teaching
Learning activities and teaching methods:
Lectures (8 h) and laboratory work (20 h), written exam.
Target group:
Engineering students, medical and wellness technology students, and other students interested in biomedical engineering. Students of the University of Oulu.
Prerequisites and co-requisites:
The basic engineering math courses, digital filtering, programming skills, Biosignal Processing I.
Recommended optional programme components:
-
Recommended or required reading:
The course is based on selected parts from books "EEG Signal Processing", S. Sanei and J. A. Chambers, "Bioelectrical Signal Processing in Cardiac and Neurological Applications", L. Sörnmo and P. Laguna, and "Neural Engineering", B. He (ed.) as well as lecture slides and task assignment specific material.
Assessment methods and criteria:
Laboratory work is supervised by the assistants who will also check that the task assignments are completed properly. The course ends with a written exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading of the accepted exam is in the range 1-5.
Person responsible:
Jukka Kortelainen
Working life cooperation:
-

521316S: Broadband Communications Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Rajatheva Rajatheva, Satya Joshi

Opintokohteen kielet: English

Leikkaavuudet:

521316A	Wireless Communications 1	4.0 op
521316A-01	Introduction to Broadband Transmission Techniques, exam	0.0 op
521316A-02	Exercise, Broadband Communication Systems	0.0 op

ECTS Credits:
5
Language of instruction:
English
Timing:
Fall, period 1
Learning outcomes:
1. Student can distinguish the basic transmission technologies used in the most important commercial wireless communication systems.

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

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

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

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

Contents:
Introduction to Detection and Estimation Theory, Performance in AWGN and flat fading channels, Fading Multipath Channels, Mobility, Propagation, Path Loss Models, Orthogonal Frequency Division Multiplexing, Wireless Systems and Standards: 3G, LTE, 5G
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Face-to-face teaching (lectures and exercises) 64 h.
Target group:
1st year WCE-RAN students and M.Sc. students (i.e., 4th year in EE degree programme)
Prerequisites and co-requisites:
Signals and Systems, Probability, Random Variables and Processes, Linear Algebra

Recommended optional programme components:
Statistical signal processing and the course support each other.
Recommended or required reading:
Parts from books Principles of Mobile Communications, G. Stuber, Springer, 2012. Detection, Estimation, and Modulation Theory, Part I, 2nd Edition by Harry L. Van Trees, Kristine L. Bell, and Zhi Tian, Wiley, 2013. Wireless Communications, A. Molisch, John Wiley & Sons, 2nd Edition, 2011. Lecture notes and other literature.
Assessment methods and criteria:
The course is passed with mid term exams (first one during lecture periods) or with final exam and possible additional course tasks defined in the beginning of the course.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Read more about assessment criteria at the University of Oulu webpage.
Person responsible:
Nandana Rajatheva
Working life cooperation:
-
Other information:
-

813316A: Business Process Modeling, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Karin Väyrynen

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English

Timing:
The course is held in the spring semester, during period 4. It is recommended to complete the course at the 3rd spring semester.
Learning outcomes:
After completing the course, students are able to model and design business processes. The student is able to use a computer-based process modeling tool. The student is able to distinguish between business process change on the enterprise level, business process level and the implementation level. The student is able to design process architecture in teamwork with other students.

Contents:
Process architecture and how it can be fitted to the organisation, process modelling, process performance measurement, understanding process-related problems, process development, software tools for modelling and analysing processes, exercises.
Mode of delivery:

Face-to-face teaching.
Learning activities and teaching methods:
Lectures 26 h (or exam), exercises 13 h, individual assignments (lecture assignments, small process model, etc.) 34 h, large process model (group work) 60 h.

Target group:
BSc students.
Recommended or required reading:
Harmon, Paul (2007). Business Process Change. A Guide for Business Managers and BPM and Six Sigma Professionals. Morgan Kaufmann Publishers. Additional material to be announced during the course.
Assessment methods and criteria:
This course unit utilizes continuous assessment. Students can either participate in the lectures (min. 85 % attendance required) or take the exam. All students will write lecture assigments, and will create a process architecture / model with a software tool. The assessment of the course unit is based on the learning outcomes of the course unit.

Grading:
Numerical scale 1-5 or fail.
Person responsible:
Karin Väyrynen.

521324S: Communication Signal Processing I, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

521373S	Statistical Signal Processing 2	6.0 op
521373S-01	Statistical Signal Processing 2, exam	0.0 op
521373S-02	Exercise work, Communication Signal Processing I	0.0 op

ECTS Credits:
5
Language of instruction:
English
Timing:
The course is held in the spring semester, during period 3. It is recommended to complete the course at the 1st spring semester of the master studies.
Learning outcomes:
Upon completion the student will

1. understand the key design problems and constraints of the design of baseband parts of a communications transceiver.
2. have the skills to apply estimation, detection and other statistical signal processing methods to communications transceiver and system design.
3. can use linear algebra, basics of optimization and statistical signal processing to derive receiver algorithms, in particular for soft output equalization/detection and receiver synchronization.
4. can use numerical analysis to approximate optimal algorithms with iterative solutions including (un) supervised adaptive algorithms.
5. understands the basic requirements for the convergence of an iterative and adaptive algorithm.
6. can model the operation of a transceiver using Matlab and other simulators to assess the performance of transceiver algorithms.

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

Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Face-face-teaching (lectures and exercises) 50h, Matlab simulation exercises in groups 30 h, independent work & passed assignment 50 h.
Target group:
Electrical, communications and computer science and engineering students.
Prerequisites and co-requisites:
The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing. The recommended prerequisite is the completition of 521323S Wireless communications I.
Recommended optional programme components:
-
Recommended or required reading:
Parts from books:
1. P. Prandoni & M. Vetterli, “Signal Processing for Communications”, CRC Press 2008.
2. K. Vasudevan, Digital Communications and Signal Processing, Universities Press (India) 2017.
3. S. Haykin, Adaptive Filter Theory, 3rd ed. or newer, Prentice Hall 1996.
4. T. Kailath, A. H. Sayed & G. Hassibi, “Linear Estimation”, Prentice Hall 2000.
5. G. H. Golub & C. F. Van Loan, Matrix computations, 3rd ed. or newer, Johns Hopkins University Press 1996.
6. H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
7. Other literature, lecture notes and material.
Assessment methods and criteria:
Continuous evaluation by solving homework problems. Completing the simulation project tasks, and a mid-term exams during the course. The mid-term exams can be retaken by a final exam later.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.
Person responsible:
Markku Juntti
Working life cooperation:
No
Other information:
-

521325S: Communication Signal Processing II, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juntti, Markku Johannes

Opintokohteen kielet: English

Leikkaavuudet:

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

ECTS Credits:
5 ECTS cr / 130 hours of work
Language of instruction:
English
Timing:
The course is held in the spring semester, during period 4. It is recommended to complete the course at the 1st spring semester of the master studies.
Learning outcomes:

Upon completion the student

1. knows the functional structure of communications transceiver and understands the requirements for various wireless systems for the transceiver.
2. knows the architectural and functional design of (all-)digital transceiver with synchronization, channel estimation, multiantenna processing and connection establishment.
3. understands the requirements of the curren wireless communications standards and related orthogonal frequency division multiplexing and multiple access on transceiver design.
4. can derive digital domain algorithms for separate functionalities and match them to operate together via agreed interfaces.
5. can model the operation of the algorithms and the whole transceiver using Matlab and C other to assess their performance by computer simulations.
6. knows how to interface the software models to the common implementation architectures.

Contents:
Wireless transceiver functional split, digital parts and architecture, multirate filtering, transceiver digital front-end architecture and design, synchronization and channel estimation, algorithm-architecture co-simulation, multiantenna transceivers.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Face-face-teaching (lectures and exercises) 25h, Simulation and design exercises in groups 80 h, independent work & passed assignment 35 h.
Target group:
Electrical, communications and computer science and engineering students.
Prerequisites and co-requisites:
The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra, 521330A Telecommunication engineering, 521348S Statistical signal processing, 521324S Communications signal processing I. The recommended prerequisite is the completition of 521323S Wireless communications I.
Recommended optional programme components:
-
Recommended or required reading:
Parts from books:
1. P. P. Vaidyanathan, S.-M. Phoong & Y.-P. Lin, Signal Processing and Optimization for Transceiver Systems, Cambridge University Press, 2010.
2. T.-D. Chiueh, P.-Y. Tsai, I.-W. Lai, Baseband Receiver Design for Wireless MIMO-OFDM Communications, 2nd ed. IEEE Wiley 2012.
3. .H. Meyr, M. Moeneclaey & S. A. Fechtel, Digital Communication Receivers: Synchronization, Channel, Estimation and Signal Processing. John Wiley, 1998.
4. Other literature, lecture notes and material.
Assessment methods and criteria:
Continuous evaluation by solving homework problems and completing the simulation projects, and a final exam. Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.

Person responsible:
Markku Juntti
Working life cooperation:
The project focuses on timely design problems in wireless industry. Industrial visiting lectures are organized.
Other information:
-

521340S: Communications Networks I, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:
5 ECTS cr
Language of instruction:
English
Timing:
Fall, period 2
Learning outcomes:

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

Contents:
Communications architecture and protocols, mobility management, network security, network management and ad hoc, wireless local area and mobile networks. Introduction to cloud computing, edge computing, network function virtualization and software defined networking. The goal is to present the fundamentals of the new communication architectures, trends and technologies accepted by academia and industry. Technical implementation and application of the common data and local networks are also discussed.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 30 h and the compulsory design work with a simulation program (15 h).
Target group:
1st year M.Sc. and WCE students
Prerequisites and co-requisites:
-
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
S. Glisic & B. Lorenzo: Wireless Networks: 4G Technologies (2nd ed.), 2009; Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, M Liyanage, A Gurtov, M Ylianttila – 2015.
Assessment methods and criteria:
The course is passed with a final examination and the accepted simulation work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Mika Ylianttila
Working life cooperation:
No
Other information:
-

521377S: Communications Networks II, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Ylianttila

Opintokohteen kielet: English

ECTS Credits:
7 ECTS cr
Language of instruction:
English
Timing:
Spring, periods 3-4
Learning outcomes:

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

Contents:
The course will also give idea of how NFV, SDN and MEC can enable innovation in networking by providing the students with basics on to explore the networking field and perform experiments, write novel protocols and use their innovative capabilities. The course will also present interesting research areas such as network management, network security, and network load-balancing. Furthermore, the course will give hands-on experience on enabling programmable networks in a Lab environment or personal PCs/laptops using the SDN prototyping environment i.e. Mininet. For MEC and NFVs, 5G test network may be used for demonstrations, experiments and exercise work.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 30 h, exercises 15 h and the compulsory design work either with a simulation program or testbed implementation (30 h).
Target group:
1 st year M.Sc. and WCE students.
Prerequisites and co-requisites:
Communications Networks I
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture" M Liyanage, A Gurtov, M Ylianttila – 2015. Additional reading materials related to NFV, SDN and MEC are provided in OPTIMA.
Assessment methods and criteria:
The course is passed with a final examination and the accepted emulation/simulation work report. The final grade is based on examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Mika Ylianttila
Working life cooperation:
No
Other information:
-

521140S: Computer Graphics, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Guoying Zhao

Opintokohteen kielet: English

Leikkaavuudet:

521493S Computer Graphics 7.0 op

ECTS Credits:
5 ECTS credits
Language of instruction:
In English
Timing:
Spring, period 4.
Learning outcomes:
1. is able to specify and design 2D graphics algorithms including: line and circle drawing, polygon filling and clipping
2. is able to specify and design 3D computer graphics algorithms including transformations, viewing, hidden surface removal, shading, texture mapping and hierarchical modeling
3. is able to explain the relationship between the 2D and 3D versions of such algorithms
4. possesses the necessary basic skills to use these basic algorithms available in OpenGL
Contents:
The history and evolution of computer graphics; 2D graphics including: line and circle drawing, polygon filling, clipping, and 3D computer graphics algorithms including viewing transformations, shading, texture mapping and hierarchical modeling; graphics API (OpenGL) for implementation.
Mode of delivery:
Face to face teaching.
Learning activities and teaching methods:
Lectures 28 h / Self-study and programming assignments 105h
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.
Prerequisites and co-requisites:
Programming skills using C++; basic data structures; simple linear algebra.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
1) Textbook: Edward Angel, Dave Shreiner: Interactive Computer Graphics: A Top-Down Approach with WebGL, 7th Edition, Addison-Wesley 2015
2) Textbook: Edward Angel: Interactive Computer Graphics, 5th Edition, Addison-Wesley 2008
3) Reference: Peter Shirley, Michael Ashikhmin, Michael Gleicher, et al. : Fundamentals of Computer Graphics, second edition, AK Peters, Ltd. 2005
4) Lecture notes (in English)
5) Materials in the internet (e.g. OpenGL redbook) OpenGL Programming Guide or ‘The Red Book’: http://unreal.srk.fer.hr/theredbook/ OpenGL Video Tutorial: target=_blank>http://www.videotutorialsrock.com/opengl_tutorial/what_is_opengl/text.php
Assessment methods and criteria:
The assessment of the course is based on the exam (100%) with mandatory returned programming assignments. Read more about assessment criteria at the University of Oulu webpage.

Grading:
The course unit utilizes a numerical grading scale 1-5, zero stands for fail.
Person responsible:
Guoying Zhao, Xiaopeng Hong, Yingyue Xu
Working life cooperation:
No

521155S: Computer Security, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Tokola, Juha Röning

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits
Language of instruction:
English
Timing:
Autumn semester, period I.
Learning outcomes:
Upon completion of this course, students are familiar with key areas of computer security and have practiced practical skills in these areas with assignments.
Contents:
The course covers the essential aspects of computer security and computer security research in theory and through practical examples.
Mode of delivery:
Lectures and practical assignments
Learning activities and teaching methods:
Lectures 14 h, laboratory exercise 28 h, the rest as independent work.
Target group:
The course is intended for computer engineering masters students and additionally to any student interested in computer security that has the sufficient technical background to complete the course exercises.
Prerequisites and co-requisites:
As prior knowledge students should have a basic understanding of how computers and operating systems work and basic skills in programming. Examples of suitable courses to cover these fundamentals are Operating Systems 521453A, Introduction to Programming 521141P and Computer Engineering 521267A.
Recommended optional programme components:
The course is an independent entity.
Recommended or required reading:
-
Assessment methods and criteria:
Grading of the course is made based on the course practical assignments.
Grading:
Numerical scale 1-5, with 0 denoting failure to pass.
Person responsible:
Juha Röning, Teemu Tokola

Working life cooperation:
Visiting lectures from computer security –related companies arranged during the course whenever possible.
Other information:
-

521467A: Digital Image Processing, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Heikkilä, Janne Tapani

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay521467A	Digital Image Processing (OPEN UNI)	5.0 op

ECTS Credits:
5 ECTS credits / 133 hours of work
Language of instruction:
Lectures in Finnish and exercises in English. Course can be passed in Finnish and English.
Timing:
Spring, period 4.
Learning outcomes:
Upon completion of the course the student:
- understands the basic theory of digital image processing and knows its main applications,
- is able to apply spatial and frequency domain and wavelet based methods in image enhancement, restoration, compression and segmentation.

Contents:
1. Fundamentals of digital images, 2. Image enhancement in spatial and frequency domains, 3.Image restoration, 4. Color image processing, 5. Wavelets, 6. Image compression, 7. Morphological image processing and 8. Image segmentation.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 24 h, exercises 14 h and homework assignments 30 h. The rest is independent work.
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.
Prerequisites and co-requisites:
None.
Recommended optional programme components:
In order to obtain deep understanding of the content, it is a benefit if the student has completed the mathematics courses in the computer science and engineering BSc program or otherwise has equivalent knowledge.
Recommended or required reading:
Gonzalez, R.C., Woods, R.E.: Digital Image Processing, Third Edition, Prentice-Hall, 2008, Chapters 1-10.
Lecture notes and exercise
Assessment methods and criteria:
The course is completed by passing the exam and homework assignments.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Janne Heikkilä
Working life cooperation:
None.

521290S: Distributed Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Xiang Su

Opintokohteen kielet: Finnish

Leikkaavuudet:

521266S-01	Distributed Systems, Exam	0.0 op
521266S-02	Distributed Systems, Exercise Work	0.0 op
521266S	Distributed Systems	6.0 op

ECTS Credits:
5 ECTS cr
Language of instruction:
In English.
Timing:

Spring, period 3.
Learning outcomes:
After completing the course, the student
1. is able to explain the key principles of distributed systems
2. apply the principles in evaluating major design paradigms used in implementing distributed systems
3. solve distributed systems related problems
4. design and implement a small distributed system
Contents:
Introduction, architectures, processes, communication, naming, synchronization, consistency and replication, fault tolerance, security, case studies.
Mode of delivery:
Face-to-face.
Learning activities and teaching methods:
Lectures 22 h, exercises 16 h, project work 50 h, self-study 47 h.
Target group:
M.Sc. students (computer science and engineering) and other Students of the University of Oulu
Prerequisites and co-requisites:
None.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Required literature: Maarten van Steen and Andrew S. Tanenbaum, Distributed Systems – Principles and Paradigms, Third Edition, 2017.
Assessment methods and criteria:

The course uses continuous assessment so that there are 2 intermediate exams. Alternatively, the course can also be passed with a final exam. The course includes a mandatory project work.

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

Grading:
Numerical scale 1-5; zero stands for a fail.
Person responsible:
Xiang Su
Working life cooperation:
None.

521073S: Electroceramics and Intelligent Materials, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jantunen, Heli Maarit

Opintokohteen kielet: Finnish

Leikkaavuudet:

521103S Electroceramics and Intelligent Materials 4.0 op

ECTS Credits:
5 ECTS credits / 132.5 hours of work
Language of instruction:
Finnish and English
Timing:
The course is held in the period 1 biannually. The course is held next on autumn 2019.
Learning outcomes:
1. Student is able to estimate the properties and usability of functional ceramics in different electronics components applications and perform calculatory structural dimensioning for them.

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

structures.

3. Student is able to interpret new research results of the field and recognize their application areas.
Contents:
Microstructures and special features of ceramic materials. Dielectric, polarization and electrical conductivity properties and influence of lattice defects on them. Fabrication and processing of ceramics. Ceramic conductors and insulators, piezoelectric and ferroelectric ceramics, pyroelectric and electro-optic ceramics, magnetic ceramics.
Mode of delivery:
The course will be implemented as face to face teaching.
Learning activities and teaching methods:
The implementation methods of the course vary. The course will be arranged utilizing activating teaching methods agreed on together with the students. There will be 30 hours of guided teaching events and 102.5 hours of teaching without guidance either privately or in a group.
Target group:
Master's level students.
Prerequisites and co-requisites:
The recommended prerequisite is to familiarize with the course 521104P Introduction to Materials Physics
Recommended optional programme components:
-
Recommended or required reading:
Lecture notes. Text book A.J. Moulson and J.M. Herbert: Electroceramics, Wiley, 2003.
Assessment methods and criteria:
Final exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The final exam utilizes a numerical grading scale 1-5.
Person responsible:
Heli Jantunen
Working life cooperation:
No
Other information:
-

521405A: Electronic System Design, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Määttä

Opintokohteen kielet: Finnish

ECTS Credits:
5
Language of instruction:
English/Finnish.
Timing:
Period 1
Learning outcomes:
1. is able to choose the optimum method of the choices presented in the course in the field of power supply, thermal design, grounding, and routing of the high speed signals.
2. is able to calculate problems, caused by electrical disturbances, crosstalk and non-idealities of electrical components.
3. can calculate reliability of an electrical device or system.
4. The main goal of the course is to introduce methods and techniques needed in designing larger electronic entities such as equipment and systems.
Contents:
Power supplies, thermal design, grounding, transmission of fast signals by using transmission lines, electrical disturbances, crosstalk, non-idealities of electrical components, reliability of electronics.
Mode of delivery:

Face-to-face teaching.
Learning activities and teaching methods:
The course includes 30 h of lectures and 20 h of exercises.

Target group:
Primarily in electrical engineering students. Other University of Oulu students can complete the course.
Prerequisites and co-requisites:
Both Principles of Electronics Design and Analogue Electronics I must have been accepted.
Recommended optional programme components:
The course is an independent entity and does not require other studies carried out at the same time.
Recommended or required reading:
Lecture notes. Ward & Angus: Electronic Product Design, Hall&Hall&McCall: High speed Digital Design, Montrose: EMC and the Printed Circuit Board, Ott: Noise Reduction Techniques. Eric Bogatin: Signal and Power Integrity – Simplified, 2. ed.
Assessment methods and criteria:
The course is passed by means of a final exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 0 - 5. In the numerical scale 0 stands for a fail.
Person responsible:
Kari Määttä
Working life cooperation:
No.
Other information:
-

521401S: Electronics Design II, 6 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Kostamovaara

Opintokohteen kielet: English

ECTS Credits:
6 ECTS
Language of instruction:
In Finnish (In English if needed).
Timing:
Autumn, period 1
Learning outcomes:
1. should be able to explain the structures and operating principles of the passive and active (BJT and MOS) components available for use in modern IC technologies
2. should be able to analyze and design integrated electronic blocks based on these components, such as operational amplifiers, comparators and sampling circuits
3. should be able to estimate and minimize the effects of noise in electrical circuits
4. should be able to explain the terminology used with DA and AD conversion and converters
5. should be able to analyze and outline the main architectural principles and also to evaluate the characteristics of DA and AD converters
Contents:
Modeling of BJT and MOS transistors, CMOS and BJT building blocks especially as IC-realizations, noise and analysis of noise, internal structure of operational amplifiers, critical parameters, comparators, S/H-circuits, structures and properties of A/D and D/A converters.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Face-to-face teaching: Lectures 30h, exercises 20h. Self study: a small design work 20h. Learning without guidance either privately or in a group 60h.

Target group:
Students of Electrical engineering. Other students of the University of Oulu may also participate.
Prerequisites and co-requisites:
Principles of electronics design, Electronics design I
Recommended optional programme components:
-
Recommended or required reading:
Lecture handout,T. C. Carusone, D. A. Johns & K.W. Martin: Analog integrated circuit design , Wiley cop. 2012. 2nd ed., chapters 1, 3, 6, 9, 10, 15, 16 and 17, parts of 4 ja 11; P.E. Allen & D.R. Holberg: CMOS Analog Circuit Design, Oxford University Press 2002, chapters 1,3,4,5, 6, 8 and 10.
Assessment methods and criteria:
The course unit is passed by a final exam and a passed design work.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Juha Kostamovaara
Working life cooperation:
-
Other information:
-

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

Voimassaolo: 14.11.2005 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Timo Kokkonen, Rajatheva Rajatheva

Opintokohteen kielet: English

Leikkaavuudet:

521323S Wireless Communications 2 5.0 op

ECTS Credits:
5
Language of instruction:
English.
Timing:
Fall, period 2
Learning outcomes:
1. can use basic methodology of information theory to calculate the capacity bounds of communication and data compression systems.

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

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

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

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

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

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

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

Entropy, mutual information, data compression, basics of source coding, discrete channels and their capacity, the Gaussian channel and its capacity, block codes, cyclic codes, burst error correcting codes, error correcting capability of block codes, convolutional codes, Viterbi algorithm, concatenated codes, and introduction to Turbo, LDPC and Polar coding and to coded modulation.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Face-to-face teaching (lectures and exercises) 64 h and group working.
Target group:
1st year WCE-RAN students and M.Sc. students (i.e., 4th year in EE degree programme)
Prerequisites and co-requisites:
Signal Analysis, Telecommunication Engineering
Recommended optional programme components:
Wireless Communications I and the course support each other. Their simultaneous studying is recommended.
Recommended or required reading:
Parts from books Thomas M. Cover & Joy A. Thomas: Elements of Information Theory, 2nd ed. John Wiley & Sons, 2006 ISBN-13 978-0-471-24195-9, ISBN-10 0-471-24195-4, David J. C. Makay: Information Theory, Inference and Learning Algorithms, ISBN, ISBN-13: 978-0521642989, ISBN-10: 0521642981, and S. Benedetto and E. Biglieri: Principles of Digital Transmission with Wireless Applications, 1999, Chapters 3, 10 and in part 11 and 12. Lecture notes and other literature.
Assessment methods and criteria:
The course is passed with continuous evaluation (only during lecture period) or with final exam and possible additional course tasks defined in the beginning of the course.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Read more about assessment criteria at the University of Oulu webpage.
Person responsible:
Timo Kokkonen (Coding) / Nandana Rajatheva (Information theory)
Working life cooperation:
No
Other information:
-

815303A: Embedded Software Development Environments, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juustila, Antti Juhani

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English.
Timing:
The course is held in the spring semester, during period 4. It is recommended to complete the course at the 1st spring semester.
Learning outcomes:
After completing the course, a student is able to work with the essential software development tools of a selected embedded platform. The student is able to implement memory and power efficient applications by exploiting existing libraries and knowledge of the programming interfaces provided by the platform.
Contents:
The focus of the course is in the software development environments and tools for mobile and embedded platforms, such as Android and iOS. In addition, the course covers memory and power management, core services of the platform, networking and the utilisation of existing libraries. One platform will be selected for deeper study, and the course introduces its essential software development tools and libraries. The emphasis is on application development for the platform as an exercise.
Mode of delivery:

Blended teaching.
Learning activities and teaching methods:
Lectures and exercises about 40 h, exercises and exercise work 93 h.
Target group:
MSc students
Prerequisites and co-requisites:
Course “815309A Real-time Distributed Software Development”, C/C++ and / or Java programming skills or similar knowledge obtained from other courses.
Recommended or required reading:
Course material, the documentation of selected technologies, and other related literature.
Assessment methods and criteria:
Exercise work.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Antti Juustila

813626S: Emerging Technologies and Issues, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Xiuyan Shao

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st spring semester.
Learning outcomes:
After completing the course, the student is able to **:**

- Analyse the on-going changes in online and consumer behaviour, customer requirements, ICT markets and technological development;
- Evaluate key enabling web-based and other information technologies and become an effective participant in web-enabled business endeavours and initiatives;
- Design ways for leveraging information and communication technologies to improve intra- and inter-organisational processes and enhance a firm’s competitive position;
- Plan ways for searching innovations; and
- Develop his / her skills for building careers and taking advantage of entrepreneurial opportunities through emerging technologies, in particular related to the web.

Contents:
- A shift in thinking about the web and emerging technologies
- How the social web is transforming businesses, software design, our perception of people as well as skills required of us
- How to accelerate innovation creation through web-based and other emerging technologies: Ecosystem thinking, strategies, core business values
- Transformation of the social web into humanized web.

Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h, exercises 8 h, reflective personal exercises 21 h, independent work and exam (required reading) 80 h.

Target group:
MSc students
Recommended optional programme components:

Recommended or required reading:
Oinas-Kukkonen H. & Oinas-Kukkonen H.: Humanizing the Web: Change and Social Innovation. Palgrave Macmillan, Basingstoke, UK, 2013 (required reading).

Assessment methods and criteria:
Exam.

Grading:
Numerical scale 1-5 or fail.
Person responsible:
Harri Oinas-Kukkonen

811600S: Emerging Trends in Software Engineering, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Mäntylä

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during periods 1 and 2. It is a recommended to compelete the course at the 1st autumn semester.
Learning outcomes:
After completing the course, the student understands the recent trends in software engineering. The student is able to perform computer supported trend mining to discover new trends of any given topic. The student is able to critically think about the trends.
Contents:
- Software engineering trends (varies yearly)
- Automated trend mining from online databases
- Writing, arguing and discussing about the trends.

Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 24 h, exercises 18 h, essays 30 h, project 30 h, independent study 31 h.
Target group:
MSc students
Prerequisites and co-requisites:
Basics on software engineering.
Recommended or required reading:
Articles + lectures.
Assessment methods and criteria:
Active lecture participation, exercises, assignments, essays.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Mika Mäntylä

812351A: Enterprise Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course
Vastuuyksikkö: Information Processing Science DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Xiuyan Shao
Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the spring semester, during period 3. It is a recommended to compelete the course at the 1st spring semester.
Learning outcomes:
After completing the course, the student understands Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Inventory
Management, CRM, Knowledge Management, Online Business systems, Marketing systems, etc., and also understands the intellectual capital and
organizational competitive advantage. The student should be able to describe how processes integrate the internal functions of the firm and allow the firm to interact with its environment, and be able to recognize, model, and improve processes to help the firm achieve efficiency and effectiveness.
Contents:
1. Principles of enterprise systems, and business
processes that integrate the internal functions of
the enterprise and connect the enterprise with its
business environment;
2. Manage enterprises' intellectual capital to achieve competitive
advantage;
3. Enterprise resource planning (ERP);
4. Supply chain management (SCM);
5. Global supply chain & inventory management systems
6. Knowledge management systems;
7. Customer relationship management (CRM);
8. Internet-based Business and Marketing Systems;
9. Enterprise application integration (EAI)
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 20 h, exercises 18 h, homework 25 h, essays 34 h, examination 36 h.
Target group:
MSc students
Prerequisites and co-requisites:
Understanding of the business process modeling helps.

Recommended optional programme components:

Recommended or required reading:
Refer to the course webpages
Assessment methods and criteria:
Exercises, assignments, essay, and examination.

Grading:
Numerical scale 1-5 or fail.
Person responsible:
Xiuyan Shao
Working life cooperation:
No

521145A: Human-Computer Interaction, 5 op

Voimassaolo: 01.08.2012 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Simo Hosio
Opintokohteen kielet: English

ECTS Credits:
5 ECTS cr
Language of instruction:
In English.

Timing:
Autumn, period 2
Learning outcomes:
1. Knowledge of the Human Computer Interaction (HCI) fundamentals
2. Knowledge of evaluation techniques
3. Knowledge of prototyping techniques
4. Knowledge of how HCI can be incorporated in the software development process
Contents:
Human and computer fundamentals, design and prototyping, evaluation techniques, data collection and analysis.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures (12 h), exercises (16 h), and practical work (105 h). The course is passed with an approved practical work (several assignments). The implementation is fully English.
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.
Prerequisites and co-requisites:
While no specific courses are not required, elementary programming and design skills are desired.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time. The course involves some basic programming.
Recommended or required reading:
All necessary material will be provided by the instructor.
Assessment methods and criteria:
The assessment is project-based. Students have to complete several individual exercises throughout the semester: 1: Using questionnaires; 2: Fitts law; 3: Advanced, team-based design exercise and essay. Passing criteria: all exercises must be completed, each receiving more than 50% of the available points.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Simo Hosio (Dr. Tech.)
Working life cooperation:
If relevant, guest lectures may be organized (optional).

812651S: ICT and Behaviour Change, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Information Processing Science DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Piiastiina Tikka
Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work
Language of instruction:
English
Timing:
The course is held in the autumn semester, during period 2.
Learning outcomes:
After successfully completing the course, a student will be able to
-analyze methods and techniques that are used in and for ICT-based persuasion
-apply these methods in an ethical manner as design guidelines for developing applications that target change in human behaviour or attitudes.
Contents:
Attitudinal theories from social psychology have been quite extensively applied to the study of user intentions and behaviour. These theories have been developed mostly for predicting user acceptance of information technology rather than for providing systematic analysis and design methods for developing software solutions that aim at attitude or behaviour change. At the same time a growing number of information technology systems and services are being developed for these purposes.

This course will focus on persuasive technology. It will address the process of designing and evaluating persuasive systems, the types of content and software functionality in such systems, the underlying assumptions behind these, methods for analysing the persuasion context, and principles for persuasive system design. Positive examples of persuasive systems include motivating knowledge workers to do their work better or safer and embracing citizens for healthy living habits. Negative examples include games that inflict addiction. Both sides of influence will be discussed.
Mode of delivery:
Blended teaching
Learning activities and teaching methods:
Lectures 24h, reflective personal exercises 27h, independent work 82h (of which reading for lectures 27h and assignments 55h).
Target group:
MSc students
Prerequisites and co-requisites:
-
Recommended optional programme components:
The BSc course "Humans as Users and Developers of Information Technology", or similar understanding and the MSc course "Emerging Technologies and Issues" would be helpful, but are not required
Recommended or required reading:
Research articles to be announced more specifically during the course implementation
Assessment methods and criteria:
Participation in lectures, personal reflection reports, course assignments.
Grading:
Numerical scale 1-5 or fail
Person responsible:
Harri Oinas-Kukkonen
Working life cooperation:
-

817604S: ICT and Organizational Change, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Karin Väyrynen

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:

English
Timing:
The course is held in the autumn semester, during periods 1 and 2. It is recommended to complete the course at the 2nd autumn semester.
Learning outcomes:
After completing the course the student is able to distinquish various roles of information and communication technology (ICT) in change of organization and its context, and is able to analyze the role of ICT in relation with change taking place in an organization.
Contents:
The course studies organisations at four levels: individuals, practices, organizational structures and transformations, and the societal context of organisations. The organizational role of ICT and the relation between ICT and knowledge are also discussed. The role of power, trust and control in the change process is discussed. The different aspects of change agents are presented and analysed. Students familiarize themselves with 7 organizational theories.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 28 h, individual work 105 h (for self-studying for weekly in-class exams - or optionally a traditional exam), and a review and analysis of selected course materials and writing a case analysis).
Target group:
MSc students
Prerequisites and co-requisites:
Recommended to take Emerging Technologies and Issues before this course.
Recommended optional programme components:

Recommended or required reading:
A list of research articles will be provided for the lectures and assignments.
Assessment methods and criteria:
Week exams and weekly case analysis (or traditional exam at end of the course), course assignment (literature review, case analysis).
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Karin Väyrynen

813625S: Information Systems Theory, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Netta Iivari

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English.
Timing:
The course is held in the autumn semester, during periods 1 and 2. It is recommended to complete the course at the 2nd autumn semester.
Learning outcomes:
After completing the course, students will have a good knowledge and understanding of a broad array of research topics and themes within the field of information systems; will have good knowledge and understanding of information systems research and the process by which that research is produced; will have competence in critiquing research articles published in some of the leading academic journals and conference proceedings; will have competence in critical thinking, and analysis and synthesis of academic sources; will have competence in verbally presenting arguments in an academic fashion; will know how to write a literature review on an information systems research topic.
Contents:

Information Systems Research Overview, A contemporary selection of Information Systems research themes.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 24 h, seminars 10 h, individual and group assignments 100 h; or self-study: opening lecture 2 h, assignments 132 h.

Target group:
MSc students
Prerequisites and co-requisites:
Bachelor's degree or similar, Research Methods course. Recommended to take before Master's Thesis.
Recommended optional programme components:

Recommended or required reading:
Lectures and Selection of scientific articles.
Assessment methods and criteria:
Accepted assignments.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Netta Iivari

812331A: Interaction Design, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Minna Pakanen

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during period 1. It is recommended to complete the course at the 1st autumn semester.
Learning outcomes:
Objective: The course explains the role of human interaction with IT products, systems, and services, explains the factors and problems related to it to motivate interaction design, and teaches some user-centered methods for analysis, evaluation and design of interactions.
Learning Outcomes: After completing the course, the student can assess the role of human interaction with IT products, systems, and services and identify factors and problems related to it within a practical design case. The student is able to:

- use methods for analysis and evaluation of existing interfaces;
- understand the role of requirements, plan and conduct a simple requirements collection and analysis;
- use basic principles of usability and user experience for user interface design;
- use interaction design methods in designing for target user experiences.

Contents:
The course provides an overview of interaction design, introducing the terminology and fundamental concepts, the main activities, and the importance of user involvement in the design process. The course addresses establishing requirements for IT products, systems, and services. The focus is on usability and user experience from the viewpoint of the intended users, their tasks and the context of use. The course covers user-centered methods for designing for and evaluating usability and user experience of IT products, systems, and services. All the main activities of interaction design are carried out in a practical design case.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:

Lectures 20 h, exercises and seminar 25 h, individual and group assignments 90 h; or self-study: an opening lecture 2 h, one larger
assignment 110 h and individual tasks 21 h.
Target group:
MSc students
Prerequisites and co-requisites:
Basic knowledge on human-computer interaction with usability and user-centered design.
Recommended or required reading:
Sharp et al. (2015) Interaction Design, chapters 1-2, 4-5, 7-13 (pages 1-64, 100-157, 226-473).
Assessment methods and criteria:
Accepted assignments.

Grading:
Numerical scale 1-5 or fail.
Person responsible:
Minna Pakanen
Working life cooperation:
Invited lectures, assignments.

521043S: Internet of Things, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
5 ECTS / 135 hours of work
Language of instruction:
English
Timing:
Spring semester during period IV
Learning outcomes:
Upon completion of the course, the student will be able to:
1. explain application areas of IoT and requirements from such application areas for IoT systems.
2. will be able to explain the state-of-the-art IoT solutions, and understand the basic technologies behind them.
3. learn the principles of the novel IoT technologies and know important directions IoT research towards.
Contents:
The basic technologies and novel applications of the Internet of Things, including networking technologies as well as Web of Things. IoT sensor technologies and sensing solutions for smart buildings including smart home, city, office, or campus environments, and wearables and other personal devices such as fabrication. Exercises will include hands-on programming and sensing data analytics tasks.
Mode of delivery:
face-to-face teaching and exercises (both individual and group work)
Learning activities and teaching methods:
20h lectures, 12h exercise sessions, independent studying 95 hours.
Target group:
M.Sc. students of Computer Science and Engineering, M. Sc. students of Ubicomp International master program. The course fits also for Statistics and Math MSc student interested in applying their knowledge into sensing and IoT data.
Prerequisites and co-requisites:
The Bachelor level knowledge of Computer science and engineering study programmes. Good programming skills in a chosen language.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Lecture hand-out, complementary reading list, and exercise material will be provided.
Assessment methods and criteria:
Attending lectures and exercise sessions, and returning the weekly exercises online.

Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilises a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Ella Peltonen
Working life cooperation:
The course may include the invited guest lectures from industry and other top EU universities.

521242A: Introduction to Biomedical Engineering, 5 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Teemu Myllylä
Opintokohteen kielet: English

ECTS Credits:
5 ECTS cr
Language of instruction:
English
Timing:
Period 1
Learning outcomes:
After completing the course, the student has a basic knowledge of the biomedical engineering discipline and the applications of engineering science to biomedical problems.

Contents:
Biomedical engineering is a multidisciplinary field of study that ranges from theory to applications at the interface between engineering, medicine and biology. This course will introduce the subdisciplines within biomedical engineering, including such as systems physiology, bioinstrumentation, bioimaging, biophotonics and biomedical signal analysis. General issues of the subdisciplines will be presented together with selected examples and clinical applications. A number of lectures will be given by professionals working in health tech companies, University of Oulu and Oulu University Hospital, presenting different fields of the biomedical engineering. In addition, course offerings of biomedical engineering at the University of Oulu are introduced.
Mode of delivery:
Face-to-face teaching. Under some circumstances distance learning using online material is possible (please, ask the teacher).

Learning activities and teaching methods:
The course includes online material, lectures and a group project. Lectures 28h and laboratory exercises 4 h and self-study 100h

Target group:
-
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Participation in lectures or using the online material and writing a work report.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1 - 5, pass, fail
Person responsible:
Teemu Myllylä
Working life cooperation:

Guest lecturers
Other information:
-

031025A: Introduction to Optimization, 5 op

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

ECTS Credits:
5 ECTS credits / 135 hours of work
Language of instruction:
English
Timing:
The course is held in the autumn, during period 1.
Learning outcomes:
After completing the course the student is able to solve optimization convex optimization problems with the basic optimization algorithms. The student is also able to form the necessary and sufficient conditions for the optimality.
Contents:
Linear optimization, Simplex-algorithm, nonlinear optimization, KKT-conditions, duality, conjugate gradient method, penalty and barrier function methods.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 28 h / Group work 14 h / Self-study 93 h.
Target group:
Students in Wireless Communication Engineering
Prerequisites and co-requisites:
The recommended prerequisite is the completion of the courses Calculus I and II, Matrix algebra
Recommended optional programme components:
-
Recommended or required reading:
P. Ciarlet; Introduction to numerical linear algebra and optimization, M. Bazaraa, H. Sherali, C.M. Shetty; Nonlinear programming
Assessment methods and criteria:
The course can be completed by a final exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail
Person responsible:
Keijo Ruotsalainen
Working life cooperation:
-
Other information:
-

521157A: Introduction to Social Network Analysis, 5 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Mourad Oussalah

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 120 hours of works
Language of instruction:
English
Timing:
Period 4. It is recommended to complete the course at the end of period 4
Learning outcomes:
Upon completing the course, the student is expected to i) understand social aspects of the web; ii) learn to collect, clean and represent social media data; iii) quantify important properties of social media; iv) find and analyze (online) communities; v) understand the diffusion process in social network; vi) familiarize with simple modelling toolkits for social media analysis
Contents:
The course describes basics of social network analysis, allowing the students to understand structure and evolution of the network, while enabling them to use appropriate tools and techniques to draw inferences and discover hidden patterns from the network. The course is designed to accommodate computer science, mathematical and social science student background, which helps in emergence of multi-disciplinary research in the university
Mode of delivery:
Face- to-face teaching and laboratory sessions
Learning activities and teaching methods:
Lectures (24 h), tutorial/laboratory sessions (12h), seminar (6 h) and practical work. The course is passed with an approved practical work and class test. The implementation is fully in English.
Target group:
Students with moderate logical reasoning skills
Prerequisites and co-requisites:
None
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time
Recommended or required reading:
R. Zafarani, M. A. Abbasi, and H. Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014
Assessment methods and criteria:
One class test (30%) in the middle of the term + Project work (70%)
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Mourad Oussalah
Working life cooperation:
-
Other information:
We hope to attract students from humanties, economics and political in order to encourage multidisciplinary studies and enforce interesting student projects where each group contains at least one student from computer science and one from another faculty.

521289S: Machine Learning, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapio Seppänen

Opintokohteen kielet: Finnish

Leikkaavuudet:

521497S-01	Pattern Recognition and Neural Networks, Exam	0.0 op
521497S-02	Pattern Recognition and Neural Networks; Exercise Work	0.0 op
521497S	Pattern Recognition and Neural Networks	5.0 op

ECTS Credits:
5 ECTS cr
Language of instruction:
English. Examination can be taken in English or Finnish.
Timing:
The course unit is held in the spring semester, during period III. It is recommended to complete the course at the end of studies.
Learning outcomes:
After completing the course, student
1. can design simple optimal classifiers from the basic theory and assess their performance.

2. can explain the Bayesian decision theory and apply it to derive minimum error classifiers and minimum cost classifiers.

3. can apply the basics of gradient search method to design a linear discriminant function.

4. can apply regression techniques to practical machine learning problems.
Contents:
Introduction. Bayesian decision theory. Discriminant functions. Parametric and non-parametric classification. Feature extraction. Classifier design. Example classifiers. Statistical regression methods.
Mode of delivery:
Face-to-face teaching, guided laboratory work and independent assignment.
Learning activities and teaching methods:
Lectures 2h, Laboratory work 16h, Exercise 16h and Self-study the rest (Independent task assignment, written examination).
Target group:
Students who are interested in data analysis technology. Students of the University of Oulu.
Prerequisites and co-requisites:
The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Programming skills, especially basics of the Matlab.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Duda RO, Hart PE, Stork DG, Pattern classification, John Wiley & Sons Inc., 2nd edition, 2001. Handouts.
Assessment methods and criteria:
Laboratory work is supervised by assistants who also check that the task assignments are completed properly. The independent task assignment is graded. The course ends with a written exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail. The final grade is established by weighing the written exam by 2/3 and the task assignment by 1/3.
Person responsible:
Tapio Seppänen
Working life cooperation:
No

521096S: Measurement Systems, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Saarela

Opintokohteen kielet: Finnish

Leikkaavuudet:

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

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

ECTS Credits:
5 ECTS credits / 128h
Language of instruction:
Finnish. English, if there are more than 2 foreign students.
Timing:
Period 2.
Learning outcomes:
1. is able to design a multisensor measurement systems which store the measurement data.
2. is able to assembly a multisensor measurement systems which store the measurement data.
3. is able to program with LabView.
Contents:
Basics of measurement and testing systems, especially wired and wireless data transmission. Data acquisition cards. Basics of LabView programming.
Mode of delivery:
face-to-face teaching.
Learning activities and teaching methods:
The course includes 28h lectures and guided exercises. 100 h self-studies.
Target group:
Master level students regardless of master's programme.
Prerequisites and co-requisites:
None.
Recommended optional programme components:
This course compensates earlier courses with same core content but different course code or credit named Measuring and Testing Systems.
Recommended or required reading:
Course material is in English and Finnish and can be found in Optima.
Assessment methods and criteria:
Final exam and passed laboratory works.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Grade is based on exam and grade is on numerical scale 1-5.
Person responsible:
Juha Saarela
Working life cooperation:
No.

521074S: Microelectronics and Micromechanics, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Krisztian Kordas

Opintokohteen kielet: English

Leikkaavuudet:

521224S Microelectronics and Micromechanics 6.0 op

521224S-01 Microelectronics and Micromechanaics, exam 0.0 op

521224S-02 Microelectronics and Micromechanics, exercise 0.0 op

ECTS Credits:
5
Language of instruction:
English
Timing:
3rd period
Learning outcomes:

Objective: The course provides advanced knowledge on the semiconductor techniques of VLSI and on special topics of micromechanics and hybrid fabrication. Especially recent progress on the field is introduced in application point of view.
Learning outcomes: After completing the course the student can give account on correlations between basic physics/chemistry and materials processing/technology in microelectronics, micromechanics and nanotechnology. The student can describe design aspects and operation principles of micro and nano-devices. The students get acquainted with working in laboratory environment similar to those in academic and industrial research labs. Laboratory work practice on either (i) thin film fabrication in clean room, (ii) inkjet printing and electrical characterization of thin film devices with nanopartciles or (iii) synthesis of carbon nanotubes and characterization by electron microscopy techniques will provide a good opportunity also to learn how to design and run experiments safely and manage laboratory reports.
Contents:
Theory and practice of VLSI semiconductor fabrication technologies to support and deepen the understanding of general fabrication and operation principles introduced during previous courses. The state-of-the-art semiconductor devices and circuits: pushing the limits of dimensions and speed. Implementation of VLSI technologies in fabrication of components for micromechanics. Sensors (flow, pressure) and actuators (valves, pumps, motors, switches and components for micro-optics) using MEMSs. Devices on the nanoscale and integration of nanomaterials in microsystems: new concepts of design, fabrication and operation.
Mode of delivery:
Lectures, laboratory exercise with supervision and guidance.
Learning activities and teaching methods:
Though the course is primarily based on lectures, the communication channel is open in both directions enabling continuous comments, questions and feedback from the students. Critical explanations and think alouds are also applied to motivate thinking and active learning.
Target group:
Students of the University of Oulu.
Prerequisites and co-requisites:
Passing the basic course “521070A Introduction to microfabrication techniques” before the advanced course is recommended.
Recommended optional programme components:
-
Recommended or required reading:
Lecture notes and references therein.
Assessment methods and criteria:
Examination and completion of both laboratory exercise and report.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading 1-5.
Person responsible:
Krisztian Kordas
Working life cooperation:
-
Other information:
-

521215S: Microelectronics project, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Juuti

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits / 132,5 hours of work
Language of instruction:
Finnish or English
Timing:

The course is held in the spring semester, durin periods 3 and 4. It is recommended to complete the course at the 4th spring semester (1. year of MSc studies)
Learning outcomes:
After completing the course, the student
1. Is able to carry out all the stages needed to develop electronics components or materials beginning from design the material or component to realization and characterization.
2. Student is able to use independently professional and research methods, software, equipment and tools.
3. Student is able to do technical documentation of the work and keep laboratory work book during the work.
Contents:
Independent manufacturing, design, characterization or modelling work for electronics materials or components.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Project work for 132,5 hours
Target group:
Masters students on Electrical engineering
Prerequisites and co-requisites:
Bachelors degree in electrical engineering or equivalent.
Recommended optional programme components:
The course is an independent entity.
Recommended or required reading:
Given in the beginning of the course.
Assessment methods and criteria:
Project work is assessed by the achievement of the project targets and quality of the report.
Grading:
The course utilizes verbal grading scale ”Laudatur/pass/fail”.
Person responsible:
Jari Juuti
Working life cooperation:
Some of the project work can be made in cooperation with companies.
Other information:
-

521072S: Microsensors, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Hannu

Opintokohteen kielet: Finnish

Leikkaavuudet:

521228S Microsensors 4.0 op

ECTS Credits:
5 ECTS credits / 132,5 hours of work
Language of instruction:
English. Guidance and exams also possible in Finnish.
Timing:
The course is held in the 2nd period. Teaching is available every second year. The next time course is arranged on autumn 2018.
Learning outcomes:
1. After completing the course, student can explain the basic concepts of sensor theory and technology, classification of sensors, properties of ideal and real sensors, pros and cons of integrated smart sensor systems, and the interface between sensor and pro

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

3. Students can explain the basic structures, physical operation principles, and fabrication processes of main sensor types for different forms of energy.
Contents:
The principles of microsensors, physical magnitudes which can be measured and manufacturing technologies for microsensors.
Mode of delivery:
Blended teaching (web-based and face-to-face teaching).
Learning activities and teaching methods:
The course will be arranged utilizing activating teaching methods agreed on together with the students. There will be 14 hours of guided teaching events and 118,5 hours of teaching with web-based guidance either privately or in a group.
Target group:
Master students in electrical engineering.
Prerequisites and co-requisites:
Recommended prerequisite is Bachelors degree in Electrical Engineering.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Will be informed at the beginning of the course.
Assessment methods and criteria:
This course utilizes continuous assessment. The method will be informed at the beginning of the course.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Jari Hannu
Working life cooperation:
No
Other information:
-

521045S: Mobile Computing, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Denzil Teixeira Ferreira

Opintokohteen kielet: English

Leikkaavuudet:

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

ECTS Credits:
5ECTS / 138 hours of work
Language of instruction:
English
Timing:
Spring, periods 3 and 4
Learning outcomes:
This course focuses on one of the core demands of industry today: deep understanding of mobile interaction, mobile computing constrains and mobile development. After this class, students will possess the:
- ability to design and prototype a mobile user interface taking into account usability aspects of interaction on smaller displays
- ability to explain and leverage the fundamental concepts of context awareness using smartphone hardware, software and human sensors
- ability to understand and implement from scratch a mobile application that leverages both usability and context to create engaging mobile experiences

Contents:
The basic concepts of mobile interface design, implementation, mobile sensor acquisition, context awareness.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
5 ECTS cr = 138h of course work. Lectures (14h), in-class exercises (14h) and practical work (107h) (project, assignments).
Target group:
Computer Science and Engineering students and other students.
Prerequisites and co-requisites:
Recommended to have experience with object-oriented programming (Java, C#).
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
All necessary material will be provided by the instructor.
Assessment methods and criteria:
The assessment depends on whether the student attends or not the class. For attending students, the assessment is based on 5 laboratory exercises (which the student needs a passing grade). For non-attending students, 5 individual assignments are assigned instead of the laboratory exercises (which the student needs a passing grade). For non-attending students, there is an intermediate exam at the end of period 3 and another at the end of period 4. All students, attending or not, are peer-assessed in a team project during period 4.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:
Denzil Socrates Teixeira Ferreira
Working life cooperation:
-

521385S: Mobile Telecommunication Systems, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Katz, Marcos Daniel

Opintokohteen kielet: English

ECTS Credits:
5
Language of instruction:
English
Timing:
Spring, period 3
Learning outcomes:
1. Upon completing the required coursework, the student will be able to determine and fit the values of the main parameters for modern mobile telecommunication systems network planning. The course gives skills to describe mobility management, adaptive resource control and dynamic resource allocation in mobile networks.
The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.
Contents:
Concept and structures of modern mobile communications systems. Basics of radio network planning and capacity. Distributed transmission power control and mobility management. Resource allocation techniques: adaptive resource control, dynamic resource allocation. Cooperative communications. Examples of digital mobile telecommunication systems in practice.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:

Lectures 30 h, exercises 16 h and the compulsory laboratory work (16 h)
Target group:
2nd year M.Sc. and WCE students
Prerequisites and co-requisites:
Telecommunication Engineering, Broadband Communications Systems and Wireless Communications I.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
The course material will be defined at the beginning of the course.
Assessment methods and criteria:
The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Marcos Katz
Working life cooperation:
-
Other information:
Objective: The goal of this course is to provide the basic understanding of dimensioning and performance of mobile communications systems. In addition, the current mobile communications system standards as well as the ones being developed are also studied, preparing students to understand the structure, functionality and dimensioning of these systems.

521161S: Multi-Modal Data Fusion, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Abdenour Hadid

Opintokohteen kielet: English

ECTS Credits:
5 ECTS / 135 hours of work
Language of instruction:
English
Timing:
Period 2
Learning outcomes:
Upon completion the student should be able to understand the problem of combining data (such as images and audios) of different natures and coming from different sources. The student should be able to implement basic solutions towards the accomplishment of a given task requiring the integration and
combination of data.
Contents:
This course will provide a comprehensive introduction to the concepts and ideas of multi-sensor data fusion. The course will be illustrated with many real-life examples taken from a diverse range of applications. The course will be self-contained as much as possible (no previous knowledge of multisensor
data fusion is assumed). Basic knowledge on related topics like image processing and signal processing will be a plus.
The course will discuss the following topics:
Introduction
Sensors
Architecture
Common Representational Format
Spatial Alignment
Temporal Alignment
Semantic Alignment
Radiometric Normalization
Bayesian Inference

Parameter Estimation
Robust Statistics
Sequential Bayesian Inference
Bayesian Decision Theory
Ensemble Learning
Sensor Management
Mode of delivery:
The course will be based on a combination of lectures (face-to-face teaching), home exercises and a final project.
Learning activities and teaching methods:
Face-to-face teaching: 20 h, home exercises: 80 h, final project: 35h
Target group:
Computer Science and Engineering, Ubiquitous Computing (M.Sc level, study years 4-5).
Prerequisites and co-requisites:
The course will be self-contained as much as possible (no previous knowledge is assumed). Basic knowledge on related topics like image processing and signal processing will be a plus.
Recommended optional programme components:
-
Recommended or required reading:
The course will be based on the following text book: H.B. Mitchell. Data Fusion: Concepts and Ideas. Springer (2012)
Assessment methods and criteria:
To pass the course, the student should retrun the exercices, complete a final programming project and pass an exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course will utilize a numercial grading scale 1-5.
Person responsible:
Abdenour Hadid (lecturer), Mohammad Tavakolian (Assistant)
Working life cooperation:
The course includes one or two guest lectures from experts with practical experience.
Other information:
-

521288S: Multiprocessor Programming, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Miguel Bordallo Lopez

Opintokohteen kielet: Finnish

Leikkaavuudet:

521280S DSP Laboratory Work 5.0 op

ECTS Credits:
5 ECTS cr / 135 hours of work
Language of instruction:
English
Timing:
Spring semester, periods 3-4
Learning outcomes:
Upon completition of the course, the student:
1. has basic understanding of multiprocessor architectures and heterogeneous computing,
2. has basic understanding on how to design and implement algorithms for heterogeneous platforms,

3. understands the possible challenges and shortcomings related to the current heterogeneous systems,

4. is able to use the OpenCL framework for designing, implementing and optimizing signal processing algorithms for heterogeneous platforms

Contents:
Algorithm design, general purpose computing on graphics processing units, heterogeneous computing, OpenCL programming and optimization
Mode of delivery:
Opening lecture and independent exercise project, which is divided into smaller sub-entities. The exercise project is performed using both desktop and mobile platforms. After each sub-entity, a short seminar is held where the students discuss their results and possible ways to optimize the performance of their implementation.
Learning activities and teaching methods:
Opening lecture (2h), seminars (8h) and independent exercise project (125h).
Target group:
Computer Science and Engineering students and other Students of the University of Oulu. This is an advanced-level course intended for masters-level students and post-graduate students, especially to those interested in signal processing, processor architectures and embedded systems programming.
Prerequisites and co-requisites:
Matrix Algebra 031078P, Elementary programming 521141P, Computer Systems 521286A, Digital Filters 521337A
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
-
Assessment methods and criteria:
Students complete the course exercises after the attending to the opening lecture in groups of two students. Assessment is based on the quality of the completed exercises and exercise reports. More detailed information on assessment will be announced at the beginning of the course.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5; zero stands for a fail.
Person responsible:
Miguel Bordallo
Working life cooperation:
-
Other information:
-

521158S: Natural Language Processing and Text Mining, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mourad Oussalah

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 120 hours of works
Language of instruction:
English
Timing:
Period 2. It is recommended to complete the course at the end of period 2
Learning outcomes:
Upon completing the course, the student is expected to i) comprehend, design and implement basic (online) text retrieval and query systems; ii) account for linguistic aspects and perform word sense disambiguation; iii) perform basic (statistical) inferences using corpus; iv) manipulate (statistical) language modelling toolkits, online lexical databases and various natural language processing tools.
Contents:
Foundation of text retrieval systems, Lexical ontologies, word sense disambiguation, Text categorization, Corpus-based inferences and Natural Language Processing tools
Mode of delivery:
Face- to-face teaching and laboratory sessions
Learning activities and teaching methods:

Lectures (24 h), tutorial/laboratory sessions (16h), seminar (6h) and practical work. The course is passed with an approved practical work and class test. The implementation is fully in English.
Target group:
students with (moderate to advanced) programming skills in Python
Prerequisites and co-requisites:
Programming skills (preferably) in Python

Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time
Recommended or required reading:
Introduction to Information Retrieval, by C. Manning, P. Raghavan, and H. Schütze. Cambridge University Press, 2008. (Free from http://nlp.stanford.edu/IR-book/) Foundations of statistical natural language processing, by Manning, Christopher D., Schütze, Hinrich. Cambridge, Mass.: MIT Press, 2000
Assessment methods and criteria:
One class test (30%) in the middle of the term + Project work (70%)
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Mourad Oussalah
Working life cooperation:
-

815657S: Open Source Software Development, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Henrik Hedberg

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during periods 1 and 2. It is recommended to complete the course in the 2nd autumn semester.
Learning outcomes:
After passing the course, a student will be able to
- define the historical background and the ideology of Open Source Software (OSS),
- participate in an OSS development project,
- evaluate the impact of the usage of OSS and OSS licenses on software development and exploitation, and
- view the phenomenon through the essential scientific research.
Contents:
The course introduces OSS development paradigm and current topics in OSS research. OSS affects both the way to produce software and the decisions of user organizations. It can be understood, for example, from different social, legal, economical, software engineering and data security viewpoints. The aim is to study from different perspectives, for example, what OSS is and what it is not, the history and organisation of OSS projects, methods of OSS development and usage, as well as licensing models and possible risks. The emphasis is on research work.
Mode of delivery:
Blended teaching.
Learning activities and teaching methods:
Independent personal and group work about 40 h, weekly meetings and seminars about 30 h, seminar article and presentation about 60 h.
Target group:
MSc students
Prerequisites and co-requisites:

Compulsory prerequisites are Bachelor degree or other equivalent degree and basic knowledge on software engineering and research work.
Recommended or required reading:
Fogel, K. (2017): Producing Open Source Software - How to Run a Successful Free Software Project, O'Reilly Media; Rosen L. (2004): Open Source Licensing: Software Freedom and Intellectual Property Law, Prentice Hall; scientific articles covering the topic.
Assessment methods and criteria:
Active participation, seminar article and other assignments.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Henrik Hedberg

521094S: Optoelectronic Sensors of Future, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Igor Meglinski

Opintokohteen kielet: Finnish

Leikkaavuudet:

521238S	Optoelectronic Measurements	4.0 op

ECTS Credits:
5
Language of instruction:
English
Timing:
Period 4
Learning outcomes:
Objective: The goal of this course is to make the student familiar with optical measurement principles, sensors and device configurations used in industrial inspection tasks.
Learning outcomes: Upon completion of the course, the student is able to explain the operating principles of the most common optical measurement methods used in industrial production, name the factors affecting their performance, design certain sensor systems and evaluate the applicability of measurement methods for various measurement tasks. Additionally he is able to independently find information and discover the operating principles of various optical measurements and to condense the collected information into written and verbal report.
Contents:
Principles of optical measurements. Surface inspection, distance and profile measurements. Non-destructive testing methods. Optical measurements for process control. Material analyses with optical methods.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
The course includes 42 h lectures or calculation exercises and 100 h self-studies.
Target group:
4th year students
Prerequisites and co-requisites:
Completion of the course 766329A Wave Motion and Optics is recommended.
Recommended optional programme components:
Course replaces earlier by same name but different code and credit points.
Recommended or required reading:
Lecture handouts and discourse material prepared by students. Delivery through Optima.
Assessment methods and criteria:
Final exam and a passed discourse.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5.
Person responsible:

Igor Meglinski
Working life cooperation:
No.

521159P: Principles of Digital Fabrication, 5 op

Voimassaolo: 01.01.2017 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Georgi Georgiev
Opintokohteen kielet: Finnish
Leikkaavuudet:

ay521159P Principles of Digital Fabrication (OPEN UNI) 5.0 op

ECTS Credits:
5 ECTS credits/ 135 hours of work
Language of instruction:
Finnish/English
Timing:
The course will be held in the spring semester, during period IV.

Learning outcomes:
In this course the students will learn the whole process of digital fabrication in FabLab. They will learn how to create an interactive 3D prototype, design mechanical parts for prototype, create basic electronics, implement a control logic for open hardware embedded board, and work in teams on project.
Contents:
The course teaches students to (1) design mechanical components with solid modeling tools, (2) build necessary electronics, and (3) implement software to a microcontroller, to create in FabLab a physical gadget that interacts with the world around it.
Mode of delivery:
Face-to-face teaching (Lectures)/ Individual work towards project
Learning activities and teaching methods:
Lectures 30h / Individual work 123h. There are sessions each week in FabLab where guidance is available (min total 16 h).
Target group:
This course is included in the computer science bachelor degree program. It is also available for all degree programs in the university. The course is offered to high-school students.
Prerequisites and co-requisites:
-
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
There is no recommended or required reading. The tutorials for tools and software (or links to such tutorials) will be provided in the course.
Assessment methods and criteria:
The course will be evaluated on the basis of the project delivered by the teams of students. Essential part of this reporting is the documentation of the project.
Grading:
pass/fail
Person responsible:
Georgi Georgiev
Working life cooperation:
-
Other information:
The course is also offered to high-school students with special study right and gives 5 ECTS credits that can be included in some bachelor's degrees at University of Oulu.
The exercises are in FabLab:
https://www.oulu.fi/fablab/node/32345

521089S: Printed Electronics, 5 op

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

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

ECTS Credits:
5
Language of instruction:
Finnish. English if more than two international students in the course.
Timing:
Period 3.
Learning outcomes:
1. Knows the most typical materials and printing methods suitable for their processing
2. Can explain the principles of materials and printing methods
3. Can utilize the material and manufacturing process knowledge to design fabrication processes for electrical components
4. Can analyse how the selected materials and printing methods influence on the performance of electrical components
Contents:
Materials (conductive and semi-conductive polymers, photoactive polymers, dielectrics, particle based inks) and processing methods (screen printing, gravure printing, flexo printing, inkjet) utilized in printed electronics, surface wetting and film formation, printed electrical components (passive components, solar cells, light emitting diodes, transistors) and their fabrication. Possibilities and challenges of printing based processing methods and how to take them into account in the printed electronics fabrication.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Combined lectures and exercises 30 h and self-study 100 h
Target group:
Primarily for the students of electrical engineering
Prerequisites and co-requisites:
None.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time
Recommended or required reading:
D.R. Gamota, P. Brazis, K. Kalyanasundaram and J. Zhang, "Printed organic and molecular electronics", handout
Assessment methods and criteria:
Course is completed by final examination.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.

Person responsible:
Tapio Fabritius
Working life cooperation:
Not included.

521386S: Radio Channels, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies

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

ECTS Credits:
5 ECTS credits / 130 hours of work
Language of instruction:
English
Timing:
The course is held in the spring semester, during period IV.
Learning outcomes:
1. will be able to define what the radio channel is and is able to distinguish it into modellable parts.

2. knows different radio wave propagation mechanisms.

3. can apply physical and empirical radio channel models.

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

5. will know how to measure the properties of different radio channels.
Contents:
The radio channels of different radio systems. Characterization of radio waves and propagation media. Different mechanisms of radio wave propagation: direct free-space propagation, absorption, scattering, reflection, refraction, diffraction, surface and ground waves, ionospheric waves and multipath propagation. Principles of the radio channel modelling. Noise calculations. Radio wave propagation phenomena over fixed terrestrial, ionospheric and satellite links. Radio channel modelling for outdoor mobile systems. Radio wave propagation inside or into buildings. Radio channels of mobile satellite links. Slow fading. Multipath propagation and its effects on narrowband and wideband radio channels. MIMO radio channels. Ultra wideband radio channels. Measurement methods of radio channels.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h / Exercises 12 h / compulsory laboratory work 14 h / Self-study 80 h.
Target group:
1st or 2nd year M.Sc. and WCE students
Prerequisites and co-requisites:
The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Basics of Radio Engineering, Signal Analysis
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Simon R. Saunders & Alejandro Aragón-Zavala: Antennas and propagation for wireless communication systems. Second edition. John Wiley & Sons Ltd, 2007.
Assessment methods and criteria:
The course is passed with a final examination and the accepted laboratory work report.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Markus Berg
Working life cooperation:
No
Other information:
Course will be given every second year in odd years. Will be held next time in the spring of 2019.

521326S: Radio Engineering 1, 5 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies

Laji: Course
Vastuuyksikkö: Electrical Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Risto Vuohtoniemi, Aarno Pärssinen
Opintokohteen kielet: Finnish
Leikkaavuudet:

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

ECTS Credits:
5
Language of instruction:
English
Timing:
Fall, period 2
Learning outcomes:
1. learns key components of radio transceivers used in wireless communications including LTE and 5G.
2. knows different kind of impedance matching methods and can design the impedance matching network using lumped components and microstrip lines.

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

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

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

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

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

7. knows concept of noise, non-linearity and dynamic range as used in radio frequency communications.

8. can classify power amplifiers and will be able in the basic case design the matching network for a power amplifier.
Contents:
Noise, impedance matching using lumped components, microstrip matching networks, low noise amplifier (LNA) design, active and passive mixers, power dividers, directional couplers, automatic gain control (AGC), power amplifier design.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h, exercises 16 h and the compulsory RF design work with ADS simulation software (20 h).
Target group:
1st year M.Sc. and WCE-RF students. 2nd year M.Sc. (Telecom.) and WCE-RAN students.
Prerequisites and co-requisites:
Basics of Radio Engineering
Recommended optional programme components:
-
Recommended or required reading:
Lecture notes. Parts from D.M. Pozar: Microwave Engineering, 4th edition, John Wiley & Sons, Inc., 2012. Parts from B. Razavi: RF Microelectronics, 2nd edition, 2012. Also, additional material from other sources.
Assessment methods and criteria:
The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.

Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Risto Vuohtoniemi, Aarno Pärssinen.
Working life cooperation:
No
Other information:
-

521327S: Radio Engineering II, 6 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Aarno Pärssinen, Risto Vuohtoniemi

Opintokohteen kielet: English

Leikkaavuudet:

521375S	Design of Tranceivers	5.0 op
521375S-01	Exam, Radio Engineering II	0.0 op
521375S-02	Design of tranceivers, partial credit	0.0 op

ECTS Credits:
6 ECTS cr
Language of instruction:
English
Timing:
Spring, period 3
Learning outcomes:
1. understands radio system and RF design for modern wireless equipment like cellular phones.
2. recognizes the blocks of a transceiver and can explain the operating principle of a transceiver.

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

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

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

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

7. understands the principles of frequency synthesis in a transceiver.
8. understands principles of key implementation technologies of radio transceivers and relation to electronics.
Contents:
Designing a transceiver at the system level, transceiver architectures, performance characteristics of transceivers, nonlinearities, factors which limit the performance of a transceiver, placement of the A/D-converter in a receiver, frequency synthesis, design and implementation examples.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 32 h and the compulsory design exercise with ADS simulation software (40 h).
Target group:
1st year M.Sc. and WCE-RF students
Prerequisites and co-requisites:
Radio Engineering I
Recommended optional programme components:

-
Recommended or required reading:
Lecture notes. Parts from B. Razavi: Microelectronics, 2nd edition, 2012. Parts from A. Luzatto, M. Haridim: Wireless Transceiver Design, 2nd edition, 2017.
Assessment methods and criteria:
The course is passed with a final examination and the accepted simulation work report. In the final grade of the course, the weight for the examination is 0.75 and that for the simulation work 0.25.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5.
Person responsible:
Risto Vuohtoniemi, Aarno Pärssinen.
Working life cooperation:
No
Other information:
-

815305A: Real Time Distributed Software Development, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Petri Pulli

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during periods 1 and 2.
Learning outcomes:
After completing the course, the student is able to analyse the characteristics of real-time distributed systems; is able to acquire an object-oriented, model-based approach to solve the design problems found in real-time systems; is able to detect and derive specific problems facing the real-time software designer, and to suggest design patterns to solve those problems.

Contents:
Introduction 1. Characteristics of real-time systems; 2. Resource management; 3. Safety and reliability; 4. Time constraints; 5. Concurrency; 6. Scheduling; 7. Interrupts Characteristics of Distribution 1. Distribution architectures 2. Concept of time; 3. Synchronisation; 4. Latency and jitter; 5. Quality of service; 6. Service discovery; 7. Networking primitives Real-Time UML Modelling Methodology Real-Time Design Patterns Design Examples: Embedded, Ubiquitous, Mobile, Web / Internet, Blockchain and Bitcoin.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 40 h, design exercises 15 h, student project 80 h.
Target group:
MSc students
Prerequisites and co-requisites:
Computer architecture, object-oriented analysis and design (UML), programming language C and / or Java.
Recommended or required reading:
Lecture notes. Course book: Douglass B.P. (2009) Real-Time Design Patterns – Robust Scalable Architecture for Real-Time Systems. Addison-Wesley ISBN 0-201-69956-7. 500 p.
Assessment methods and criteria:
Exam and project evaluation.
Grading:
Numerical scale 1-5 or fail.
Person responsible:

Petri Pulli
Working life cooperation:
One or two industrial guest lecturers.

813621S: Research Methods, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Arto Lanamäki

Opintokohteen kielet: English

Leikkaavuudet:

521146S Research Methods in Computer Science 5.0 op

ECTS Credits:
5 ECTS credits / 133 hours of work
Language of instruction:
English
Timing:
The course is held in the autumn semester, during periods 1 and 2. It is recommended to complete the course in the 1st autumn semester.
Learning outcomes:
Having completed the course, the student is able to explain the general principles of scientific research and the practices of scientific methodology. The student is also able to generate research problems in information processing sciences. The student is able to identify and describe the main research approaches and methods in information processing sciences, and choose the appropriate approach and method for a research problem. The student is also able to evaluate the methodological quality of a research publication. After the course the student is able to choose and apply the proper approach and method for his or her Master's thesis and find more information on the method from scientific literature.
Contents:
Introduction to general scientific principles, scientific research practices and quality of scientific publications, qualitative research approaches and selected research methods, quantitative research approaches and selected research methods, design science research and selected methods, requirements and examples of Master's theses, evaluation of research.
Mode of delivery:
Face-to-face teaching, lecture videos.
Learning activities and teaching methods:
Lectures 40 h, exercises 30 h and individual work 65 h. Learning diary is written about the lectures and exercises. Exercises include group work.
Target group:
MSc students
Prerequisites and co-requisites:
Completion of Bachelor's studies.
Recommended or required reading:
Lecture slides and specified literature.
Assessment methods and criteria:
Accepted learning diary.
Grading:
Pass or fail.
Person responsible:
Arto Lanamäki

521124S: Sensors and Measuring Techniques, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Teemu Myllylä, Igor Meglinski

Opintokohteen kielet: Finnish

ECTS Credits:
5
Language of instruction:
English.

Timing:
Period 2.
Learning outcomes:
After the course the student is capable to explain the operating principles of different sensors and can select a right sensor for each measuring target. He/she is able to quantify the requirements that affect sensor selection as well as recognize and evaluate the uncertainty of a measurement. In addition the student is able to plan and design sensor signal conditioning circuits.
Contents:
Methods for measuring displacement, velocity, acceleration, torque, liquid level, pressure, flow, humidity, sound and temperature. Ultrasound, optical and nuclear measurement techniques and applications, material analyses such as pH measurement and gas concentration, pulp and paper measurements and smart sensors.
Mode of delivery:
Pure face-to-face teaching.
Learning activities and teaching methods:
Lectures 26h, exercises 12h and self-study 100h.
Target group:
4 year students.
Prerequisites and co-requisites:
No.
Recommended optional programme components:
No.
Recommended or required reading:
H. N. Norton: Handbook of Transducers, Prentice Hall P T R, 1989 or 2002; lecture and exercise notes.
Assessment methods and criteria:
The course is passed by a final exam and passed exercises.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Igor Meglinski
Working life cooperation:
No.

521279S: Signal Processing Systems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS cr
Language of instruction:
English
Timing:
Autumn, period 2
Learning outcomes:
1. Student can explain the challenges of signal processing hardware, software, and design methodologies.

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

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

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

Contents:
Binary and floating point arithmetic, DSP programming models and co-design, digital signal processors, algorithms and implementations, including CORDIC, transforms (FFT and DCT), multi-rate signal processing, polyphase filters, filter banks, adaptive algorithms and applications. The software environments of the course are Matlab with the Fixed Point Toolbox extension and Simulink with the DSP Blockset extension.
Mode of delivery:
Lectures, independent work, group work.
Learning activities and teaching methods:
The course consists of lectures (30 h) and design exercises (6-12 h). the rest as independent work (33h).
Target group:
Computer Science and Engineering students: This is an advanced-level course intended for masters-level students, especially to those that are specializing into signal processing. + Other Students of the University of Oulu.
Prerequisites and co-requisites:
521337A Digital Filters, 521267A Computer Engineering or 521286A Computer Systems, 8 ECTS cr or 521287A Introduction to Computer Systems, 5 ECTS cr
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Lecture notes and exercise materials. Material is in English.
Assessment methods and criteria:
Grading is based on the evaluation of the design exercises, which are done during the course, and exams, which are arranged during the lectures.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Olli Silven
Working life cooperation:
None.

521044A: Social Computing, 5 op

Voimassaolo: 01.08.2018 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Simo Hosio

Opintokohteen kielet: English

ECTS Credits:
5 ECTS cr / 135 hours of work
Language of instruction:
Finnish; course can also be completed in English.
Timing:
The course is organsed during the spring semester, during period III. It is recommended to complete the course at the 3rd spring semester.
Learning outcomes:
By the end of the course, students:
-- possess the skills for analysing and designing socially intelligent applications that consist of individuals and computing devices in a variety of contexts.
-- apply the best practices and avoid major pitfalls in designing social services and applications

-- have advanced understanding of both the positive and negative real-world consequences/aspects of social computing systems
-- aree able to explain human behaviour with social computing systems by using theories from such as sociology or psychology.

Contents:
Basics of social computing, computer-mediated human communication, designing social software, analysing social computing projects, crowdsourcing
Mode of delivery:
The course consists of lectures, exercises and individual / group-based assignments.
Learning activities and teaching methods:
The course consists of lectures (12h), exercises (16h), assignments and self-study (102h).
Target group:
M.Sc. and B.Sc. students. The course recommended for anyone who wishes to strengthen their expertise on human-computer interaction regards the social component.
Prerequisites and co-requisites:
Recommended: 521145A - Human-Computer Interaction
Recommended optional programme components:
The course is an independent entity, and does not require other courses from the student.
Recommended or required reading:
Selected academic publications, delivered upon starting the course.
Assessment methods and criteria:
The students are assessed based on the quality of the assignments. Some of the assignments are peer-evaluated and some are assessed by the course staff.
All the assessment criteria are based on the learning goals of the course.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical (1-5)
Person responsible:
Simo Hosio
Working life cooperation:
When possible, guest lectures by local companies are organized, to explain further how social computing drives business.

813620S: Software Business Management, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Marianne Kinnula

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.

Language of instruction:
English

Timing:
The course is held in the spring semester, during period 3. It is recommended to complete the course in the 1st spring semester.
Learning outcomes:
Upon completion of the course, the student will be able to assess the main problem areas in software business management and is able to describe how to manage these problems; will be able to use different kinds of tools for managing this diverse and ambiguous environment; will understand the differences between leading and managing and be able to apply these to practice; will be able to analyse a company situation in a continually changing, unpredictable and even hostile environment, and is able to make well-grounded recommendations for the company courses of action.
Contents:

The software business environment and context is complex and under continuous change. Competences and creativity of company employees are needed for creating value and growth to the company. Managing a software business is a challenging task as traditional, rational management models are often inadequate for the needs of the managers. This course provides an overview of the strategic management of the software business in a software company.
Mode of delivery:
Face-to-face teaching.

Learning activities and teaching methods:
Lectures and exercises 24 h, course assignments 72 h, (home) exam 30 h.
Target group:
MSc students
Prerequisites and co-requisites:
Basic knowledge of academic writing technique is needed. Basic understanding of software business is an advantage.
Recommended optional programme components:

Recommended or required reading:
Lecture slides and specified literature.
Assessment methods and criteria:
Participation in lectures / exercises, group work, course assignments.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Marianne Kinnula

815662S: Software Engineering Management, Measurement and Improvement, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Oivo, Markku Tapani

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during period 2. It is recommended to complete the course in the 2nd autumn semester.
Learning outcomes:
After completing the course the student understands the fundamental principles of software processes and their development in professional software engineering. The course extends the understanding of quality based on individual techniques (e.g. reviews) so that after completing the course the student is able to:
- Understand professional software development processes in agile, lean and traditional environments
- Evaluate different methods and techniques
- Select from them appropriate ones for different software engineering environments
- Have capabilities to participate in systematic efforts for improvement in software companies.

Contents:
The course covers the most fundamental process centred software quality improvement and management approaches, methods and latest research results, as well as approaches to software measurement. The topics of the course include: traditional waterfall, agile (extreme programming, Scrum, Rational unified process, crystal, feature driven development, adaptive software development, dynamic systems development method) and lean methods, process improvement approaches, software process and product measurement, agile and lean practices, process improvement at the enterprise level and practical examples from software industry.
Mode of delivery:
Face-to-face teaching + Seminars.
Learning activities and teaching methods:

9 Lectures (30 hours), 7 Seminars (30 hours), Individual weekly assignments (43 hours), Group work (30 hours).
Target group:
MSc students
Prerequisites and co-requisites:
BSc or other equivalent degree and basic knowledge of software engineering.
Recommended or required reading:

- Agile Project Management with Scrum. Ken Schwaber, Microsoft Press, ISBN 0-7356-1993-X. 2004
- Dingsøyr T., Dybå T., Moe N.B., Agile Software Development: Current Research and Future Directions, Springer, 2010
- C. Jones, Applied Software Measurement: Global Analysis of Productivity and Quality, 3rd ed. McGraw-Hill Osborne Media, 2008
- Craig Larman and Bas Vodde, Scaling Lean & Agile Development: Thinking and Organizational Tools for Large-Scale Scrum, Addison-Wesley, 2009
- CMMI: Guidelines for Process Integration and Product Improvement. Mary Beth Chrissis, Mike Konrad, Sandy Shrum. Addison-Wesley, ISBN 032-115496-7, 2004.

Assessment methods and criteria:
Active and regular participation to lectures and seminars AND report evaluation AND seminar presentations.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Markku Oivo
Working life cooperation:
Visiting lecture from industry.

815663S: Software Engineering Research, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Muhammad Ahmad, Oivo, Markku Tapani

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during periods 1 and 2. It is recommended to complete the course in the 2nd autumn semester.
Learning outcomes:
After completing the course the student will know the current research areas in software engineering and the most important software engineering research methods. The student understands academic research and publishing in software engineering, and is able to critically analyse scientific articles from the viewpoint of the content and research methods used in the article. The student is able to present academic research and actively participate in an academic discussion of research papers and research results.
Contents:
State of the art research methods and topics in software engineering.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures and seminars 28 h, exercises / assignments 78 h, weekly study 42 h.
Target group:
MSc students
Prerequisites and co-requisites:
BSc or other equivalent degree.
Recommended or required reading:

Assessment methods and criteria:

Active participation in lectures and attendance. Final grade is composed of attendance, assignments and term paper. No remote participation or distance learning.
Grading:
Numerical scale 1-5 or fail.

Person responsible:
Markku Oivo

817614S: Software Factory Project, 10 op

Voimassaolo: 01.08.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Information Processing Science DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Pasi Kuvaja
Opintokohteen kielet: English

ECTS Credits:
10 ECTS credits / 267 hours of work.
Language of instruction:
English
Timing:
The course is held in the spring semester, during periods 3 and 4. It is recommended to complete the course in the 1st spring semester.
Learning outcomes:
After completing the course, the students should demonstrate their abilities to work on a challenging ICT project. Students will learn to acquire and apply professional expertise in the topic of the project. Students will also demonstrate their skills to conduct an ICT project in a professional way. By completing this course, students are able to act as independent professional members of an ICT project and have advanced professionalism in project work and management. The topics for the course can be anything from the ICT field. As a professional expert conducting a successful project in a managed way, the student is able to: collectively produce, monitor and update the plan of the project (project with fixed time and human resources); search up to date information on the subject matter of the project in order to build professional expertise on the topic and apply this in the project work; build professional working knowledge and skills focused in the subject area of the project (e.g. software development, user experience evaluation); develop analytical and creative skills for successful completion of the project; monitor and communicate the status (time & human resources used) of the project in real time within the project team (weekly/daily meetings); use systematic means (e.g. ICT tools) to enable communication and transparency of the project work; develop skills to communicate with the customer in a professional context; manage a successful project review with the steering group/project team organization; report and explain the status (progress, results and future estimations of the project) to the steering group to support the decision making and problem resolution concerning the project's future; work as responsible project team member; as an expert and/or project manager; work as a project team member with people from different technical and/or cultural backgrounds; produce a realistic outcome in relation to the project time and human resources (ok, good, excellent); reflect the relationship between the process model(s) selected for the project (waterfall, evolutionary, agile etc.) and the management practices followed in the project.
Contents:
Starting lectures (4 x 2 h) and two workshops (2 x 8 h), where the steps of carrying out the course will be described together with other important information. Allocation of the project teams will immediately follow the starting lectures. The project work will take two periods (one semester). Unique project material provided by the customer of the project and / or material to be collected and studied by the project team.
Mode of delivery:
Blended teaching.
Learning activities and teaching methods:
Project work 260 h per student. Working hours reported during the project. Attendance at the starting lectures (8 h) and wokshops (16 h) is mandatory.

Target group:
MSc students.
Prerequisites and co-requisites:

Mandatory: B.Sc. degree or other equivalent degree. Students enrolling directly to the Master's programme should take the "Preparatory course for MSc studies (811392A)" course first (see the timetable for the autumn semester, period 1) or otherwise master the basics of project work and management as in Pressman, R.S. Software Engineering: A Practitioner's Approach, the chapters related to project management.

Recommended or required reading:
Agile Project Management with Scrum. Ken Schwaber, Microsoft Press, ISBN 0-7356-1993-X. 2004. - R.S. Pressman: Software Engineering - A Practitioner's Approach. Sixth Edition. McGraw-Hill 2005 -Avison, D., Fitzgerald, G. (2006) Information Systems Development, methodologies, techniques & tools. Fourth Edition. London: McGraw-Hill.
Assessment methods and criteria:
Skills will be reported by a project portfolio. Details about the assessment criteria will be given at the starting lecture and they will also be available in the web-based learning environment
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Pasi Kuvaja
Working life cooperation:
Learning by doing, i.e. managing authentic, resource-limited project work and integrating the practices of an academic expert into the unique project assignment.
Other information:
Enrollment for the course is well beforehand, i.e. until the end of December during 1st study year.

815312A: Software Production and Maintenance, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mika Mäntylä

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work
Language of instruction:
English
Timing:
The course is held in the spring semester, during period 3. It is recommended to complete the course in the 1st spring semester.
Learning outcomes:
After completing the course, the student:
- Can apply the framework of product line engineering in large scale software production
- Can apply the maintenance process and techniques in software production.

Contents:
Product line engineering: 1. Product line variability; 2. Domain engineering; 3. Application engineering; 4. Transition strategies and organisational issues. Principles and practices of software evolution and maintenance.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h, exercises/ assignments 18 h, weekly study and learning diary 4 2h, term project 45 h.
Target group:
MSc students
Prerequisites and co-requisites:
Basic knowledge of software engineering and software architectures.
Recommended or required reading:
Pohl, K., Böckle, G., van der Linden, F. Software Product Line Engineering. Foundations, Principles, and Techniques, Springer-Verlag, 2005; chapters 1-5, 10, 15, 19-20. Chastek G.J., Donohoe P., McGregor J.D., Formulation of a Production Strategy for a Software Product Line, Technical Note CMU/SEI-2009-TN-025, Carnegie Mellon, 2009. Software Evolution and Maintenance, Priyadarshi Tripathy, Kshirasagar Naik, ISBN: 978-0-470-60341-3, 416 pages, January 2015.

Assessment methods and criteria:
Active participation to lectures and attendance. Final grade is composed of attendance, learning diary, assignments and term project.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Mika Mäntylä

521479S: Software Project, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Christian Wieser

Opintokohteen kielet: English

ECTS Credits:
7
Language of instruction:
Finnish/English, material available in English.
Timing:
Autumn, periods 1-2.
Learning outcomes:
After completing the course, students have demonstrated their capabilities to design, develop and test real-life software. Further, they have shown their proficiency in professionally documenting their work during the assignment.
Contents:
Phases of software engineering process: requirement gathering, analysis, design, implementation, testing, (maintenance). Project-work, starting a project, project management, working with external parties, project documentation. Project related implementation techniques and tools, software documentation.
Mode of delivery:
Face-to-face and independent studies.
Learning activities and teaching methods:
Working methods: The course is done in groups of 3-4 students. The clients are typically various companies and societies. Project progress is supervised in formal reviews, where the project teams present their work as it reaches the milestones: the software requirement specification, the project plan, the software design specification, an operational prototype demonstration, the test documentation, and finally the functional software demonstration and release. In addition to formal reviews the project work is coordinated with steering group meetings. The work environment and development tools vary between projects. The number of students that can attend the course is limited. Lectures 10 h, design project in period 4-6 180 h.
Target group:
Computer Science and Engineering students and other Students of the University of Oulu.
Prerequisites and co-requisites:
521457A Software Engineering, 521453A Operating Systems, 521141P Elementary Programming, 521286A Computer Systems or 521142A Embedded Systems Programming and varying project related background reading.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Pressman, R.S.: Software Engineering A Practitioner's Approach, 4th edition, Mc Graw-Hill, 1997; Phillips, D.: The Software Project Manager's Handbook, IEEE Computer Society, 2000; Project documentation; project related manuals and handbooks.
Assessment methods and criteria:
Project work and documentation.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Christian Wieser
Working life cooperation:

-

Other information:

-

815311A: Software Quality and Testing, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Umar Farooq

Opintokohteen kielet: English

Leikkaavuudet:

ay815311A Software Quality and Testing (OPEN UNI) 5.0 op

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
The course is held in the autumn semester, during period 1. It is recommended to complete the course in the 1st autumn semester.
Learning outcomes:
The student understands different views on software quality and the role of testing as a part of software engineering validation and verification activities, and defect identification / removal techniques. The student knows testing levels, strategies and techniques, can create test cases and conduct unit testing with appropriate testing tools. The student knows the basics of test driven development and test automation.
Contents:
Software quality and quality assurance. Software quality management and metrics. Fundamental concepts of software testing. Functional and structural testing. Unit, integration, system, acceptance and regression testing. Hands on test-driven development. Test automation.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h, exercises / assignments 24 h, weekly study 42 h, term project 42 h.
Target group:
MSc students
Prerequisites and co-requisites:
Working knowledge of Java programming language is required. Basic knowledge of software engineering.
Recommended optional programme components:

Recommended or required reading:
Pezze M.,Young M., “Software Testing and Analysis: Process, Principles and Techniques”, John Wiley&Sons, 2008 *** Lasse Koskela, “Test Driven: Practical TDD and Acceptance TDD for Java Developers”, Manning Publications, 2007 *** Galin D., “Software Quality Assurance: From theory to implementation”, Addison-Wesley, 2004.
Assessment methods and criteria:
Active Participation to lectures and exercises. Final grade is composed of attendance, assignments and term project.
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Umar Farooq
Working life cooperation:
Usually visiting lecture from industry.

521348S: Statistical Signal Processing, 5 op

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

521484A Statistical Signal Processing 5.0 op

ECTS Credits:
5 ECTS
Language of instruction:
English
Timing:
Fall, during period 1
Learning outcomes:
Upon completion the student will

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

Contents:
Estimation theory, minimum variance unbiased estimator, Cramer-Rao lower bound, linear models, general minimum variance unbiased estimation, best linear unbiased estimators, maximum likelihood estimation, leas squares estimation, Bayesian estimation, linear Bayesian estimation, Kalman filters, statistical decision theory, receiver operating characteristics, hypothesis testing, matched filter.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Face-face-teaching, lectures and exercises 50 h and compulsory Matlab assignments 30 h, independent work 50 h. Some lectures may be replaced with video lectures.
Target group:
Electrical, communications, computer and system engineering as well as mathematics, physics and computer science students with knowledge of statistics in master or senior undergraduate level.
Prerequisites and co-requisites:
The required prerequisite is the completion of the following courses prior to enrolling for the course: 031080A Signal analysis, 031021P Statistics, 031078P Matrix algebra
Recommended optional programme components:
-
Recommended or required reading:
Parts from books Kay, Steven M. "Fundamentals of statistical signal processing, volume I: estimation theory." (1993), Kay, Steven M. "Fundamentals of statistical signal processing: Detection theory, vol. 2." (1998).
Assessment methods and criteria:
The course is passed with two midterms exams (there will also be arranged a University Exam covering whole course around 5-6 weeks after the course) and accepted MATLAB assignments (programs + reports). In the final grade of the course, the weight for the examination is 0.7 and that for the MATLAB assignments is 0.3.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero (0) stands for a fail.
Person responsible:
Markku Juntti
Janne Lehtomäki
Working life cooperation:
-

Other information:
-

817603S: System Design Methods for Information Systems, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Information Processing Science DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Pasi Karppinen
Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.
Language of instruction:
English
Timing:
E-exam.
Learning outcomes:
After the course the student understands the complexity of business, organizational, technical, and human aspects that affect ISD and the selection of methods in information systems design (ISD). The student also understands the defects of traditional waterfall model and how other methods aim to answer to these defects and to other challenges. In particular, with socio-technical methods (e.g., SSM) and their techniques the student is able to re-plan and develop the sub-systems (automated and non-automated) of organization into a coherent whole. The student is also able to assess and give arguments which method is suitable for an ISD project in an organization.
Contents:
Information Systems Strategy, Information Systems Development Life Cycle (SDLC), Information systems success, Soft Systems Methodology (SSM), Socio-Technical Approach, Evolutionary development, Agile methodologies.
Target group:
MSc students
Prerequisites and co-requisites:
Bachelor studies recommended.
Recommended optional programme components:

Assessment methods and criteria:
E-exam
Grading:
Numerical scale 1-5 or fail.
Person responsible:
Pasi Karppinen

521156S: Towards Data Mining, 5 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Computer Science and Engineering DP
Arvostelu: 1 - 5, pass, fail
Opettajat: Satu Tamminen
Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits
Language of instruction:

Finnish or English
Timing:
Autumn, period I.
Learning outcomes:
Student can recognize the type of the data before further analysis and the required preprocessing. The concrete learning outcomes are:

1. Student can design and implement the data gathering
2. Student can combine data from different sources
3. Student can normalize and transfor data, and handle missing or incorrect data.
4. Student can ensure the generalizability of the results.

Contents:
Course provides good ability to start Master's Thesis or graduate studies. Topics at the course include data mining process in general level, data gathering and different data types, quality and reliability of the data, data preparation including the processing of missing values, outliers, and privacy issues, combination of signals from several sources, utilization of data bases in data mining process, and normalization and transformation of data and interdependence of the observations and their distributions. Additionally, topics concerning the generality of the results are covered, as well as, the principles of data division, for example, train-test-validate, cross-validation and leave-one-out methods.
Mode of delivery:
Lectures, independent work, group work
Learning activities and teaching methods:
16h lectures, 16h exercises, independent studying.
Target group:
The course is suitable for Master level students in Computer science and engineering study programmes, for minor subject studies or for doctoral students.
Prerequisites and co-requisites:
031021P Probability and Mathematical Statistics or similar
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Lecture hand-out and exercise material will be provided. The course book will be announced in the beginning of the course. The material is mostly in English.
Assessment methods and criteria:
Participation in mandatory classes and final exam.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 1-5; zero stands for a fail.
Person responsible:
Tamminen Satu
Working life cooperation:
-
Other information:
-

521154S: UBISS - International UBI Summer School, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ojala, Timo Kullervo

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
5 ECTS credits / 133 hours of work
Language of instruction:
English.
Timing:

Summer semester (June).
Learning outcomes:
Summer school comprises of multiple parallel workshops that each have specific learning outcomes.
Contents:
Each workshop has specific contents.
Mode of delivery:
Face-to-face teaching in workshops.
Learning activities and teaching methods:
Lectures, a project completed as group work, self-study.
Target group:
MSc. and doctoral students.
Prerequisites and co-requisites:
Each workshop may have specific prerequisites.
Recommended optional programme components:
None.
Recommended or required reading:
Each workshop has a specific reading package.
Assessment methods and criteria:
Final exam (50%), project (50%).
Grading:
The summer school uses a numerical grading scale 1-5.
Person responsible:
Professor Timo Ojala.
Working life cooperation:
None

521148S: Ubiquitous Computing Fundamentals, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Ojala, Timo Kullervo

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits / 133 hours of work
Language of instruction:
English
Timing:
Autumn, periods 1-2.
Learning outcomes:
Upon completing the course the student:
1. understands the history and current state of ubiquitous computing.
2. is able to design, implement, and evaluate a ubiquitous computing system.
3. is able to carry out a research project from initial research problem statement to prototype implementation, empirical evaluation in-the-wild, and reporting in form of a research paper.
Contents:
Ubiquitous computing systems, privacy, field studies, ethnography, interfaces, location, context-aware computing, processing sequential sensor data.
Mode of delivery:
Face-to-face
Learning activities and teaching methods:
Lectures 20 h / exercises 20 h / project work 50 h / self-study 43 h. Exercises and project work are completed as a group work.
Target group:
M.Sc. students (computer science and engineering) and other students of the University of Oulu.
Prerequisites and co-requisites:
None.
Recommended optional programme components:

None.
Recommended or required reading:
Required literature: John Krumm (editor) Ubiquitous Computing Fundamentals, Chapman & Hall, 2010, ISBN 978-1-4200-9360-5, 328 pages; selected scientific publications.
Assessment methods and criteria:
The course is passed with approved exercise reports and an approved project work.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course uses numerical scale 1-5.
Person responsible:
Professor Timo Ojala
Working life cooperation:
None.

812671S: Usability Testing, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Information Processing Science DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Rajanen

Opintokohteen kielet: English

ECTS Credits:
5 ECTS credits / 133 hours of work.

Language of instruction:
English and Finnish
Timing:
The course is held in the spring semester, during periods 3 and 4.

Learning outcomes:
After completing the course, the student can:

- Design and follow through a usability testing process;
- Design usability test scenarios and tasks;
- Select test subjects;
- Plan and follow through usability tests as laboratory tests or field tests;
- Analyse and report the findings from usability tests.

Contents:
Basic terms and types of usability testing, usability tests process, usability test tasks and scenarios, test subjects, following through a usability test, analysing usability test material, reporting the findings from usability tests.

Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24h, assignment tutoring 13h, assignment 90h, seminar 7h.
Target group:
MSc students

Prerequisites and co-requisites:
Student is familiar with most common user interface design terms, design and evaluation methods as in “Introduction to Human-Computer Interactions” course.
Recommended optional programme components:

Recommended or required reading:

Dumas, J. S. & Redish, J. C. (1993): A Practical Guide to Usability Testing. Ablex Publishing Corporation. Rubin, J. (1994): Handbook of
Usability Testing: How to Plan, Design, and Conduct Effective Tests. Chichester: John Wiley & Sons, Inc.

Assessment methods and criteria:
Assessment of the course is based on the learning outcomes of the course based on the written usability test plan, supervised usability tests, written usability test report and oral seminar presentation

Grading:
Numerical scale 1-5 or fail.

Person responsible:
Mikko Rajanen

Working life cooperation:
No

Other information:

521323S: Wireless Communications I, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Iinatti

Opintokohteen kielet: English

Leikkaavuudet:

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

ECTS Credits:
5 ECTS cr

Language of instruction:
English

Timing:
Fall, period 2

Learning outcomes:
1. can analyze the performance of multilevel digital modulation methods in AWGN channel
2. can explain the effect of fading channel on the performance of the modulation method and can analyze the performance
3. recognizes the suitable diversity methods for fading channel and related combining methods
4. can define the basic carrier and symbol synchronization methods and is able to make the performance comparison of them
5. can explain design methods signals for band-limited channels
6. can classify different channel equalizers, and perform the performance analysis

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

Mode of delivery:
Face-to-face teaching

Learning activities and teaching methods:
Lectures and exercise (total 44 hours) and the compulsory design work with a simulation program (20 h)

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

Prerequisites and co-requisites:
521330A Telecommunication Engineering 521316S Broadband Communications Systems
Recommended optional programme components:
-
Recommended or required reading:
Parts of book: Andrea Goldsmith: Wireless Communications, Cambridge University Press, 2005. Parts of book: J. G. Proakis: Digital Communications, 4th ed, McGraw Hill, 2001.
Assessment methods and criteria:
The course is passed with minor exams (only during lecture period) or with final exam; and the accepted design work report. In the final grade of the course, the weight for the examination(s) is 0.6 and that for the design work report 0.4.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:
Jari Iinatti
Working life cooperation:
No
Other information:
-

521097S: Wireless Measurements, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Saarela

Opintokohteen kielet: English

Leikkaavuudet:

521114S	Wireless Measurements	4.0 op
521114S-01	Wireless Measurements, exam	0.0 op
521114S-02	Wireless Measurements, exercise work	0.0 op

ECTS Credits:
5 ECTS credits / 128h
Language of instruction:
In Finnish or in English if two or more foreign students participate.
Timing:
Period 3.
Learning outcomes:
1. can tell and justifying argument the benefits and challenges of using wireless measurement solutions
2. can apply the most important standards when designing wireless measurement solutions
3. can apply wireless technologies in industrial, traffic, environmental, home and healthcare measurements
Contents:
Basics of wireless measurement technologies and standards, wireless sensors and sensor networks, wireless building and smart home applications, wireless measurement applications in traffic, wireless environmental measurements and wireless human health monitoring.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
Lectures 22h. Seminars 6-12h depending on the number of students participating the course. The students prepare seminar presentations about contemporary topics selected by themselves or proposed by the teacher and give 10 minutes presentation to other students in the seminars.
Target group:
Master level students regardless of master's programme.
Prerequisites and co-requisites:
No prerequirements, but basics of measurements systems are recomended.

Recommended optional programme components:
The course replaces previous courses with same name, but different credits and code.
Recommended or required reading:
Lecture notes and seminar reports is Optima.
Assessment methods and criteria:
The course is passed with a written final exam (70 %) and a contemporary seminar (30 %).
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Grade is on numerical scale 1-5.
Person responsible:
Juha Saarela
Working life cooperation:
No.

521080S: X-ray Diffraction, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Electrical Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Juha Hagberg

Opintokohteen kielet: Finnish

ECTS Credits:
5 ECTS credits / 132,5 hours of work
Language of instruction:
Finnish, English if needed
Timing:
Autumn semester period 2. Lectured every other year.
Learning outcomes:
1. explain the general principles of interaction between X-rays and solid matter and the physics underlying behind these phenomena

2. explain how the crystal structure, phase ratio, grain size and stress state in a solid material with X-ray diffraction (XRD) method can be experimentally determined
Contents:
Generation, detection and properties of x-rays. X-ray scattering and diffraction methods. Determination of crystal structure and phase composition. Analysis of grain size, texture and stresses. Electron and neutron diffraction.
Mode of delivery:
Lectures, exercises and laboratory work.
Learning activities and teaching methods:
Lectures and exercises altogether 32 h / laboratory work 18 h / self-access writing of work report 30 h / self-access learning 52,5 h.
Target group:
Primarily for students in Electronics and Communications Engineering.
Prerequisites and co-requisites:
Basic physics and mathematics.
Recommended optional programme components:
The course is an independent entity and does not require additional studies carried out at the same time.
Recommended or required reading:
Lecture notes. For reference, parts from books B.E. Warren: X-ray diffraction, Addison-Wesley, 1969., B.D. Cullity and S.R. Stock: Elements of X-Ray Diffraction, 3rd Edition, 2001, Prentice Hall and some other books informed by lecturer.
Assessment methods and criteria:
Final grade of the course will be a weighted average of theoretical examination (2/3) and laboratory exercises (1 /3).
Read more about assessment criteria at the University of Oulu webpage.
Grading:
The course utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail.
Person responsible:

Juha Hagberg
Working life cooperation:
No
Other information:
The course is held next in autumn 2019.