

Opasraportti

FSci -Master's programme in Mathematical Sciences (2017 - 2018)

Tutkintorakenteet

Master's degree (Mathematical Sciences)

Tutkintorakenteen tila: archived

Lukuvuosi: 2017-18

Lukuvuoden alkamispäivämäärä: 01.08.2017

Studies of the line of specialization (vähintään 120 op)

Mathematics orientation

H325053: Mathematics advanced module, 0 - 100 op

Electives

- 802656S: Algebraic numbers, 5 op
- 802664S: Differential geometry, 10 op
- 802649S: Dynamical systems, 10 op
- 802666S: Linear Optimization, 5 op
- 802667S: Nonlinear Optimization, 5 op
- 802647S: Fourier series and the discrete Fourier transform, 10 op
- 802650S: Fractal Geometry, 10 op
- 802652S: Hilbert Spaces, 5 op
- 802635S: Introduction to partial differential equations, 10 op
- 802655S: Continued Fractions, 5 op
- 801698S: Cryptography, 5 op
- 802645S: Number Theory A, 5 op
- 802607S: Introduction to Mathematical Software, 5 op
- 800693S: Theory of Matrices, 5 op
- 802651S: Measure and Integration, 5 op
- 802665S: Numerical Analysis, 5 op
- 802660S: Operator theory and integral equations, 10 op
- 802669S: Topology, 5 op
- 805628S: Probability Distributions, 5 op
- 805622S: Simulation methods, 5 op
- 800683S: Project in mathematics, 10 op
- 802668S: Introduction to Functional Analysis, 5 op
- 800600S: Maturity test, 0 op
- 800698S: Pro gradu thesis, 30 op

Applied mathematics orientation

H325853: Advanced Studies in Computational Mathematics, 40 - 80 op

Alternative

- 802665S: Numerical Analysis, 5 op
- 031051S: Numerical Matrix Analysis, 5 op
- 802666S: Linear Optimization, 5 op
- 802667S: Nonlinear Optimization, 5 op
- 805628S: Probability Distributions, 5 op
- 805627S: Theory of Statistical Inference, 5 op
- 801645S: Special Work in Applied Mathematics, 10 op
- 802647S: Fourier series and the discrete Fourier transform, 10 op
- 802652S: Hilbert Spaces, 5 op
- 802635S: Introduction to partial differential equations, 10 op
- 802661S: Introduction to numerical inverse problems, 5 op
- 806624S: Practical training/consulting, 5 - 7 op

H325852: Advanced Studies in Data Science, 40 - 80 op

Mandatory Advanced Studies

- 805627S: Theory of Statistical Inference, 5 op
- 805628S: Probability Distributions, 5 op
- 806624S: Practical training/consulting, 5 - 7 op

Alternative

- 805630S: Generalized Linear Models, 5 op
- 805665S: Bayesian analysis, 5 op
- 805679S: Time series analysis, 5 op
- 805629S: Sampling methods, 5 op
- 805663S: Experimental design, 5 op
- 805661S: Quantitative genetics, 5 op
- 805662S: Survival analysis, 5 op
- 806635S: Mixed Linear Models, 5 op

Mandatory studies

- 521289S: Machine Learning, 5 op
- 521283S: Big Data Processing and Applications, 5 op
- 521156S: Towards Data Mining, 5 op
- 521158S: Natural Language Processing and Text Mining, 5 op
- 521290S: Distributed Systems, 5 op

800600S: Maturity test, 0 op

805687S: Pro gradu seminar, 5 op

800699S: Pro gradu thesis, 30 op

805622S: Simulation methods, 5 op

Subject teacher's orientation

800600S: Maturity test, 0 op

800697S: Pro Gradu Thesis, 20 op

802641S: Special Course for Teachers of Mathematics: Training, 2 - 5 op

800661S: Special course for teachers of mathematics, 5 op

H325052: Subject teacher's advanced module, 0 - 100 op

Advanced studies for subject teacher students

- 802662S: Supervising advanced problems, 5 op
- 802655S: Continued Fractions, 5 op
- 802652S: Hilbert Spaces, 5 op
- 802666S: Linear Optimization, 5 op
- 802667S: Nonlinear Optimization, 5 op
- 801698S: Cryptography, 5 op
- 801389A: Basic Geometry, 6 op
- 802336A: Introduction to Cryptography, 5 op
- 802365A: Introduction to Mathematical Software, 5 op
- 802328A: Basics in Number Theory, 5 op
- 800323A: Field extensions, 5 op
- 802334A: A Second Course in Differential Equations, 5 op
- 031022P: Numerical Analysis, 5 op
- 031025A: Introduction to Optimization, 5 op
- 031077P: Complex analysis, 5 op
- 802338A: Complex Analysis II, 5 op

801396A: Introduction to Probability Theory II, 5 op

Intermediate studies

800320A: Differential equations, 5 op

802365A: Introduction to Mathematical Software, 5 op

801396A: Introduction to Probability Theory II, 5 op

802361A: Numerical Computation, 5 op

805350A: Estimation and Test Theory, 5 op

805306A: Introduction to Multivariate methods, 5 op

801396A: Introduction to Probability Theory II, 5 op

805305A: Introduction to Regression and Analysis of Variance, 5 op

805349A: Likelihood and Bayesian Inference, 5 op

805351A: Linear Regression, 5 op

805353A: Statistical Software, 5 op

Other minor studies

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuuluvien opintokohteiden kuvaukset

H325053: Mathematics advanced module, 0 - 100 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Electives

802656S: Algebraic numbers, 5 op

Voimassaolo: 01.01.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish and English

Timing:

3/4 year, 1st period

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

First we revise some basics of rings and fields which are needed to proceed ahead field extensions. In particular, divisibility in an integral domain is carefully studied yielding to applications in the theory of polynomial algebra and algebraic integers. The theory of algebraic numbers is strongly based on polynomial algebra, where the properties of zeros and divisibility of polynomials are considered. The definition of an algebraic number will be generalized to the algebraic elements of field extensions going forward to algebraic fields. Considered as most important algebraic fields we get number fields which are finitely generated subfields of the field A of all complex algebraic numbers. In particular, we study quadratic number fields. Further, we shall consider the divisibility and factorization of algebraic integers with some applications to Diophantine equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h lectures, 14 h exercises, 91 h independent study

Target group:

Mathematics majors

Prerequisites and co-requisites:

Basics in Algebra, Algebraic structures, Matrix algebra, Linear algebra, Basics in Number Theory

Recommended or required reading:

I.N. Stewart and D.O. Tall: Algebraic number theory, Mollin, Richard A., Advanced number theory with applications,

Course material: <http://cc.oulu.fi/~tma/OPETUS.html>

Grading:

1-5, i

Person responsible:

Tapani Matala-aho

Working life cooperation:

-

802664S: Differential geometry, 10 op

Voimassaolo: 01.06.2014 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:

10 ECTS cr

Language of instruction:

English or Finnish

Timing:

4th or 5th year

Learning outcomes:

After completing the course successfully, students know the basic concepts of differential geometry and masters differential calculus on manifolds.

Contents:

Manifolds, vector fields, tensor fields and differential forms.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 56 h and exercises 28 h

Target group:

Major students in mathematics and physics

Prerequisites and co-requisites:

Bachelor's degree in mathematics or equivalent

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:

Lectures. Recommended reading is given on the first lecture.

Assessment methods and criteria:

Final exam or written work and talk.

Grading:

1-5 or pass/fail

Person responsible:

Esa Järvenpää

Working life cooperation:

No

802649S: Dynamical systems, 10 op

Voimassaolo: 01.01.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Esa Järvenpää

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802666S: Linear Optimization, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

800688S Theory of Optimization 10.0 op

Ei opintojaksokuvauksia.

802667S: Nonlinear Optimization, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

4th or 5th year of studies

Learning outcomes:

On successful completion of this course, the student will be able to choose the correct methods for solving the nonlinear convex optimization problems and implement the most typical numerical algorithms for solving them.

Contents:

The lecture course is focused to methods, which can apply for solving essential optimization problems of technical and economical sciences. The lectures consist of following topics: Convex optimization problem, unconstrained convex optimization, constrained convex optimization, dual of convex problem, Karush-Kuhn-Tucker conditions and penalty optimization method. The topics are considered theoretically and also numerical algorithms for problem solution are presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 14 h

Target group:

Major and minor students

Prerequisites and co-requisites:

Bachelor degree in mathematics or equivalent

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

A. L. Peressini, F.E. Sullivan, J.J. Uhl: The mathematics of Nonlinear Programming David g. Luenberger: Introduction to Linear and Nonlinear Programming

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Erkki Laitinen

Working life cooperation:

No

Other information:

-

802647S: Fourier series and the discrete Fourier transform, 10 op**Voimassaolo:** 01.01.2010 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Valeriy Serov**Opintokohteen kielet:** English

Ei opintojaksokuvauksia.

802650S: Fractal Geometry, 10 op**Voimassaolo:** 01.01.2010 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Esa Järvenpää**Opintokohteen kielet:** Finnish**Assessment methods and criteria:**Read more about [assessment criteria](#) at the University of Oulu webpage.**802652S: Hilbert Spaces, 5 op****Voimassaolo:** 01.08.2010 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800624S Analysis III 10.0 op

ECTS Credits:

5 ECTS credits

Assessment methods and criteria:Read more about [assessment criteria](#) at the University of Oulu webpage.**802635S: Introduction to partial differential equations, 10 op****Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802655S: Continued Fractions, 5 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Language of instruction:

FI/EN

Recommended or required reading:

G.H. Hardy & E.M. Wright: An Introduction to the Theory of Numbers.

Kenneth H. Rosen: Elementary number theory and its applications.

Lisa Lorentzen and Haakon Waadeland: Continued Fractions with Applications (1992).

Oskar Perron: Die Lehre von den Kettenbrüchen (1913).

Course material: <http://cc.oulu.fi/~tma/OPETUS.html>

801698S: Cryptography, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Language of instruction:

Finnish/English

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

In our lectures we study mathematical basics of encrypting, key exchange and signature systems. As examples, we mention elementary group and number theory used in primality tests and factoring, complexity estimates of computations-in particular in finite fields, repeated squaring and discrete logarithm in finite cyclic groups- applied in multiplicative groups of finite fields and addition groups of elliptic curves. Deduction of addition formulae in projective and affine Weierstrass elliptic curves. Diffie-Hellman key exchange, ElGamal encrypting and signature systems in finite cyclic groups applied in finite fields or in elliptic curves defined over finite fields. DSA, ECDSA, Massey-Omura. Some algorithms and tests: AKS, Fermat, Lenstra, Lucas, Miller-Rabin, Pohlig-Hellman, Pollard's p-1 and rho, pseudoprimes, quadratic sieve, Solovay-Strassen.

Assessment methods and criteria:

Read more about [assessment criteria](#) at the University of Oulu webpage.

802645S: Number Theory A, 5 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Tapani Matala-aho
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802607S: Introduction to Mathematical Software, 5 op

Voimassaolo: 01.08.2016 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Mikko Orispää
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800693S: Theory of Matrices, 5 op

Voimassaolo: 01.01.2017 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Emma Leppälä
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802651S: Measure and Integration, 5 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Ville Suomala
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802665S: Numerical Analysis, 5 op

Voimassaolo: 01.06.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

4th or 5th year of studies

Learning outcomes:

On successful completion of this course, the student will be able to choose proper numerical methods for solving basic mathematical problems and approximate the errors of numerical results.

Contents:

The lecture course is focused to numerical methods for solving the most common basic problems in mathematics. For the methods, convergence, stability and suitability for computer arithmetic are considered. The course contains numerical solution methods for the following basic problems: systems of nonlinear equations, systems of linear equations, interpolation, integration, derivation and differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 14 h

Target group:

Major and minor students

Prerequisites and co-requisites:

Bachelor's degree in mathematics or equivalent studies

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 Ward Cheney, David Kincaid: Numerical Mathematics and Computing

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Erkki Laitinen

Working life cooperation:

No

Other information:

-

802660S: Operator theory and integral equations, 10 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: English

ECTS Credits:

10 ECTS cr

Language of instruction:

English

Timing:

The course is held in the whole autumn semester 2014/2015, during periods I and II. It is recommended to complete the course at the end of autumn semester.

Learning outcomes:

Upon completion the student should be able to:

- Operate with self-adjoint operators in the Hilbert spaces.
- Operate with compact operators in the Hilbert spaces.
- Operator with one-dimensional integral equations of the first and second order.

Contents:

1. Inner product spaces and Hilbert spaces.
2. Symmetric operators in the Hilbert space. J. von Neumann's theorems about symmetric operators. Basic criterion of self-adjointness.
3. Orthogonal projection operators. J. von Neumann's spectral theorem.
4. Spectrum of self-adjoint operator.
5. Riesz theory of compact operators.
6. Quadratic forms. Friedrichs extension of symmetric operators.
7. Elliptic differential operators in bounded domains.
8. Spectral function of self - adjoint operators. Green's function.
9. Integral operators with weak singularities. Integral equations of the first and second kind.
10. Volterra integral equations.
11. Singular integral equations.
12. Nyström's method for equation of second kind.
13. The Galerkin method for integral equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 56 h / Group work 24 h / Self-study 24 h. The exercises are completed as group work. (N.B. This must show all the course hours, which means that total 104 hours = 10 ECTS credits).

Target group:

Major students in mathematics, physics and engineering.

Prerequisites and co-requisites:

The required (or recommended) prerequisite is the completion of the following courses prior to enrolling for the course: Linear Algebra, Ordinary differential equations (I), Complex analysis (I), Analysis (I) and (II).

Recommended optional programme components:

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

Recommended or required reading:

The following books are recommended (the course based on these books):

- 1) R. Kress, Linear integral equations, Springer-Verlag New York, 1999.
- 2) F. Riesz and B. Sz-Nagy, Functional analysis, Ungar, 1978.
- 3) A.N. Kolmogorov and S.V. Fomin, Elements of the theory of functions and functional analysis, Dover Publications, 1999.

Assessment methods and criteria:

The assessment criteria are based on the learning outcomes of the course. The final exam is required only.

Grading:

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

Person responsible:

Valery Serov

Working life cooperation:

-

802669S: Topology, 5 op**Voimassaolo:** 01.06.2016 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** English, Finnish

Ei opintojaksokuvauksia.

805628S: Probability Distributions, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

806631S Random variables and distributions 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3rd or 4th year of studies

Learning outcomes:

After successful completion of the course the student can define the basic concepts and theorems of uni- and multidimensional discrete and continuous probability distributions and can apply this knowledge in other studies in statistics or applied mathematics. After successful completion of the course the student can define the basic concepts and theorems of uni- and multidimensional discrete and continuous probability distributions and can apply this knowledge in other studies in statistics or applied mathematics.

Contents:

Point mass function, density function, cumulative distribution function and quantile function of uni- and multivariate distributions; joint, marginal and conditional distribution; expectation, variance, covariance, correlation coefficient; moment and cumulant generating function; distributions of transformations of random variables and vectors; delta-method; convergence of random variable sequences and limit theorems; main univariate distribution models, multivariate normal distribution, important sampling distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h) and practicals (14 h)

Target group:

Master's students of statistics, applied mathematics and mathematics

Prerequisites and co-requisites:

Introduction to probability theory I and II, vector analysis (or corresponding)

Recommended optional programme components:

Prerequisite for the course Theory of Statistical Inference

Recommended or required reading:

Severini, T. Elements of Distribution Theory, Cambridge University Press, 2012

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

Other information:

-

805622S: Simulation methods, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Sillanpää

Opintokohteen kielet: English, Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

Period 3

Learning outcomes:

After successful completion of the course the student is able to implement simple MCMC sampler to the computer and understand the basic principle of the MCMC sampling.

Contents:

The course covers basic methods how to generate samples from common distributions. Also principles of MCMC methods (Metropolis-Hastings, Gibbs sampling) needed in Bayesian analysis are central in the course.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h) and exercises (14 h)

Target group:

Statistics major and minor students

Recommended optional programme components:

Closely related to the course: Bayesian analysis

Recommended or required reading:

Christian P. Robert, George Casella (2010) Introducing Monte Carlo methods in R. Springer.

Grading:

Numerical grading 1-5 (or fail)

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

800683S: Project in mathematics, 10 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Esa Järvenpää

Opintokohteen kielet: Finnish, English

ECTS Credits:

10 ECTS credits / 266 hours of work

Language of instruction:

Finnish or English

Timing:

4th or 5th year

Contents:

The course starts with presentations of mathematics research groups. Students are divided into research groups and they make a small thesis under the supervision of a research group. The thesis is presented in a talk to other students.

Mode of delivery:

Face-to-face teaching and independent work.

Learning activities and teaching methods:

Seminars and own work

Target group:

Major's in pure mathematics

Prerequisites and co-requisites:

Bachelor's degree in mathematics

Recommended optional programme components:

Independent course

Recommended or required reading:

-

Assessment methods and criteria:

Thesis and talk

Grading:

1-5

Person responsible:

Esa Järvenpää

Working life cooperation:

-

802668S: Introduction to Functional Analysis, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** English

Ei opintojaksokuvauksia.

800600S: Maturity test, 0 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

800698S: Pro gradu thesis, 30 op**Opiskelumuoto:** Advanced Studies**Laji:** Diploma thesis**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

H325853: Advanced Studies in Computational Mathematics, 40 - 80 op**Voimassaolo:** 01.08.2017 -**Opiskelumuoto:** Advanced Studies**Laji:** Study module**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

*Alternative***802665S: Numerical Analysis, 5 op****Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

4th or 5th year of studies

Learning outcomes:

On successful completion of this course, the student will be able to choose proper numerical methods for solving basic mathematical problems and approximate the errors of numerical results.

Contents:

The lecture course is focused to numerical methods for solving the most common basic problems in mathematics. For the methods, convergence, stability and suitability for computer arithmetic are considered. The course contains numerical solution methods for the following basic problems: systems of nonlinear equations, systems of linear equations, interpolation, integration, derivation and differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 14 h

Target group:

Major and minor students

Prerequisites and co-requisites:

Bachelor's degree in mathematics or equivalent studies

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 Ward Cheney, David Kincaid: Numerical Mathematics and Computing

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Erkki Laitinen

Working life cooperation:

No

Other information:

-

031051S: Numerical Matrix Analysis, 5 op**Voimassaolo:** 01.08.2012 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Applied Mathematics and Computational Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Marko Huhtanen**Opintokohteen kielet:** Finnish**ECTS Credits:**

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish or English.

The course can be completed in English by intermediate exams or by a final exam.

Timing:

Fall semester, period 1

Learning outcomes:

After completing the course the student knows the most efficient and numerically stable methods to solve the basic problems in linear algebra. He/she knows the basic matrix factorizations and their approximations. The student has the capability to solve very large and sparse problems with the iterative solutions methods and understands the significance of preconditioning.

Contents:

Theory of matrix decompositions, SVD-decomposition, LU-decomposition, QR-decomposition, Schur-decomposition, FFT, eigenvalue- and generalized eigenvalue problems, matrix functions, GMRES, MINRES, Preconditioning.

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:

-

Prerequisites and co-requisites:

Completion of courses Calculus I and II, a course on Differential Equations and a Course on Linear Algebra and Numerical analysis

Recommended optional programme components:

-

Recommended or required reading:

Material posted on the web-page of the course.

Assessment methods and criteria:

Intermediate exams or a final exam.

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

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

Person responsible:

Marko Huhtanen

Working life cooperation:

-

Other information:

-

802666S: Linear Optimization, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

800688S Theory of Optimization 10.0 op

Ei opintojaksokuvauksia.

802667S: Nonlinear Optimization, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

4th or 5th year of studies

Learning outcomes:

On successful completion of this course, the student will be able to choose the correct methods for solving the nonlinear convex optimization problems and implement the most typical numerical algorithms for solving them.

Contents:

The lecture course is focused to methods, which can apply for solving essential optimization problems of technical and economical sciences. The lectures consist of following topics: Convex optimization problem, unconstrained convex optimization, constrained convex optimization, dual of convex problem, Karush-Kuhn-Tucker conditions and penalty optimization method. The topics are considered theoretically and also numerical algorithms for problem solution are presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 14 h

Target group:

Major and minor students

Prerequisites and co-requisites:

Bachelor degree in mathematics or equivalent

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

A. L. Peressini, F.E. Sullivan, J.J. Uhl: The mathematics of Nonlinear Programming David g. Luenberger: Introduction to Linear and Nonlinear Programming

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Erkki Laitinen

Working life cooperation:

No

Other information:

-

805628S: Probability Distributions, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

806631S Random variables and distributions 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3rd or 4th year of studies

Learning outcomes:

After successful completion of the course the student can define the basic concepts and theorems of uni- and multidimensional discrete and continuous probability distributions and can apply this knowledge in other studies in statistics or applied mathematics. After successful completion of the course the student can define the basic concepts and theorems of uni- and multidimensional discrete and continuous probability distributions and can apply this knowledge in other studies in statistics or applied mathematics.

Contents:

Point mass function, density function, cumulative distribution function and quantile function of uni- and multivariate distributions; joint, marginal and conditional distribution; expectation, variance, covariance, correlation coefficient; moment and cumulant generating function; distributions of transformations of random variables and vectors; delta-method; convergence of random variable sequences and limit theorems; main univariate distribution models, multivariate normal distribution, important sampling distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h) and practicals (14 h)

Target group:

Master's students of statistics, applied mathematics and mathematics

Prerequisites and co-requisites:

Introduction to probability theory I and II, vector analysis (or corresponding)

Recommended optional programme components:

Prerequisite for the course Theory of Statistical Inference

Recommended or required reading:

Severini, T. Elements of Distribution Theory, Cambridge University Press, 2012

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

Other information:

-

805627S: Theory of Statistical Inference, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805611S Mathematical statistics II 10.0 op

Ei opintojaksokuvauksia.

801645S: Special Work in Applied Mathematics, 10 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

802647S: Fourier series and the discrete Fourier transform, 10 op**Voimassaolo:** 01.01.2010 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Valeriy Serov**Opintokohteen kielet:** English

Ei opintojaksokuvauksia.

802652S: Hilbert Spaces, 5 op**Voimassaolo:** 01.08.2010 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800624S Analysis III 10.0 op

ECTS Credits:

5 ECTS credits

Assessment methods and criteria:

Read more about [assessment criteria](#) at the University of Oulu webpage.

802635S: Introduction to partial differential equations, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802661S: Introduction to numerical inverse problems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

806624S: Practical training/consulting, 5 - 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Päckilä

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

Ei opintojaksokuvauksia.

H325852: Advanced Studies in Data Science, 40 - 80 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Mandatory Advanced Studies

805627S: Theory of Statistical Inference, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805611S Mathematical statistics II 10.0 op

Ei opintojaksokuvauksia.

805628S: Probability Distributions, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

806631S Random variables and distributions 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3rd or 4th year of studies

Learning outcomes:

After successful completion of the course the student can define the basic concepts and theorems of uni- and multidimensional discrete and continuous probability distributions and can apply this knowledge in other studies in statistics or applied mathematics. After successful completion of the course the student can define the basic concepts and theorems of uni- and multidimensional discrete and continuous probability distributions and can apply this knowledge in other studies in statistics or applied mathematics.

Contents:

Point mass function, density function, cumulative distribution function and quantile function of uni- and multivariate distributions; joint, marginal and conditional distribution; expectation, variance, covariance, correlation coefficient; moment and cumulant generating function; distributions of transformations of random variables and vectors; delta-method; convergence of random variable sequences and limit theorems; main univariate distribution models, multivariate normal distribution, important sampling distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h) and practicals (14 h)

Target group:

Master's students of statistics, applied mathematics and mathematics

Prerequisites and co-requisites:

Introduction to probability theory I and II, vector analysis (or corresponding)

Recommended optional programme components:

Prerequisite for the course Theory of Statistical Inference

Recommended or required reading:

Severini, T. Elements of Distribution Theory, Cambridge University Press, 2012

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

Other information:

-

806624S: Practical training/consulting, 5 - 7 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Jari Päckilä**Opintokohteen kielet:** Finnish**Voidaan suorittaa useasti:** Kyllä

Ei opintojaksokuvauksia.

*Alternative***805630S: Generalized Linear Models, 5 op****Voimassaolo:** 01.08.2017 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Mikko Sillanpää**Opintokohteen kielet:** English, Finnish**Leikkaavuudet:**

805352A Generalized Linear Models 5.0 op

Ei opintojaksokuvauksia.

805665S: Bayesian analysis, 5 op**Voimassaolo:** 01.08.2017 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Mikko Sillanpää**Opintokohteen kielet:** Finnish, English**Leikkaavuudet:**

806365A Introduction to Bayesian Statistics 5.0 op

806633S Introduction to Bayesian Statistics 5.0 op

Ei opintojaksokuvauksia.

805679S: Time series analysis, 5 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Jussi Klemelä**Opintokohteen kielet:** Finnish**ECTS Credits:**

5 cr

Language of instruction:

Finnish

Learning outcomes:

After finishing the course, a student can apply linear, nonlinear and nonparametric modeling of time series. A student learns how to choose between alternative time series models and can apply statistical software to fit time series models.

Contents:

1. The course covers basic concepts of time series analysis: stationarity, autocorrelation, spectral distribution and periodogram.
2. Linear time series analysis includes explanation, prediction, parameter estimation and model diagnostics in ARMA models.
3. Nonlinear time series analysis includes threshold models and heteroskedastic time series models (ARCH and GARCH).
4. Furthermore, nonlinear nonparametric smoothing is covered (time space smoothing and state space smoothing) and nonparametric estimation of spectral densities. Nonparametric function estimation includes kernel estimation, local polynomial regression and additive modeling.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Besides lectures, there are voluntary exercises.

There are 14 times 2 hour lectures and 7 times 2 hour exercises.

Target group:

Students of mathematical sciences, econometrics and finance students.

Prerequisites and co-requisites:

Basic probability theory.

Recommended optional programme components:

-

Recommended or required reading:

Fan, J. ja Yao, Q. (2005). Nonlinear Time Series, Springer.

Assessment methods and criteria:

Examination

Read more about [assessment criteria](#) at the University of Oulu webpage.**Grading:**

1 - 5

Person responsible:

Jussi Klemelä

Working life cooperation:

-

Other information:Home page of the course is <http://cc oulu.fi/~jklemela/timeseries/>

Recommended reading:

P. J. Brockwell and R. A. Davis: Time Series: Theory and Methods, Springer, 1991.
 H. Lutkepohl: Introduction to Multiple Time Series Analysis, Springer.
 J. Hamilton: Time Series, Princeton University Press The MIT Press, 1994.

805629S: Sampling methods, 5 op

Voimassaolo: 01.08.2016 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Läärä Esa
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

805663S: Experimental design, 5 op

Voimassaolo: 01.08.2017 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Läärä Esa
Opintokohteen kielet: English, Finnish

Leikkaavuudet:

806634S	Experimental Design	6.0 op
806353A	Experimental design	6.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

The course is organized in intervals of 2-3 years during the 1st or 2nd period; next in Autumn 2017.

Learning outcomes:

After successful completion of the course the student can describe the main statistical principles of comparative experiments, recognize the most important experimental designs and their typical contexts of use, and is able to appropriately analyze and interpret results obtained from studies applying these designs.

Contents:

Principles of experimental design; randomization, replication, blocking; completely randomized and randomized blocks designs; factorial experiments, split-unit and cross-over trials; linear model for continuous response, analysis of variance and covariance; use of R environment in data analysis.

Mode of delivery:

Contact teaching

Learning activities and teaching methods:

Lectures 28 h, practicals 14 h, and independent work. The practicals consist of homework and computer class exercises.

Target group:

Students having statistics as the major or a minor subject.

Prerequisites and co-requisites:

806112P Basic methods of data-analysis or 805305A Introduction to regression and analysis of variance plus preceding courses in statistics -- or corresponding skills otherwise acquired.

Recommended optional programme components:

The course is independent.

Recommended or required reading:

Lecture notes and material distributed during lectures and practicals. Recommended reading: Lawson, J. (2014). Design and Analysis of Experiments with R. Chapman and Hall/CRC.

Assessment methods and criteria:

Practical exercises and final exam. Passing the course requires adequate participation in practical and sufficient activity in homework.

Grading:

Numeric scale from 1 to 5.

Person responsible:

Esa Läärä

Working life cooperation:

None

805661S: Quantitative genetics, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Sillanpää

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

Period 1

Learning outcomes:

After successful completion of the course the student can describe some basic principles and models of quantitative genetics and relatedness.

Contents:

quantitative genetics, relatedness coefficients and how to measure it, heritability, how to measure selection, polygenic and one locus model, dominance, epistasis, breeding value, hidden Markov model.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h), exercises (14 h), and independent practical work, student presentation.

Target group:

Students having statistics (or genetics) as the major or a minor subject.

Prerequisites and co-requisites:

Introduction to statistics

Recommended optional programme components:

-

Recommended or required reading:

Introduction to Quantitative Genetics: Falconer, D.S. & Mackay, T.F.C. Forth Edition. 1996. Prentice Hall.

Assessment methods and criteria:

Final exam, exercises, independent practical work, student presentation

Grading:

Fail, 1-5

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

805662S: Survival analysis, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Läärä Esa

Opintokohteen kielet: English, Finnish

Ei opintojaksokuvauksia.

806635S: Mixed Linear Models, 5 op

Voimassaolo: 01.01.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Mandatory studies

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 10h, Laboratory work 20h, Self-study 20h, 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

Other information:

-

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
Opintokohteen kielet: English

ECTS Credits:

5 ECTS cr

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 fundamentals, 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, the exercises do not require programming skills but they are an advantage.

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 reference 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 for each part. No exam.

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.

Other information:

-

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Computer Science and Engineering DP

Arvostelu: 1 - 5, pass, fail

Opettajat: Satu Tamminen, Heli Koskimäki

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 transform 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 and Koskimäki Heli

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 1. It is recommended to complete the course at the end of period 1

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 (10h), 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:

-

Other information:

-

521290S: Distributed Systems, 5 op**Voimassaolo:** 01.08.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Computer Science and Engineering DP**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Xiang Su**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

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

ECTS Credits:

5 ECTS cr

Language of instruction:

In English.

Timing:

Spring, period 3.

Learning outcomes:

After completing the course, the student

1. is able to explain the key principles of distributed systems
2. apply the principles in evaluating major design paradigms used in implementing distributed systems
3. solve distributed systems related problems
4. design and implement a small distributed system

Contents:

Introduction, architectures, processes, communication, naming, synchronization, consistency and replication, fault tolerance, security, case studies.

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

Lectures 22 h, exercises 16 h, project work 50 h, self-study 47 h.

Target group:

M.Sc. students (computer science and engineering) and other Students of the University of Oulu

Prerequisites and co-requisites:

None.

Recommended optional programme components:

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

Recommended or required reading:

Required literature: Maarten van Steen and Andrew S. Tanenbaum, Distributed Systems – Principles and Paradigms, Third Edition, 2017.

Assessment methods and criteria:

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

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

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

Person responsible:

Professor Timo Ojala

Working life cooperation:

None.

Other information:

-

800600S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

805687S: Pro gradu seminar, 5 op

Voimassaolo: 01.06.2016 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800699S: Pro gradu thesis, 30 op

Voimassaolo: 01.01.2017 -

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English, Finnish

Ei opintojaksokuvauksia.

805622S: Simulation methods, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Sillanpää

Opintokohteen kielet: English, Finnish

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

Period 3

Learning outcomes:

After successful completion of the course the student is able to implement simple MCMC sampler to the computer and understand the basic principle of the MCMC sampling.

Contents:

The course covers basic methods how to generate samples from common distributions. Also principles of MCMC methods (Metropolis-Hastings, Gibbs sampling) needed in Bayesian analysis are central in the course.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h) and exercises (14 h)

Target group:

Statistics major and minor students

Recommended optional programme components:

Closely related to the course: Bayesian analysis

Recommended or required reading:

Christian P. Robert, George Casella (2010) Introducing Monte Carlo methods in R. Springer.

Grading:

Numerical grading 1-5 (or fail)

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

800600S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800697S: Pro Gradu Thesis, 20 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802641S: Special Course for Teachers of Mathematics: Training, 2 - 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

802632S-03	Special course for teachers of mathematics / Other training	3.0 op
802632S-01	Special course for teachers of mathematics / Lesson plans for teaching mathematics	4.0 op
802632S-02	Special course for teachers of mathematics / Correcting tests in mathematics	3.0 op
802632S	Special course for teachers of mathematics	10.0 op

ECTS Credits:

2-5 ECTS cr

Language of instruction:

Finnish

Timing:

4th or 5th year, any period

Learning outcomes:

The student is able to apply her/his skills in practice and gains experience in teaching mathematics.

Contents:

Teaching practice in mathematics. The practice may include training, preparation of teaching materials and reporting.

Mode of delivery:

Depends on the practice.

Learning activities and teaching methods:

53 h to 133 h work depending on the practice.

Target group:

Mathematics subject teacher students

Prerequisites and co-requisites:

Bachelor degree in mathematics or equivalent

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Practice, reporting

Grading:

pass / fail

Person responsible:

Pekka Salmi

Working life cooperation:

Yes

Other information:

-

800661S: Special course for teachers of mathematics, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Salmi

Opintokohteen kielet: Finnish

Leikkaavuudet:

802639S	Special Course for Teachers of Mathematics: Content Planning	5.0 op
---------	--	--------

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

4th year, 3rd and 4th period

Learning outcomes:

After completing the course the student is able to

- combine a mathematical way of thinking to teaching
- plan teaching content that supports mathematical understanding
- use studies in didactics of mathematics in their teaching
- find and interpret articles in didactics of mathematics.

Contents:

In this course the students plan and execute teaching samples. In addition we examine research in didactics of mathematics. The students also report about their works. Works are discussed in a seminar.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h seminar, 105 h group work and independent studies

Target group:

Mathematics subject teacher students

Prerequisites and co-requisites:

Bachelor degree in mathematics or equivalent

Recommended or required reading:

Handed out during the course

Assessment methods and criteria:

Active participation to seminars, written works

Grading:

Pass/Fail

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

Replaces the course 802639S Special course for teachers of mathematics: content planning.

H325052: Subject teacher's advanced module, 0 - 100 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Advanced Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Advanced studies for subject teacher students

802662S: Supervising advanced problems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

4-5 year

Learning outcomes:

After completing the course, students are able to

- combine mathematical thinking and teaching
- plan mathematical tasks which support profound mathematical understanding rather than computational procedures.

Contents:

In this course a mathematics tutorial group is planned and implemented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h seminar, 7 h teaching

Target group:

Mathematics teacher students

Prerequisites and co-requisites:

B.Sc and teacher pedagogical studies

Assessment methods and criteria:

Participation

Grading:

Pass / fail

Person responsible:

Marko Leinonen

Working life cooperation:

Yes, teaching and course planning

802655S: Continued Fractions, 5 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Language of instruction:

FI/EN

Recommended or required reading:

G.H. Hardy & E.M. Wright: An Introduction to the Theory of Numbers.

Kenneth H. Rosen: Elementary number theory and its applications.

Lisa Lorentzen and Haakon Waadeland: Continued Fractions with Applications (1992).

Oskar Perron: Die Lehre von den Kettenbrüchen (1913).

Course material: <http://cc.oulu.fi/~tma/OPETUS.html>

802652S: Hilbert Spaces, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800624S Analysis III 10.0 op

ECTS Credits:

5 ECTS credits

Assessment methods and criteria:Read more about [assessment criteria](#) at the University of Oulu webpage.**802666S: Linear Optimization, 5 op****Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Erkki Laitinen**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800688S Theory of Optimization 10.0 op

Ei opintojaksokuvauksia.

802667S: Nonlinear Optimization, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**ECTS Credits:**

5 ECTS credits

Language of instruction:

Finnish

Timing:

4th or 5th year of studies

Learning outcomes:

On successful completion of this course, the student will be able to choose the correct methods for solving the nonlinear convex optimization problems and implement the most typical numerical algorithms for solving them.

Contents:

The lecture course is focused to methods, which can apply for solving essential optimization problems of technical and economical sciences. The lectures consist of following topics: Convex optimization problem, unconstrained convex optimization, constrained convex optimization, dual of convex problem, Karush-Kuhn-Tucker conditions and penalty optimization method. The topics are considered theoretically and also numerical algorithms for problem solution are presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h and exercises 14 h

Target group:

Major and minor students

Prerequisites and co-requisites:

Bachelor degree in mathematics or equivalent

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

A. L. Peressini, F.E. Sullivan, J.J. Uhl: The mathematics of Nonlinear Programming David g. Luenberger:

Introduction to Linear and Nonlinear Programming

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Erkki Laitinen

Working life cooperation:

No

Other information:

-

801698S: Cryptography, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Language of instruction:

Finnish/English

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

In our lectures we study mathematical basics of encrypting, key exchange and signature systems. As examples, we mention elementary group and number theory used in primality tests and factoring, complexity estimates of computations-in particular in finite fields, repeated squaring and discrete logarithm in finite cyclic groups- applied in multiplicative groups of finite fields and addition groups of elliptic curves. Deduction of addition formulae in projective and affine Weierstrass elliptic curves. Diffie-Hellman key exchange, ElGamal encrypting and signature systems in finite cyclic groups applied in finite fields or in elliptic curves defined over finite fields. DSA, ECDSA, Massey-Omura. Some algorithms and tests: AKS, Fermat, Lenstra, Lucas, Miller-Rabin, Pohlig-Hellman, Pollard's p-1 and rho, pseudoprimes, quadratic sieve, Solovay-Strassen.

Assessment methods and criteria:

Read more about [assessment criteria](#) at the University of Oulu webpage.

801389A: Basic Geometry, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

801399A Geometry 5.0 op

Ei opintojaksokuvauksia.

802336A: Introduction to Cryptography, 5 op

Voimassaolo: 01.06.2016 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay802336A Introduction to Cryptography (OPEN UNI) 5.0 op

801346A Introduction to Cryptography 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd year or later, 2nd period

Learning outcomes:

After completing the course, student

- knows the principles of some traditional symmetric key methods
- knows how public key methods (RSA, discrete logarithm, knapsack) work
- is familiar with the possibility to use and apply number theory in cryptography

Contents:

The course considers some traditional symmetric key methods (affine system, matrix cryptography) and three public key methods, namely RSA, discrete logarithm and knapsack.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h lectures, 14 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

802354A Basics of Algebra, 802120P Introduction to Matrices

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam.

Grading:

1-5, fail

Person responsible:

Marko Leinonen

Working life cooperation:

No

802365A: Introduction to Mathematical Software, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Mikko Orispää**Opintokohteen kielet:** Finnish**ECTS Credits:**

5 ECTS cr

Language of instruction:

Finnish (also English if needed)

Timing:

2.-3. year

Learning outcomes:

Upon completion of the course, the student knows the basics of the use of the most common mathematical software, is able to use mathematical software in solving mathematical tasks and problems, and is able to independently deepen her knowledge of different mathematical software as necessary.

Contents:

During the course, the student learns the basics of some of commonly used mathematical software which include Matlab and Python (Numpy/Scipy).

Mode of delivery:

The course is arranged in a computer class as a series of lectures and rehearsals. On the lectures, the students have the possibility to use and try the mathematical software during the lectures. In the rehearsals, different given problems and tasks are solved together.

Learning activities and teaching methods:

Lectures 22 h / Rehearsals 22 h / Self-study 60 h. The self-study contains the independent learning of the software and also the preparation of the final assignments.

Target group:

Anybody interested in mathematical software.

Prerequisites and co-requisites:

The required prerequisite is the completion of following courses (or corresponding knowledge of the subject):

- 802120P Matrix calculus
- 802320A 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:

The required and recommended reading consists mainly on free material (manuals/tutorial) found in the internet. More information will be given at the beginning of the course.

Assessment methods and criteria:

The course is assessed by final assignments. The student who wish to complete the course at A-level will make two separate assignments of given topics using (at least) two different mathematical software. Those who wish to complete the course in S-level will need to discuss with the lecturer about the extra work needed to pass. For example, it could be possible to do assignments of wider topics, making an assignment (s) with a software not covered in the course, or making an assignment that requires particular skills and knowledge.

Grading:

The course utilizes grading scale pass / fail.

Person responsible:

Mikko Orispää

Working life cooperation:

-

Other information:

-

802328A: Basics in Number Theory, 5 op

Voimassaolo: 01.06.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

ECTS Credits:

5 cr

Language of instruction:

Finnish/English

Timing:

2.-3. year of studies. Timing varies.

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

In our lectures we consider arithmetical properties of the common numbers involved in studying mathematics and in particular number theory. Also the methods will get a special interest. Examples of the numbers under the research will be binomials, continued fractions, sums of powers and some numbers sharing a name with the mathematicians Bernoulli, Euler, Fermat, Fibonacci, Heron, Lucas, Mersenne, Neper, Pythagoras, Stirling, Wilson and Wolstenholme. From the tools we mention congruences of rational numbers and polynomials, difference operators, generating series, irrationality considerations, matrix presentations, recurrences and telescopes.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

36h lectures, 18h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

802354A Lukuteoria ja ryhmät,
 802355A Rings, fields and polynomials
 802118P Linear algebra I
 802119P Linear algebra II
 802352A Euclidean topology
 802353A Series and integrals

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes,
 G.H. Hardy ja E.M. Wright: An Introduction to the Theory of Numbers;
 Kenneth H. Rosen: Elementary number theory and its applications.

Assessment methods and criteria:

Mid-term exams or final exam
 Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Tapani Matala-aho

Working life cooperation:

-

800323A: Field extensions, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Leikkaavuudet:

802333A	Permutations, Fields and Galois Theory	10.0 op
800343A	Algebra 2	8.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish and English

Timing:

2/3 year, 3rd period

Learning outcomes:

An ultimate target is to deepen students algebraic mindset and to give completeness e.g. for advanced courses in algebraic numbers, number theory, cryptography, and group theory.

Contents:

Under the inspection are factor structures of rings, quotient rings and field extensions. As examples we study finite fields, fields of rational functions and quotient fields of formal series as well as basics of number fields. An ultimate target is to deepen students algebraic mindset and to give completeness e.g. for advanced courses in algebraic numbers, number theory, cryptography, and group theory.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h lectures, 14 h exercises, 91 h independent study

Target group:

Mathematics majors

Prerequisites and co-requisites:

802354A Basics in Algebra, 802355A Algebraic Structures, 802120P Introduction to Matrices, 802320A Linear Algebra

Recommended or required reading:

<http://cc.oulu.fi/~tma/OPETUS.html>

Assessment methods and criteria:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Grading:

1-5, i

Person responsible:

Tapani Matala-aho

Other information:

Replaces part of the course 802333A Permutations, fields and Galois theory

802334A: A Second Course in Differential Equations, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800346A Differential Equations II 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd year or later, 2nd period

Learning outcomes:

On successful completion of this course, the student will be able to

- apply method of Frobenius to solve second order linear differential equations
- derive and prove the basic properties of Bessel functions, Legendre polynomials and Hermite polynomials
- apply integral transformations to solve some integral equations and ordinary differential equations with constant coefficients
- recognize heat and wave equations and choose the proper method to solve them.

Contents:

The course is devoted to second order ordinary differential equations that are important in applications and classical partial differential equations such as heat and wave equations. Method of Frobenius is introduced

to solve second order ordinary differential equations. Some special functions (Gamma function and Bessel functions etc.) and also orthogonal polynomials (Legendre and Hermite polynomials) are considered. Basic facts about Fourier series and Fourier transform are given. Laplace transform is discussed at more advanced level than in earlier studies. Separation of variables is introduced as a method to solve certain boundary value problems for heat and wave equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h, exercises 14 h

Target group:

Students majoring in mathematics or applied mathematics, physics or engineering students

Prerequisites and co-requisites:

Differential equations, Complex analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes. Additional reading: Colton D, Partial differential equations, Dover, 1988 Lebedev N N, Special Functions and their applications, Dover, 1972 Nagle R K, Fundamentals of differential equations and boundary value problems, Addison-Wesley, 1996 Zill D G and Cullen M R, Differential equations with boundary-value problems, Brooks/Cole, 2001

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Markus Harju

Working life cooperation:

No

Other information:

-

031022P: Numerical Analysis, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Marko Huhtanen

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish. English speaking students should contact the instructor.

The course can be completed in English by intermediate exams or by a final exam.

Timing:

Spring semester, period 3

Learning outcomes:

Knows numerical algorithms for solving basic problems in computing. Knows basics about numerical linear algebra and some of its applications. Knows how nonlinear systems are solved and how they appear in optimization. Knows how differential equations are solved numerically.

Contents:

Numerical linear algebra, numerical methods for systems of equations, unconstrained optimization, basics of the approximation theory, numerical quadratures, numerical methods for ordinary differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h / Group work 22 h / Self-study 85 h.

Target group:

-

Prerequisites and co-requisites:

Completion of courses Calculus I and II, a course on Differential Equations and a Course on Linear Algebra.

Recommended optional programme components:

-

Recommended or required reading:

Material posted on the web-page of the course.

Assessment methods and criteria:

Intermediate exams or a final exam.

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

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

Person responsible:

Marko Huhtanen

Working life cooperation:

-

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:

-

031077P: Complex analysis, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ruotsalainen Keijo

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031077P Complex analysis (OPEN UNI) 5.0 op

031018P Complex Analysis 4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish

Timing:

Fall semester, period 1.

Learning outcomes:

After completing the course the student

1. is able to calculate the derivative and the integral of functions of complex variable,
2. understands the concept of analyticity

3. is capable of calculating the contour integrals and using the theory of residues for computing the line integrals, will be able to apply the techniques of complex analysis to simple problems in signal processing.

Contents:

Complex numbers and functions, complex derivative and analyticity, complex series, Cauchy's integral theorem, Laurent and Taylor expansions, theory of residues, applications to signal analysis.

Mode of delivery:

Face-toface teaching, Stack(web-based too) exercises.

Learning activities and teaching methods:

Lectures 28 h/Exercises 14 h/Self study 93 h.

Target group:

The students in the engineering sciences. The other students are welcome, too.

Prerequisites and co-requisites:

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

Recommended optional programme components:

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

Recommended or required reading:

The lecture notes

Assessment methods and criteria:

Intermediate exams or a final exam.

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

The course utilizes a numerical grading scale 0-5. In the numerical scale zero stands for a fail.

Person responsible:

Jukka Kemppainen

Working life cooperation:

-

Other information:

-

802338A: Complex Analysis II, 5 op

Voimassaolo: 01.06.2016 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Contents:

like - terminating, non-terminating, irrationality, periodicity, approximation properties will be studied.

801396A: Introduction to Probability Theory II, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

2nd or 3rd year

Learning outcomes:

On successful completion of this course, the student will be able to:

- understand probability theory deeper than before
- apply various stochastic models
- derive the basic results associated with the new concepts introduced

Contents:

The central topics are the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem, two-dimensional distributions as well as conditional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h of lectures, 14 h of exercises, 91 h of independent study

Target group:

Mathematics major and minor students. Recommended for students aiming for the profile of computational mathematics and data science.

Prerequisites and co-requisites:

801195P Introduction to probability I, 800328A Calculus of several variables (or Vector Calculus)

Recommended or required reading:

P. Tuominen: Todennäköisyyslaskenta I, Limes 2002 and other books on probability.

Assessment methods and criteria:

Final exam

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

1-5, fail

Person responsible:

Pekka Salmi

Working life cooperation:

-

800320A: Differential equations, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

031076P	Differential Equations	5.0 op
031017P	Differential Equations	4.0 op
800345A	Differential Equations I	4.0 op

ECTS Credits:

5 ECTS credits / 133 hours of work

Language of instruction:

Finnish

Timing:

2nd year

Learning outcomes:

Upon completing the course the student

- is able to classify differential equations and is able to apply correct solution methods to them
- knows the conditions that guarantee the unique solvability of an equation
- understands the concept of implicitly defined solution

Contents:

The course is devoted to ordinary differential equations. Central part is formed by first order differential equations (separable, homogeneous, linear, exact equations and certain equations which can be transformed into these). The equations are solved using algebraic, iterative and numerical methods. The second part which is central to applications is formed by linear inhomogeneous differential equations with constant coefficients and linear second order equations with continuous coefficient functions. In addition, systems of differential equations are considered. Certain second order linear differential equations (e.g. Legendre's equation) is solved via power series.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h, exercises 14 h, independent work

Target group:

Major and minor students

Prerequisites and co-requisites:

Continuity and derivative 800317A and Integral 800318A

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Erkki Laitinen

Working life cooperation:

no

Other information:

Homepage in Noppa portal.

802365A: Introduction to Mathematical Software, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Orispää

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish (also English if needed)

Timing:

2.-3. year

Learning outcomes:

Upon completion of the course, the student knows the basics of the use of the most common mathematical software, is able to use mathematical software in solving mathematical tasks and problems, and is able to independently deepen her knowledge of different mathematical software as necessary.

Contents:

During the course, the student learns the basics of some of commonly used mathematical software which include Matlab and Python (Numpy/Scipy).

Mode of delivery:

The course is arranged in a computer class as a series of lectures and rehearsals. On the lectures, the students have the possibility to use and try the mathematical software during the lectures. In the rehearsals, different given problems and tasks are solved together.

Learning activities and teaching methods:

Lectures 22 h / Rehearsals 22 h / Self-study 60 h. The self-study contains the independent learning of the software and also the preparation of the final assignments.

Target group:

Anybody interested in mathematical software.

Prerequisites and co-requisites:

The required prerequisite is the completion of following courses (or corresponding knowledge of the subject):

- 802120P Matrix calculus
- 802320A 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:

The required and recommended reading consists mainly on free material (manuals/tutorial) found in the internet. More information will be given at the beginning of the course.

Assessment methods and criteria:

The course is assessed by final assignments. The student who wish to complete the course at A-level will make two separate assignments of given topics using (at least) two different mathematical software. Those who wish to complete the course in S-level will need to discuss with the lecturer about the extra work needed to pass. For example, it could be possible to do assignments of wider topics, making an assignment(s) with a software not covered in the course, or making an assignment that requires particular skills and knowledge.

Grading:

The course utilizes grading scale pass / fail.

Person responsible:

Mikko Orispää

Working life cooperation:

-

Other information:

-

801396A: Introduction to Probability Theory II, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

2nd or 3rd year

Learning outcomes:

On successful completion of this course, the student will be able to:

- understand probability theory deeper than before
- apply various stocastic models
- derive the basic results associated with the new concepts introduced

Contents:

The central topics are the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem, two-dimensional distributions as well as conditional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h of lectures, 14 h of exercises, 91 h of independent study

Target group:

Mathematics major and minor students. Recommended for students aiming for the profile of computational mathematics and data science.

Prerequisites and co-requisites:

801195P Introduction to probability I, 800328A Calculus of several variables (or Vector Calculus)

Recommended or required reading:

P. Tuominen: Todennäköisyysslaskenta I, Limes 2002 and other books on probability.

Assessment methods and criteria:

Final exam

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

1-5, fail

Person responsible:

Pekka Salmi

Working life cooperation:

-

802361A: Numerical Computation, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

2nd or 3rd year

Learning outcomes:

On successful completion of this course, the student will be able to solve basic numerical problems using Fortran programming and to exploit the Unix computers and software libraries for solving numerical problems.

Contents:

On the course students train programming of numerical algorithms using Fortran 95 programming language in Unix (Linux) operating system. On the course, DISLIN subroutine library is used for the visualization of the numerical calculation results.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h + exercises+practical work. Self-study has important role.

Target group:

Major and minor students

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 required and recommended reading consists mainly on free material (manuals/tutorial) found in the internet. More information will be given at the beginning of the course.

Assessment methods and criteria:

The assessment of the course is based on the assesment of practical work at the end of course.

Grading:

The course utilizes verbal grading scale pass / fail.

Person responsible:

Erkki Laitinen

Working life cooperation:

No

Other information:

-

805350A: Estimation and Test Theory, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Läärä Esa

Opintokohteen kielet: Finnish

Leikkaavuudet:

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year during B.Sc. studies

Learning outcomes:

After successful completion of the course the student can describe the basic principles of frequentist and bayesian statistical inference, compute point and interval estimates, test statistics and P-values based on likelihood function of models with few parameters, and interpret results thus obtained.

Contents:

Statistical model and observational data; construction and properties of point estimators and confidence intervals; likelihood ratio, score and Wald test statistics and their asymptotic sampling distribution; jackknife and bootstrap methods; elements of bayesian inference; use of R environment in inferential problems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h), practicals and computer classes (14 h), and independent work

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Likelihood inference, Introduction to probability theory I, Basic Methods of Data Analysis

Recommended optional programme components:

Needed in nearly all intermediate and advanced courses of statistics

Recommended or required reading:

Migon, H.S., Gamerman, D., Louzada, F. Statistical Inference: An Integrated Approach, Second Edition. Chapman & Hall/CRC, 2014; Pawitan, Y: In All Likelihood: Statistical Modelling and Inference Using Likelihood, Oxford, 2001; Sprott, D. A.: Statistical Inference in Science, Springer, 2000; Kalbfleisch, J.G.: Probability and Statistical Inference, volume 2: Statistical Inference, Second Edition, Springer, 1985.

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805306A: Introduction to Multivariate methods, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Pääkkilä

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

801396A: Introduction to Probability Theory II, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

2nd or 3rd year

Learning outcomes:

On successful completion of this course, the student will be able to:

- understand probability theory deeper than before
- apply various stochastic models
- derive the basic results associated with the new concepts introduced

Contents:

The central topics are the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem, two-dimensional distributions as well as conditional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h of lectures, 14 h of exercises, 91 h of independent study

Target group:

Mathematics major and minor students. Recommended for students aiming for the profile of computational mathematics and data science.

Prerequisites and co-requisites:

801195P Introduction to probability I, 800328A Calculus of several variables (or Vector Calculus)

Recommended or required reading:

P. Tuominen: Todennäköisyyyslaskenta I, Limes 2002 and other books on probability.

Assessment methods and criteria:

Final exam

Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

1-5, fail

Person responsible:

Pekka Salmi

Working life cooperation:

-

805305A: Introduction to Regression and Analysis of Variance, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Pääkkilä

Opintokohteen kielet: Finnish

Leikkaavuudet:

806112P Basic Methods of Data Analysis 10.0 op

Ei opintojaksokuvauksia.

805349A: Likelihood and Bayesian Inference, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Läärä Esa

Opintokohteen kielet: Finnish

Leikkaavuudet:

805310A Statistical Inference I 10.0 op

Ei opintojaksokuvauksia.

805351A: Linear Regression, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Läärä Esa

Opintokohteen kielet: Finnish

Leikkaavuudet:

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year during B.Sc. studies

Learning outcomes:

After successful completion of the course the student can describe basic concepts and assumptions in linear models for continuous outcome variables as well as main principles of regression modelling, and can also apply these methods in analysis of experimental and non-experimental observation data.

Contents:

Linear regression models for a continuous outcome variable; formulation of the model, selection of variables and interpretation of parameters; fitting the models, estimation of parameters and prediction using method of least squares; model criticism and diagnostics; use of R environment and SAS software in modelling.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (28 h), practicals and computer classes (14 h) and independent work.

Target group:

Students having statistics as the major or a minor subject.

Prerequisites and co-requisites:

Basic Methods of Data Analysis; Core courses in the B.Sc curriculum of mathematical sciences.

Recommended optional programme components:

Prerequisite to the course Generalized Linear Models

Recommended or required reading:

Weisberg, S. (2014). Applied Linear Regression, fourth edition, Hoboken NJ: John Wiley.

Assessment methods and criteria:

Active participation in practicals and final exam. Read more about assessment criteria at the University of Oulu webpage

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805353A: Statistical Software, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805340A Statistical Software 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3. year studies. Fall semester. Timing varies.

Learning outcomes:

After successful completion of the course the student can use independently major statistical software needed in data analysis.

Contents:

The course covers R, SAS and IBM SPSS, and their most important tools for data management, statistical computation, graphics and programming will be introduced and proficiency for their fluent use is acquired.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

42 h lectures, exercises and tutoring. 88 h learning tasks and self-study.

Target group:

Major and minor students

Prerequisites and co-requisites:

806112P Basic methods of data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Home works and/or exam

Grading:

Numerical grading 1-5 (or fail)

Person responsible:

Hanna Heikkinen

Working life cooperation:

No