Opasraportti

FSci -Master's programme in Mathematical Sciences (2019 - 2020)

Tutkintorakenteet

Master's degree (Mathematical Sciences)

Tutkintorakenteen tila: published

Lukuvuosi: 2019-20

Lukuvuoden alkamispäivämäärä: 01.08.2019

Studies of the line of speciallization (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
  - 802668S: Introduction to Functional Analysis, 5 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
  - 800694S: Introduction to Fractal Geometry, 5 op
  - 801631S: Modern real analysis, 5 op
  - 802642S: Symmetry groups, 5 op
  - 802672S: Pro Gradu seminar/Thesis seminar, 5 op
  - 800683S: Project in mathematics, 10 op
  - 802675S: Introduction to Additive Combinatorics, 5 op

802673S: Additive Combinatorics, 5 op
802676S: Introduction to Inverse Problems, 5 op
802661S: Computational Inverse Problems, 5 op
802677S: Fourier analysis of measures, 5 op
802628S: Advanced studies special course, 2 - 18 op
800600S: Maturity test, 0 op
800698S: Pro gradu thesis, 30 op

Applied mathematics orientation

H325853: Advanced Studies in Computational Mathematics, 40 - 80 op
Obligatory
805622S: Simulation methods, 5 op
805687S: Pro gradu seminar, 5 op
800699S: Pro gradu thesis, 30 op
800600S: Maturity test, 0 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
802635S: Introduction to partial differential equations, 10 op
802652S: Hilbert Spaces, 5 op
802676S: Introduction to Inverse Problems, 5 op
806624S: Practical training/consulting, 5 - 7 op

Orientation data science

H325852: Advanced Studies in Data Science, 40 - 80 op
Mandatory Advanced Studies
805628S: Probability Distributions, 5 op
805627S: Theory of Statistical Inference, 5 op
806624S: Practical training/consulting, 5 - 7 op
805622S: Simulation methods, 5 op
805687S: Pro gradu seminar, 5 op
800699S: Pro gradu thesis, 30 op
800600S: Maturity test, 0 op
Choose here one course
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
805609S: Statistical methods in epidemiology, 9 op
805666S: Causal 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

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
802355A: Algebraic Structures, 5 op
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
800694S: Introduction to Fractal Geometry, 5 op
802642S: Symmetry groups, 5 op
802675S: Introduction to Additive Combinatorics, 5 op
802656S: Algebraic numbers, 5 op
800332A: History of Mathematics, 5 op
801399A: Geometry, 5 op
802336A: Introduction to Cryptography, 5 op
802365A: Introduction to Mathematical Solfware, 5 op
802328A: Basics in Number Theory, 5 op
800323A: Field extensions, 5 op
800320A: Differential equations, 5 op
802334A: A Second Course in Differential Equations, 5 op
031022P: Numerical Analysis, 5 op
031025A: Introduction to Optimization, 5 op
031080A: Signal Analysis, 5 op
031077P: Complex analysis, 5 op
802338A: Complex Analysis II, 5 op
801396A: Introduction to Probability Theory II, 5 op

Intermediate studies

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, 4th period

Learning outcomes:

As usual in my mathematical studies I shall be ableto solve problems arising from the subject andto 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, Alcebraic 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 succesfully, 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

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 identify the correct methods for solving the linear optimization problems and implement the most typical numerical algorithms for solving linear optimization problems.

Contents:

The lecture course is focused to methods, which can apply for solving essential linear optimization problems of technical and economical sciences. The lectures consist of following topics: Convex sets, Graphical solution of LP problem, dual formulation, simplex algorithm, dual-simplex algorithm. 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:

Pää- ja sivuaineopiskelijat

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 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:

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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:

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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

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

Learning outcomes:

After passing the course the student -is able to use the central methods in fractal geometry -can determine different dimensions -knows the basic properties of dimensions

Contents:

Fractals are irregular sets having varying structure at all scales. Fractal geometry is a branch of mathematics where geometric properties of fractals are studied. Fractal are used in various fields of mathematics as well a in applications. The course concentrates on basics tools of fractal geometry including different concepts of dimenson.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 h lectures, 28 h exercises, 182 h independent study

Target group:

Mathematics majors

Prerequisites and co-requisites:

Measure and integration

Assessment methods and criteria:

Final exam

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

Grading:

Fail, 1-5

Person responsible:

Esa Järvenpää

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 oppimateriaali:
Colton, David, , 1988
Kress, Rainer, , 1999
Folland, Gerald B. , , 1995
Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Timing:

First and second period.

Learning outcomes:

On successful completion of this course, the student will be able to
- solve linear and quasi-linear partial differential equations of first order using the method of characteristics
- apply the method of separation of variables to solve initial-boundary value problems for heat, wave and Laplace equations
- verify that a given function is a fundamental solution of a partial differential operator
- use single and double layer potentials to solve boundary value problems for Laplacian

Contents:

Linear and nonlinear equations of the first order, trigonometric Fourier series, Laplace equation in R^n and in bounded domains, potential theory, Green's function, Heat equation in R^n and in bounded domains, Wave equation in R^n and in bounded domans, d'Alembert formula for any dimensions, Fourier method.

Assessment methods and criteria:

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

Person responsible:

Valeriy Serov

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

ECTS Credits:

5 ECTS cr

Language of instruction:

English

Timing:

4th year

Learning outcomes:

This is an introduction course, it includes normed spaces, subspaces, quotients, bounded linear operators and functionals, Banach duals, uniform boundedness principle, open mapping theorem and Hahn-Banach theorem. If time permits, reflexive spaces will also be studied.

Contents:

Definition of normed spaces. Examples. Quotient spaces. Bounded linear operators. Banach duals. Uniform bounded principle. Open mapping theorem. Hahn-Banach theorem. Reflexive spaces.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h lectures, 14 h exercises.

Target group:

Students with some background on topology.

Recommended or required reading:

Lecture notes by Filali

Assessment methods and criteria:

Final Exam

Grading:

Fail, 1-5

Person responsible:

Mahmoud Filali

Working life cooperation:

No

Other information:

Lecture in English /questions can be done in Finnish, exam in English/Finnish

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

ECTS Credits:

5 credits

Language of instruction:

Finnish/English

Timing:

1. period

Learning outcomes:

We start our lectures by considering b-base expansions and simple continued fraction expansions of real numbers. The properties of these expansions like -terminating, non-terminating, irrationality, periodicity, approximation properties will be studied.
Next we investigate general continued fractions with corresponding recurrences and transformations. A particular attention is paid for convergence and irrationality criteria.
Further, expansions of hypergeometric series are presented which imply expansions to well-known Napier's constant and pi.
The research will be directed to more general irrationality questions and Diophantine equations, too.

Contents:

We start our lectures by considering b-base expansions and simple continued fraction expansions of real numbers. The properties of these expansionslike - terminating, non-terminating, irrationality, periodicity, approximation properties will be studied.
Next we investigate general continued fractions with corresponding recurrences and transformations. A particular attention is paid for convergence and irrationality criteria. Further, expansions of hypergeometric series are presented which imply expansions to well-known Napier's constant and pi.
The research will be directed to more general irrationality questions and Diophantine equations, too.

Mode of delivery:

Lectures, Exercises.

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 Kettenbruchen (1913).

Course material

Assessment methods and criteria:

Course exam

Grading:

1-5, fail

Person responsible:

Tapani Matala-aho

801698S: Cryptography, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen oppimateriaali:
Trappe, Wade; Washington, Lawrence C., , 2005
Menezes, Alfred J.; van Oorschot, Paul C.; Vanstone, Scott A. , , 1997
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-Srassen.

Learning activities and teaching methods:

28 h lectures, 14 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Basic in Algebra, Algebraic structures, Introduction to Cryptography, Field extensions

Recommended or required reading:

Lecture notes; Wade Trappe, Lawrence C. Washington: Introduction to cryptography : with coding theory; Alfred J. Menezes: Handbook of Applied Cryptography, CRC Press 1996(http://www.cacr.math.uwaterloo.ca/hac/)

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Marko Leinonen

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
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
Opintokohteen kielet: Finnish

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

ECTS Credits:

5 credits

Language of instruction:

Finnish

Timing:

1st period

Learning outcomes:

After completing the course, the students know the basics of abstract measure and integration theory and are able to apply the main theorems in concrete situations.

Contents:

Basic concepts of measure theory: outer measure, sigma-algebra, measure, measurability, Lebesgue measure, integral, product measure.
Basic theorems: Convergence theorems, Fubini's theorem.

Mode of delivery:

Lectures, Exercises.

Prerequisites and co-requisites:

Basic knowledge of analysis in Euclidean spaces, set theory and topology.

Recommended or required reading:

Bruckner, Bruckner, Thomson: Real Analysis; Cohn: Measure Theory; Purmonen: Mitta- ja integraaliteoria; ...

Assessment methods and criteria:

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

Person responsible:

Ville Suomala

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:

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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:

They 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, DaverPublications, 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:

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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

800694S: Introduction to Fractal Geometry, 5 op

Voimassaolo: 01.01.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Esa Järvenpää

Opintokohteen kielet: Finnish

ECTS Credits:

5 ects

Learning outcomes:

After passing the course the student recognises fractal phenomena in everyday life and can calculate simple characteristics of fractals.

Contents:

The research will be directed to more general irrationality questions and Diophantine equations, too. Features, basic concepts and different characteristics of fractals.

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. Well suited for teacher students and also minor students.

Prerequisites and co-requisites:

Basic studies in mathematics.

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Maarit Järvenpää

801631S: Modern real analysis, 5 op

Voimassaolo: 01.01.2018 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Meng Wu

Opintokohteen kielet: English

ECTS Credits:

5 credits

Learning outcomes:

Description of the course 10 credits: On successful completion of this course, the student will be able to - derive and prove basic results of modern real analysis. - apply the results and methods of modern real analysis in different topics of mathematics, like in Geometric Measure Theory, Fractal Geometry, ...

Contents:

Description of the course 10 credits: The course presents Lebesgue spaces (Hölder's and Minkowski's inequalities, completeness, dual spaces), the Vitali covering theorem, the Hardy-Littlewood maximal function, Lebesgue's density theorem, ...

Person responsible:

Meng Wu

802642S: Symmetry groups, 5 op

Voimassaolo: 01.01.2018 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Pekka Salmi
Opintokohteen kielet: Finnish

ECTS Credits:

5 credits

Language of instruction:

Finnish/English

Learning outcomes:

After completing the course the student is able to
- describe well-known symmetry groups
- determine symmetry groups of geometric objects
- use groups as objects that encode symmetries
- use permutations to represent symmetries
- explain basic concepts associated to group actions
- apply algorithms associated to permutations

Contents:

The notion of group comes from symmetries of different objects such as sets or geometrical objects. In this course we consider groups from this viewpoint. Permutations, i.e. symmetries of sets, give the foundation for these considerations. Then we proceed to study symmetries of more complicated objects such as geometrical ones. Symmetries are closely related to group actions on different objects. We cover the basic notions associated to group actions such as orbits and stabilisers. One important class of symmetry groups is formed by matrix groups and also those are studied. In addition we consider the relations between all these groups.

Mode of delivery:

Face-to-face teaching, computer exercises (in Finnish)

Learning activities and teaching methods:

28 lectures, 14 h exercises, 91 h independent study

Target group:

Mathematics majors including prospective subject teachers

Prerequisites and co-requisites:

802354A Basics of algebra,
802320A Linear algebra,
802357 Euclidean spaces

Recommended or required reading:

Luewntokalvot, STACK-tehtävät

Assessment methods and criteria:

Final exam, exercises

Grading:

1-5, fail

Person responsible:

Pekka Salmi

802672S: Pro Gradu seminar/Thesis seminar, 5 op

Voimassaolo: 01.01.2018 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Maarit Järvenpää
Opintokohteen kielet: Finnish, English

ECTS Credits:

5 credits

Language of instruction:

Finnish

Timing:

4th or 5th year

Learning outcomes:

After the course, the student is able to write scientific texts and take part in scientific conversations.

Contents:

The goal of the course is to complete a master's thesis accoring to a schedule made together with the supervisor. The emphasis

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Seminar meetings, group work and independent work

Target group:

Mathematics major students

Prerequisites and co-requisites:

Bachelor degree

Assessment methods and criteria:

Active participation in seminar meetings

Grading:

Pass/Fail

Person responsible:

Maarit Järvenpää

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

Learning outcomes:

After passing the course the student is able to do a small mathematical discourse based on literature.

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:

Discourse and talk

Grading:

Pass/Fail

Person responsible:

Esa Järvenpää

Working life cooperation:

-

802675S: Introduction to Additive Combinatorics, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ville Suomala

Opintokohteen kielet: English, Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish (Most of the course material can be provided in English, if necessary).

Timing:

1st period (autumn semester)

Learning outcomes:

Upon completion of the course:
- The student is able to handle basic sumset estimates.
- Is familiar with elementary results related to arithmetic progressions such as the Cauchy-Davenport Theorem and Van der Waerdens Theorem.
- Understands how arithmetic structure is related and nonrelated to the size of the set in various settings.
- Can regognize problems related to additive combinatorics and its applications.

Contents:

Roths theorem on arithmetic progressions, Freiman's theorem, Balogh-Szemeredi-Gowers theorem. Applications of additive combinatorics.

Mode of delivery:

Lectures and exercises

Learning activities and teaching methods:

Lectures 28 h, exercises 8 h, independent study 91 h

Target group:

All math students (major and minor).

Prerequisites and co-requisites:

This is an independent cTämä kurssi antaa erinomaiset esitiedot kurssille 802673S Additiivinen kombinatoriikka ourse. Basic knowledge in University mathematics is enough.

Recommended optional programme components:

The course 802673S Additive combinatorics is a continuation of this course.

Assessment methods and criteria:

Exam

Grading:

Failed, 1-5

Person responsible:

Ville Suomala

802673S: Additive Combinatorics, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ville Suomala

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish or english depending on the participants

Timing:

2nd period (autumn semester)

Learning outcomes:

Upon completion of the course, the students:
- Are familiar with the basic methods of additive combinatorics (sumset estimates, discrete Fourier transform etc.)
- Is familiar with Roths theorem, Freimans Theorem, Balogh-Szemered- Gowers theorem and knows the main ideas in the proofs
- Is able to apply these results

Contents:

Roths theorem on arithmetic progressions, Freiman's theorem, Balogh-Szemeredi-Gowers theorem. Applications of additive combinatorics.

Mode of delivery:

Lectures and exercises

Learning activities and teaching methods:

Lectures 28 h, exercises 8 h, independent study 91 h

Prerequisites and co-requisites:

Introduction to Additive combinatorics or equivalent knowledge

Assessment methods and criteria:

Exam or a seminar presentation

Grading:

Failed, 1-5

Person responsible:

Ville Suomala

802676S: Introduction to Inverse Problems, 5 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Andreas Hauptmann
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

3rd/last year during B.Sc. studies, 1st or 2nd year of Master, 3rd period.

Learning outcomes:

After successful completion of the course the student can identify linear ill-posed inverse problems and their severity. Furthermore, the students will be able to analyze and solve such problems with direct and indirect solution methods, identify necessary regularization, is able to implement such methods and work with basic simulated and experimental data.

Contents:

Theory of ill-posed inverse problems, singular value decomposition, Generalized-Inverse and Normal equations, Landweber iterations and Tikhonov regularization, Morozov discrepancy principle. Examples include convolutions, Fourier and Radon transform, corresponding to applications in image processing, X-ray and Magnetic Resonance Tomography. Use of Matlab/Python for implementation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having mathematics, applied mathematics, or statistics as the major or a minor subject.

Prerequisites and co-requisites:

Core courses in the B.Sc curriculum of mathematical sciences, especially linear algebra; Numerical Analysis, Fourier analysis (beneficial, but not necessary), Functional analysis (beneficial, but not necessary).

Recommended or required reading:

Mueller, J and Siltanen, S (2012). Linear and nonlinear inverse problems, SIAM.

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:

Andreas Hauptmann

Working life cooperation:

No

802661S: Computational Inverse Problems, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Andreas Hauptmann

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credit

Language of instruction:

English

Timing:

4th period, 3rd/last year during B.Sc. studies, 1st or 2nd year of Master

Learning outcomes:

After successful completion of the course the student will be able to efficiently solve inverse problems computationally. Students will be able to identify suitable solution methods and incorporate prior knowledge, understand basics and difficulties of real-life inverse problems. Solutions will be implemented in Matlab/Python using simulated and experimental data.

Contents:

Efficiently deal with large-scale tomographic problems, Formulate and compute solutions with variational methods, First and second order optimization methods, Basics of convex optimization and primal-dual

methods, Basics of Bayesian methods and uncertainty quantification, Machine and Deep Learning for Inverse Problems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (24 h), practical and computer classes (18 h) and independent work.

Target group:

Students having mathematics, applied mathematics, or statistics as the major or a minor subject.

Prerequisites and co-requisites:

Introduction to Inverse Problems, Core courses in the B.Sc curriculum of mathematical sciences, Numerical Analysis, Fourier analysis (recommended), Functional analysis (beneficial, but not necessary).

Recommended or required reading:

Kaipio, J and Somersalo, E (2006), Statistical and computational inverse problems, Springer Science & Business Media.
Vogel, C (2002), Computational methods for inverse problems, SIAM.

Assessment methods and criteria:

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

Grading:

1-5, fail

Person responsible:

Andreas Hauptmann

Working life cooperation:

No

802677S: Fourier analysis of measures, 5 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Minors
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Meng Wu
Opintokohteen kielet: English

Ei opintojaksokuvauksia.

802628S: Advanced studies special course, 2 - 18 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Voidaan suorittaa useasti: Kyllä

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

ECTS Credits:
30 cr
Language of instruction:
Finnish (also English)
Learning outcomes:
After writing the Master's degree, student has written an analytical and logical study of a problem or theory in a field of mathematics, applied mathematics or statistics. Completing the thesis succesfully, student is able to write scientific articles and texts in mathematics.
Contents:
The scope of the Master's thesis is 20 cr for Teacher students and 30 cr in other disciplines. In Master's thesis, the student engages in researching a specific mathematical area or problem in the field of mathematics, appliead mathematics or statistics.
Mode of delivery:
Thesis
Learning activities and teaching methods:
Own work, meetings with the supervisor
Target group:
Major students
Prerequisites and co-requisites:
Bachelor's degree (or equivalent), 20-50 cr advanced studies
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Thesis
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Professors and other teaching personnel
Working life cooperation:
-

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.

Obligatory

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

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

ECTS Credits:

5 ECTS credist / 133 hours of work

Person responsible:

Esa Läärä

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.

800600S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies
Laji: Course
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

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 identify the correct methods for solving the linear optimization problems and implement the most typical numerical algorithms for solving linear optimization problems.

Contents:

The lecture course is focused to methods, which can apply for solving essential linear optimization problems of technical and economical sciences. The lectures consist of following topics: Convex sets, Graphical solution of LP problem, dual formulation, simplex algorithm, dual-simplex algorithm. 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:

Pää- ja sivuaineopiskelijat

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 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:

-

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

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

Period 3

Learning outcomes:

After successful completion of the course the student is able to do statistical inference in likelihood framework as well as in Bayesian analysis using common statistical softwares.

Contents:

Likelihood, Bayes, multiple testing problem, False Discovery Rate (FDR), permutation test, bootstrap method, Sandwitch estimator / robust inference

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
Prerequisites and co-requisites:
-
Recommended optional programme components:
-
Recommended or required reading:
Bradley Efron, Trevor Hastie (2016) Computer age statistical inference. Cambridge University Press.
Assessment methods and criteria:
Final exam
Grading:
Fail, 1-5
Person responsible:
Mikko Sillanpää

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

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

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 oppimateriaali:
Colton, David, , 1988
Kress, Rainer, , 1999
Folland, Gerald B. , , 1995
Opintokohteen kielet: Finnish

ECTS Credits:
10 cr

Timing:

First and second period.

Learning outcomes:

On successful completion of this course, the student will be able to
- solve linear and quasi-linear partial differential equations of first order using the method of characteristics
- apply the method of separation of variables to solve initial-boundary value problems for heat, wave and Laplace equations
- verify that a given function is a fundamental solution of a partial differential operator
- use single and double layer potentials to solve boundary value problems for Laplacian

Contents:

Linear and nonlinear equations of the first order, trigonometric Fourier series, Laplace equation in R^n and in bounded domains, potential theory, Green's function, Heat equation in R^n and in bounded domains, Wave equation in R^n and in bounded domans, d'Alembert formula for any dimensions, Fourier method.

Assessment methods and criteria:

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

Person responsible:

Valeriy Serov

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.

802676S: Introduction to Inverse Problems, 5 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Andreas Hauptmann
Opintokohteen kielet: English

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

3rd/last year during B.Sc. studies, 1st or 2nd year of Master, 3rd period.

Learning outcomes:

After successful completion of the course the student can identify linear ill-posed inverse problems and their severity. Furthermore, the students will be able to analyze and solve such problems with direct and indirect solution methods, identify necessary regularization, is able to implement such methods and work with basic simulated and experimental data.

Contents:

Theory of ill-posed inverse problems, singular value decomposition, Generalized-Inverse and Normal equations, Landweber iterations and Tikhonov regularization, Morozov discrepancy principle. Examples include convolutions, Fourier and Radon transform, corresponding to applications in image processing, X-ray and Magnetic Resonance Tomography. Use of Matlab/Python for implementation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having mathematics, applied mathematics, or statistics as the major or a minor subject.

Prerequisites and co-requisites:

Core courses in the B.Sc curriculum of mathematical sciences, especially linear algebra; Numerical Analysis, Fourier analysis (beneficial, but not necessary), Functional analysis (beneficial, but not necessary).

Recommended or required reading:

Mueller, J and Siltanen, S (2012). Linear and nonlinear inverse problems, SIAM.

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:

Andreas Hauptmann

Working life cooperation:

No

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

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Jari Päkkilä
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

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

ECTS Credits:

5 ECTS cr

Language of instruction:

Finnish

Timing:

Period 3

Learning outcomes:

After successful completion of the course the student is able to do statistical inference in likelihood framework as well as in Bayesian analysis using common statistical softwares.

Contents:

Likelihood, Bayes, multiple testing problem, False Discovery Rate (FDR), permutation test, bootstrap method, Sandwitch estimator / robust inference

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

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Bradley Efron, Trevor Hastie (2016) Computer age statistical inference. Cambridge University Press.

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Mikko Sillanpää

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

Opiskelumuoto: Advanced Studies

Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Jari Päkkilä
Opintokohteen kielet: Finnish
Voidaan suorittaa useasti: Kyllä

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

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

ECTS Credits:
5 ECTS credist / 133 hours of work
Person responsible:
Esa Läärä

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.

800600S: Maturity test, 0 op

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

Ei opintojaksokuvauksia.

Choose here one course

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

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

Period 4

Learning outcomes:

After completion of the course, student can define the generalized linear model for most common discrete outcomes like binary outcome (logit, probit) /binomial model, model for count data (poisson model), models with more than two outcome classes with and without ordering in their classes, analysis of frequency data using log-linear models.

Contents:

Interpretation of parameters and predictive inference in models for binary outcome (logit, probit), interpretation of poisson model, overdispersion, interpretation of ordered and unordered multi-class models, connection of chi-square statistics and parameters of log-linear models.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Luennot (28 h) ja pakolliset harjoitukset (14 h)

Target group:

Master´s students of statistics, applied mathematics and mathematics

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Agresti, A., Foundations of linear and generalized linear models. John Wiley & Sons, 2015.

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Mikko Sillanpää

Working life cooperation:

No

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

Opintokohteen oppimateriaali:
Harvey, Andrew C. , , 1993
Lütkepohl, Helmut , , 1991
Hamilton, James D. , , 1994
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

ECTS Credits:
5 ECTS cr

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), excercises (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

ECTS Credits:

5 ECTS

Learning outcomes:

After successful completion of the course the student is able to describe the basic concepts and assumptions of mixed linear models, as well as main principles of mixed modeling, and is also able to apply these methods in the analysis of observational data.

Contents:

Model formulation of mixed linear model, REML, BLUP, interpretation of parameters; fitting of models, estimation of parameters and prediction by the method of REML and BLUP; use of R environment in modeling.

Learning activities and teaching methods:

Lectures (28 h), calculation and computation practicals (14 h), independent work.

Person responsible:

Mikko Sillanpää

805609S: Statistical methods in epidemiology, 9 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Läärä Esa
Opintokohteen oppimateriaali:
Santos Silva, Isabel dos , , 1999

Clayton, David , , 1993
Rothman, Kenneth J. , , 1998
Opintokohteen kielet: Finnish

ECTS Credits:

9 ECTS

Assessment methods and criteria:

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

805666S: Causal Models, 5 op

Voimassaolo: 01.08.2019 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Läärä Esa
Opintokohteen kielet: Finnish

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 16 h, Laboratory work 16 h, Exercise 16 h and Self-study the rest (Independent task assignment, written examination).

Target group:

Students who are interested in data analysis technology. Students of the University of Oulu.

Prerequisites and co-requisites:

The mathematic studies of the candidate degree program of computer science and engineering, or equivalent. Programming skills, especially basics of the Matlab.

Recommended optional programme components:

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

Recommended or required reading:

Duda RO, Hart PE, Stork DG, Pattern classification, John Wiley & Sons Inc., 2nd edition, 2001. Handouts.

Assessment methods and criteria:

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

Grading:

The course unit utilizes a numerical grading scale 1-5. In the numerical scale zero stands for a fail. The final grade is established by weighing the written exam by 2/3 and the task assignment by 1/3.

Person responsible:

Tapio Seppänen

Working life cooperation:

No

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 credits

Language of instruction:

English

Timing:

Period IV. It is recommended that the course is taken on the fourth year Spring.

Learning outcomes:

Upon completion of the course, the student :

1. is able to explain the big data phenomenon, its challenges and opportunities.
2. is able to explain the requirements and common principles for data intensive systems design and implementation, and evaluate the benefits, risks and restrictions of available solutions.

3. can explain the principles of big data management and processing technologies and utilize them on a basic level.

Contents:

General introduction into big data, namely: big data fundatmenals, data storage, batch and stream data processing, data analysis, privacy and security, big data use cases.

Mode of delivery:

Face-to-face teaching, independent and group work

Learning activities and teaching methods:

Lectures, exercises, seminars, independent and group work

Target group:

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

Prerequisites and co-requisites:

The Bachelor level studies of Computer science and engineering study programmes or respective knowledge.

Recommended optional programme components:

Finishing 521290S Distributed Systems, 521497S Pattern recognition and neural networks, and 521286A Computer Systems is beneficial.

Recommended or required reading:

Lecture slides and exercise material will be provided. Each lecture will include the refernce list for recommended reading. Instructions to necessary installations will be given.

Assessment methods and criteria:

This course assesses students continuously by the completion of small project work, seminar presentations and short reports on a selected topic (group work). Answering two quizzes during the course is optional and provides additional points for final grade. To pass the course, it is enough to get 50 % of available points. No exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Ekaterina Gilman

Working life cooperation:

The course includes also invited lectures from industry.

521156S: Towards Data Mining, 5 op

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

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish or English

Timing:

Autumn, period I.

Learning outcomes:

Student can recognize the type of the data before further analysis and the required preprocessing. The concrete learning outcomes are:
1. Student can design and implement the data gathering
2. Student can combine data from different sources
3. Student can normalize and transfor data, and handle missing or incorrect data.
4. Student can ensure the generalizability of the results.

Contents:

Course provides good ability to start Master's Thesis or graduate studies. Topics at the course include data mining process in general level, data gathering and different data types, quality and reliability of the data, data preparation including the processing of missing values, outliers, and privacy issues, combination of signals from several sources, utilization of data bases in data mining process, and normalization and transformation of data and interdependence of the observations and their distributions. Additionally, topics concerning the generality of the results are covered, as well as, the principles of data division, for example, train-test-validate, cross-validation and leave-one-out methods.

Mode of delivery:

Lectures, independent work, group work

Learning activities and teaching methods:

16 h lectures, 16 h 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:

Weekly pre-lecture assignment + exercise submissions, and final exam. Half of the grade will be based on the submissions and half on the final exam.
Read more about assessment criteria at the University of Oulu webpage.

Grading:

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

Person responsible:

Tamminen Satu

Working life cooperation:

-

Other information:

-

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

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

ECTS Credits:

5 ECTS credits / 120 hours of works

Language of instruction:

English

Timing:

Period 2. It is recommended to complete the course at the end of period 2

Learning outcomes:

Upon completing the course, the student is expected to i) comprehend, design and implement basic (online) text retrieval and query systems; ii) account for linguistic aspects and perform word sense disambiguation; iii) perform basic (statistical) inferences using corpus; iv) manipulate (statistical) language modelling toolkits, online lexical databases and various natural language processing tools.

Contents:

Foundation of text retrieval systems, Lexical ontologies, word sense disambiguation, Text categorization, Corpus-based inferences and Natural Language Processing tools

Mode of delivery:

Face- to-face teaching and laboratory sessions

Learning activities and teaching methods:

Lectures (24 h), tutorial/laboratory sessions (16h), seminar (6h) and practical work. The course is passed with an approved practical work and class test. The implementation is fully in English.

Target group:

students with (moderate to advanced) programming skills in Python

Prerequisites and co-requisites:

Programming skills (preferably) in Python

Recommended optional programme components:

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

Recommended or required reading:

Introduction to Information Retrieval, by C. Manning, P. Raghavan, and H. Schütze. Cambridge University Press, 2008. (Free from http://nlp.stanford.edu/IR-book/) Foundations of statistical natural language processing, by Manning, Christopher D., Schütze, Hinrich. Cambridge, Mass.: MIT Press, 2000

Assessment methods and criteria:

One class test (30%) in the middle of the term + Project work (70%)
Read more about assessment criteria at the University of Oulu webpage.

Grading:

1-5

Person responsible:

Mourad Oussalah

Working life cooperation:

-

521290S: Distributed Systems, 5 op

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

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

521266S Distributed Systems 6.0 op

ECTS Credits:

5 ECTS cr

Language of instruction:

In English.

Timing:

Spring, period 3.

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face.

Learning activities and teaching methods:

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

Target group:

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

Prerequisites and co-requisites:

None.

Recommended optional programme components:

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

Recommended or required reading:

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

Assessment methods and criteria:

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

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

Grading:

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

Person responsible:

Xiang Su

Working life cooperation:

None.

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

ECTS Credits:
20 cr
Language of instruction:
Finnish (also English)
Timing:
5. year of studies
Learning outcomes:
After writing the Master's degree, student has written an analytical and logical study of a problem or theory in a field of mathematics, applied mathematics or statistics. Completing the thesis succesfully, student is able to write scientific articles and texts in mathematics.
Contents:
The scope of the Master's thesis is 20 cr for Teacher students and 30 cr in other disciplines. In Master's thesis, the student engages in researching a specific mathematical area or problem in the field of mathematics, appliead mathematics or statistics.
Mode of delivery:
Thesis
Learning activities and teaching methods:
Own work, meetings with the supervisor
Target group:
Major students
Prerequisites and co-requisites:
Bachelor's degree (or equivalent), 20-50 cr advanced studies
Recommended optional programme components:
-
Recommended or required reading:
-
Assessment methods and criteria:
Thesis
Read more about assessment criteria at the University of Oulu webpage.
Grading:
1-5
Person responsible:
Professors and other teaching personnel
Working life cooperation:
-

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. Part of the training may consist of training to mark the matriculation examination.
Mode of delivery:
Depends on the practice.
Learning activities and teaching methods:
53h to 133h work depending on the practice. The meetings (12 h) concern the marking of the matriculation examination.
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

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 reporst 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:
Marko Leinonen
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

802355A: Algebraic Structures, 5 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Kari Myllylä
Opintokohteen kielet: Finnish
Leikkaavuudet:

800333A	Algebra I	8.0 op

ECTS Credits:
5 ECTS credits
Language of instruction:
Finnish
Timing:
Second year, 1. period
Learning outcomes:
After completing the course, student is able to
- derive and proof main results in the course
- use and apply different proof techniques

- recognize algebraic structures and the concepts
- see connections and differences between different algebraic structures

Contents:

The course introduces algebraic structures, such as rings, subrings, ideals, integral domains, fields and finite fields. The course gives an understanding of algebraic terms and concepts used in mathematics and physics.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h lectures, 14 h exercises

Target group:

Major students

Prerequisites and co-requisites:

802354A Basics in Algebra

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Kari Myllylä

Working life cooperation:

-

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 mathmatical thinking and teaching
- plan mathematical tasks which support profound mathematical understanding rather than compunational procedurs.

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

ECTS Credits:

5 credits

Language of instruction:

Finnish/English

Timing:

1. period

Learning outcomes:

We start our lectures by considering b-base expansions and simple continued fraction expansions of real numbers. The properties of these expansions like -terminating, non-terminating, irrationality, periodicity, approximation properties will be studied.
Next we investigate general continued fractions with corresponding recurrences and transformations. A particular attention is paid for convergence and irrationality criteria.
Further, expansions of hypergeometric series are presented which imply expansions to well-known Napier's constant and pi.
The research will be directed to more general irrationality questions and Diophantine equations, too.

Contents:

We start our lectures by considering b-base expansions and simple continued fraction expansions of real numbers. The properties of these expansionslike - terminating, non-terminating, irrationality, periodicity, approximation properties will be studied.
Next we investigate general continued fractions with corresponding recurrences and transformations. A particular attention is paid for convergence and irrationality criteria. Further, expansions of hypergeometric series are presented which imply expansions to well-known Napier's constant and pi.
The research will be directed to more general irrationality questions and Diophantine equations, too.

Mode of delivery:

Lectures, Exercises.

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 Kettenbruchen (1913).

Course material

Assessment methods and criteria:

Course exam

Grading:

1-5, fail

Person responsible:

Tapani Matala-aho

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

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 identify the correct methods for solving the linear optimization problems and implement the most typical numerical algorithms for solving linear optimization problems.

Contents:

The lecture course is focused to methods, which can apply for solving essential linear optimization problems of technical and economical sciences. The lectures consist of following topics: Convex sets, Graphical solution of LP problem, dual formulation, simplex algorithm, dual-simplex algorithm. 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:

Pää- ja sivuaineopiskelijat

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 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:

-

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

Opintokohteen oppimateriaali:
Trappe, Wade; Washington, Lawrence C., , 2005
Menezes, Alfred J.; van Oorschot, Paul C.; Vanstone, Scott A. , , 1997
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-Srassen.

Learning activities and teaching methods:

28 h lectures, 14 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Basic in Algebra, Algebraic structures, Introduction to Cryptography, Field extensions

Recommended or required reading:

Lecture notes; Wade Trappe, Lawrence C. Washington: Introduction to cryptography : with coding theory; Alfred J. Menezes: Handbook of Applied Cryptography, CRC Press 1996(http://www.cacr.math.uwaterloo.ca/hac/)

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Marko Leinonen

800694S: Introduction to Fractal Geometry, 5 op

Voimassaolo: 01.01.2018 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Esa Järvenpää
Opintokohteen kielet: Finnish

ECTS Credits:

5 ects

Learning outcomes:

After passing the course the student recognises fractal phenomena in everyday life and can calculate simple characteristics of fractals.

Contents:

The research will be directed to more general irrationality questions and Diophantine equations, too. Features, basic concepts and different characteristics of fractals.

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. Well suited for teacher students and also minor students.

Prerequisites and co-requisites:

Basic studies in mathematics.

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Maarit Järvenpää

802642S: Symmetry groups, 5 op

Voimassaolo: 01.01.2018 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Pekka Salmi
Opintokohteen kielet: Finnish

ECTS Credits:

5 credits

Language of instruction:

Finnish/English

Learning outcomes:

After completing the course the student is able to
- describe well-known symmetry groups
- determine symmetry groups of geometric objects
- use groups as objects that encode symmetries
- use permutations to represent symmetries
- explain basic concepts associated to group actions
- apply algorithms associated to permutations

Contents:

The notion of group comes from symmetries of different objects such as sets or geometrical objects. In this course we consider groups from this viewpoint. Permutations, i.e. symmetries of sets, give the foundation for these considerations. Then we proceed to study symmetries of more complicated objects such as geometrical ones. Symmetries are closely related to group actions on different objects. We cover the basic notions associated to group actions such as orbits and stabilisers. One important class of symmetry groups is formed by matrix groups and also those are studied. In addition we consider the relations between all these groups.

Mode of delivery:

Face-to-face teaching, computer exercises (in Finnish)

Learning activities and teaching methods:

28 lectures, 14 h exercises, 91 h independent study

Target group:

Mathematics majors including prospective subject teachers

Prerequisites and co-requisites:

802354A Basics of algebra,
802320A Linear algebra,
802357 Euclidean spaces

Recommended or required reading:

Luewntokalvot, STACK-tehtävät

Assessment methods and criteria:

Final exam, exercises

Grading:

1-5, fail

Person responsible:

Pekka Salmi

802675S: Introduction to Additive Combinatorics, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Ville Suomala

Opintokohteen kielet: English, Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish (Most of the course material can be provided in English, if necessary).

Timing:

1st period (autumn semester)

Learning outcomes:

Upon completion of the course:
- The student is able to handle basic sumset estimates.
- Is familiar with elementary results related to arithmetic progressions such as the Cauchy-Davenport Theorem and Van der Waerdens Theorem.
- Understands how arithmetic structure is related and nonrelated to the size of the set in various settings.
- Can regognize problems related to additive combinatorics and its applications.

Contents:

Roths theorem on arithmetic progressions, Freiman’s theorem, Balogh-Szemeredi-Gowers theorem. Applications of additive combinatorics.

Mode of delivery:

Lectures and exercises

Learning activities and teaching methods:

Lectures 28 h, exercises 8 h, independent study 91 h

Target group:

All math students (major and minor).

Prerequisites and co-requisites:

This is an independent cTämä kurssi antaa erinomaiset esitiedot kurssille 802673S Additiivinen kombinatoriikka ourse. Basic knowledge in University mathematics is enough.

Recommended optional programme components:

The course 802673S Additive combinatorics is a continuation of this course.

Assessment methods and criteria:

Exam

Grading:

Failed, 1-5

Person responsible:

Ville Suomala

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, 4th period

Learning outcomes:

As usual in my mathematical studies I shall be ableto solve problems arising from the subject andto 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, Alcebraic 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:

-

800332A: History of Mathematics, 5 op

Voimassaolo: 01.08.2017 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Lehtinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

801390A History of Mathematics 6.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

4th period

Learning outcomes:

After completing the course the student is able to explain the most important developments in the history of mathematics.

Contents:

The aim of the course is to provide the student a general conception of the history of mathematics. The main emphasis is on the calculations. Contents: Egyptian and Babylonian mathematics; Euclid and the Elements, Archimedes and Apollonius; Roman era; India and China; the islamic world; medieval mathematics; the rise of algebra; Descartes, Fermat; Newton and Leibniz, the beginning of calculus.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h

Target group:

Teacher students

Prerequisites and co-requisites:

High school mathematics

Recommended or required reading:

Lecture notes; C. J. Boyer: Tieteiden kuningatar; J. Fauvel & J. Gray: The History of Mathematics. A reader.

Assessment methods and criteria:

Final exam

Grading:

1-5, pass, fail

Person responsible:

Matti Lehtinen

Working life cooperation:

No

801399A: Geometry, 5 op

Voimassaolo: 01.08.2019 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Pekka Salmi

Opintokohteen kielet: Finnish

Leikkaavuudet:

801389A Basic Geometry for University Students 6.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnsih

Person responsible:

Pekka Salmi

Working life cooperation:

No

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, every period

Learning outcomes:

After completeing the course, student
- knows the principles of sime traditianl symmetric key methods
- knows how public key methods (RSA, discrete logarithm, knapsack) work
- is familiar with the possibility to use and apply number theory in cryptography

Contents:

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

Mode of delivery:

Independent work

Learning activities and teaching methods:

Net course; Lecture slides, exercisis, solutions of exercisis (in Noppa) + stack-exercisis

Target group:

Major and minor students

Prerequisites and co-requisites:

802354A Basics of Algebra, 802120P Introduction to Matrices

Recommended optional programme components:

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Recommended or required reading:

Lecture slides, exercisis, solutions of exercisis, stack-exercisis

Assessment methods and criteria:

Final exam or Final exam + stack-exercisis

Grading:

1-5, fail

Person responsible:

Marko Leinonen

Working life cooperation:

No

802365A: Introduction to Mathematical Solfware, 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 (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:

Erkki Laitinen

Working life cooperation:

-

Other information:

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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 oppimateriaali:
Hardy, G. H., , 1979
Rosen, Kenneth H., , 1993
Opintokohteen kielet: Finnish

ECTS Credits:

5 cr

Language of instruction:

Finnish/English

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures and execises

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:

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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, 2nd 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 ableto solve problems arising from the subject andto 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

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 equatoins (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:

Valter Pohjola

Working life cooperation:

no

Other information:

Homepage in Noppa portal.

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, 3rd 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:

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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:

Valery Serov

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:

-

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:

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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:

-

031080A: Signal Analysis, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Applied Mathematics and Computational Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Kotila, Vesa Iisakki

Opintokohteen kielet: Finnish

Leikkaavuudet:

031050A Signal Analysis 4.0 op

ECTS Credits:

5 ECTS credits / 135 hours of work

Language of instruction:

Finnish.
The course can be completed in English by partial exams or by a final exam. The material is available in English.

Timing:

The course is held in the autumn semester, during period II. It is recommended to complete the course at the 2nd autumn semester.

Learning outcomes:

Upon completion of the course, the student:
-is able to calculate the energy, the power, the convolution and the frequency spectrum of discrete and analog, periodic and non-periodic deterministic signals
-is able to calculate the spectrum of a sampled signal
-is able to calculate the Hilbert transform and the complex envelope of a signal
-is able to study the stationarity, the mutual dependence and the frequency content of random signals by means of the auto- and cross-correlation functions, and the power- and cross-power spectral densities
-is able to study the effect of an LTI system on a signal

Contents:

Signals: classification, correlation, convolution, frequency. Fourier analysis: continuous-time and discrete-time Fourier transform, discrete Fourier transform, sampling. LTI system, Hilbert transform. AM- FM- and PM-modulation. Random variable. Covariance matrix. Random signal. Stationarity, autocorrelation. Power spectral density. Random signal in LTI system. Signal estimation.

Mode of delivery:

Blended teaching.

Learning activities and teaching methods:

Lectures 28 h / Exercises 14 h / Self-study privately or in a group 93 h. The independent work includes individual STACK-assignments as online work.

Target group:

-

Prerequisites and co-requisites:

The recommended prerequisite is the completion of the courses 031078P Matrix Algebra, 031021P Probability and Mathematical Statistics and 031077P Complex Analysis.

Recommended optional programme components:

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

Recommended or required reading:

Lecture notes. Additional reading: Proakis, J.G., Manolakis, D.K.: Introduction to Digital Signal Processing. Shanmugan, K.S., Breipohl, A.M.: Random Signals, Detection, Estimation and Data Analysis.

Assessment methods and criteria:

The course is completed with two partial exams or a final exam. STACK-assignments given during the course are part of the assessment with partial exams. The assessment of the course is based on the learning outcomes of the course.
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:

Vesa Kotila

Working life cooperation:

-

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: Jukka Kemppainen
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:

-

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

ECTS Credits:

5 credits

Contents:

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

Person responsible:

Valery Serov

801396A: Introduction to Probability Theory II, 5 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opintokohteen oppimateriaali:
Tuominen, P., , 1993
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:
- work with random variables both in theory and applications
- explain the central results in probability theory such that Law of large numbers and the Central limit theorem
- determine generating functions of random variables and apply them for example to calculate moments
- apply various stocastic models
- derive the basic results associated with the new concepts introduced
- use two-dimensional distributions
- work with conditional distributions

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 distibutions 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:

Antti Kemppainen

Working life cooperation:

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