

Opasraportti

(2015 - 2016)

Tutkintorakenteet

Master's degree (Mathematical Sciences)

Tutkintorakenteen tila: published

Lukuvuosi: 2015-16

Lukuvuoden alkamispäivämäärä: 01.08.2015

Studies of the line of specialization (60 - 80 op)

Subject teacher's orientation

800600S: Maturity test, 0 op

800697S: Pro Gradu Thesis, 20 op

802639S: Special Course for Teachers of Mathematics: Content Planning, 5 op

802640S: Special Course for Teachers of Mathematics: High School Mathematics, 3 op

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

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

Advanced studies for subject teacher students

800660S: Group Theory, 10 op

802645S: Number Theory A, 5 op

802646S: Number Theory B, 5 op

802653S: Lebesgue Measure and Integration Theory, 5 op

802655S: Continued Fractions, 5 op

802656S: Algebraic numbers, 5 op

802662S: Supervising advanced problems, 5 op

802666S: Linear Optimization, 5 op

802667S: Nonlinear Optimization, 5 op

Mathematics orientation

H325053: Mathematics advanced module, 0 - 100 op

Electives

800660S: Group Theory, 10 op

800667S: Coding Theory, 10 op

800674S: Fourier transform and distributions, 10 op

801698S: Cryptography, 5 op

802608S: Introduction to Mathematical Software, 4 op

802644S: Introduction to Functional Analysis, 10 op

802645S: Number Theory A, 5 op

802646S: Number Theory B, 5 op

802649S: Dynamical systems, 10 op

802650S: Fractal Geometry, 10 op

802653S: Lebesgue Measure and Integration Theory, 5 op
 802655S: Continued Fractions, 5 op
 802656S: Algebraic numbers, 5 op
 802659S: Dynamical systems II, 10 op
 802660S: Operator theory and integral equations, 10 op
 802663S: Introduction to geometric group theory, 5 op
 802664S: Differential geometry, 10 op
 802665S: Numerical Analysis, 5 op

Statistics orientation

H326651: Statistics advanced module, 0 - 100 op

Compulsory

805642S: Pro gradu thesis, 30 op
 805644S: Maturity test, 0 op
 805627S: Theory of Statistical Inference, 5 op
 805620S: Pro Gradu seminar, 8 op
 805628S: Probability Distributions, 5 op
 806624S: Practical training/consulting, 5 - 7 op

Applied mathematics orientation

H325851: Applied mathematics advanced module, 0 - 100 op

Compulsory Advanced Studies

800698S: Pro gradu thesis, 30 op
 800600S: Maturity test, 0 op

Optional Advance Studies

802647S: Fourier series and the discrete Fourier transform, 10 op
 802635S: Introduction to partial differential equations, 10 op
 802633S: Statistical Pattern Recognition, 10 op
 802636S: Information Theory, 10 op
 802629S: Function estimation, 10 op
 031051S: Numerical Matrix Analysis, 5 op
 802665S: Numerical Analysis, 5 op
 802666S: Linear Optimization, 5 op
 802667S: Nonlinear Optimization, 5 op

Mathematics and computer sciences orientation

H325851: Applied mathematics advanced module, 0 - 100 op

Compulsory Advanced Studies

800698S: Pro gradu thesis, 30 op
 800600S: Maturity test, 0 op

Optional Advance Studies

802647S: Fourier series and the discrete Fourier transform, 10 op
 802635S: Introduction to partial differential equations, 10 op
 802633S: Statistical Pattern Recognition, 10 op
 802636S: Information Theory, 10 op
 802629S: Function estimation, 10 op
 031051S: Numerical Matrix Analysis, 5 op
 802665S: Numerical Analysis, 5 op
 802666S: Linear Optimization, 5 op
 802667S: Nonlinear Optimization, 5 op

Minor subjects

Other studies

Other studies, which are not included to minor and major subjects.

Bachelor of Science (mathematical sciences)

Tutkintorakenteen tila: archived

Lukuvuosi: 2015-16

Lukuvuoden alkamispäivämäärä: 01.08.2015

Compulsory general studies (vähintään 8 op)

902002Y: English 1 (Reading for Academic Purposes), 2 op

902004Y: English 2 (Scientific Communication), 2 op

800012Y: Orientation for New Students, 3 op

901035Y: Second Official Language (Swedish), Oral Skills, 1 op

901034Y: Second Official Language (Swedish), Written Skills, 1 op

Mandatory general studies

The courses listed below are mandatory general studies. The course Introduction to LaTeX (800149P, 2 op) can be completed together with Proseminar (Bachelor's thesis).

H325090: Optional language and general studies, 0 - 10 op

Electives

800149P: Introduction to LateX, 2 op

900070Y: Scientific Communication I, 2 op

030005P: Information Skills, 1 op

Compulsory major studies (55 op)

The following studies are compulsory for everyone. Depending on orientation studies, further optional and compulsory studies must be chosen. Also Proseminar (801323A/805331A, 6 op) and maturity (800300A, 0 op) is compulsory.

802355A: Algebraic Structures, 5 op

802162P: Continuity and Limit, 5 op

802163P: Derivative, 5 op

802120P: Introduction to Matrices, 5 op

801195P: Introduction to Probability Theory I, 5 op

802161P: Introduction to Real Functions, 5 op

806113P: Introduction to Statistics, 5 op

802151P: Introduction to mathematical deduction, 5 op

802320A: Linear Algebra, 5 op

802354A: Number Theory and Groups, 5 op

802164P: Series and Integral, 5 op

Orientation modules

In addition to compulsory major studies, students must choose optional studies in major subject depending on line of orientation.

Subject teacher's orientation module

H325050: Subject teacher's orientation module, 0 - 100 op

Compulsory studies

802357A: Euclidean Spaces, 5 op

801323A: Seminar, 6 op

800300A: Maturity test, 0 op

Optional studies (min 5 ECTS credits)

H325035: Optional intermediate studies in mathematics, 0 - 180 op

Electives

- 800329A: Topology, 8 op
- 802362A: Introduction to computational inverse problems, 5 op
- 802328A: Basics in Number Theory, 5 op
- 802331A: Principles to Mathematical Modelling, 8 op
- 802360A: Introduction to inverse problems, 4 op
- 801396A: Introduction to Probability Theory II, 5 op
- 801346A: Introduction to Cryptography, 4 op
- 802364A: Introduction to Mathematical Software, 6 op
- 802322A: Basics in mathematical modelling, 5 op
- 801329A: Mathematics in Teaching, 3 op
- 800104P: Number Systems, 4 op
- 031076P: Differential Equations, 5 op

H326635: Optional intermediate studies in statistics, 0 - 180 op

Electives

- 805324A: Time series analysis, 5 op
- 805308A: Analysis of longitudinal data, 5 op
- 805349A: Likelihood Inference, 5 op
- 805350A: Estimation and Test Theory, 5 op
- 805351A: Linear Regression, 5 op
- 805352A: Generalized Linear Models, 5 op
- 805353A: Statistical Software, 5 op
- 801396A: Introduction to Probability Theory II, 5 op

Mathematics orientation module

H325051: Mathematics orientation module, 0 - 100 op

Compulsory

- 802335A: Introduction to Real Analysis, 5 op
- 802351A: Vector Calculus, 5 op
- 802358A: Metric Spaces, 5 op
- 801323A: Seminar, 6 op
- 800300A: Maturity test, 0 op

Electives

H325035: Optional intermediate studies in mathematics, 0 - 180 op

Electives

- 800329A: Topology, 8 op
- 802362A: Introduction to computational inverse problems, 5 op
- 802328A: Basics in Number Theory, 5 op
- 802331A: Principles to Mathematical Modelling, 8 op
- 802360A: Introduction to inverse problems, 4 op
- 801396A: Introduction to Probability Theory II, 5 op
- 801346A: Introduction to Cryptography, 4 op
- 802364A: Introduction to Mathematical Software, 6 op
- 802322A: Basics in mathematical modelling, 5 op
- 801329A: Mathematics in Teaching, 3 op
- 800104P: Number Systems, 4 op
- 031076P: Differential Equations, 5 op

H326635: Optional intermediate studies in statistics, 0 - 180 op

Electives

- 805324A: Time series analysis, 5 op
- 805308A: Analysis of longitudinal data, 5 op
- 805349A: Likelihood Inference, 5 op
- 805350A: Estimation and Test Theory, 5 op
- 805351A: Linear Regression, 5 op
- 805352A: Generalized Linear Models, 5 op
- 805353A: Statistical Software, 5 op
- 801396A: Introduction to Probability Theory II, 5 op

Statistics orientation module

H326650: Statistics orientation module, 0 - 100 op

Compulsory

- 802351A: Vector Calculus, 5 op
- 806112P: Basic Methods of Data Analysis, 10 op
- 805331A: Project seminar I, 6 op
- 800300A: Maturity test, 0 op

Electives

- H326635: Optional intermediate studies in statistics, 0 - 180 op

Electives

- 805324A: Time series analysis, 5 op
- 805308A: Analysis of longitudinal data, 5 op
- 805349A: Likelihood Inference, 5 op
- 805350A: Estimation and Test Theory, 5 op
- 805351A: Linear Regression, 5 op
- 805352A: Generalized Linear Models, 5 op
- 805353A: Statistical Software, 5 op
- 801396A: Introduction to Probability Theory II, 5 op
- H326601: Optional basic studies in statistics, 0 - 100 op
- H325035: Optional intermediate studies in mathematics, 0 - 180 op

Electives

- 800329A: Topology, 8 op
- 802362A: Introduction to computational inverse problems, 5 op
- 802328A: Basics in Number Theory, 5 op
- 802331A: Principles to Mathematical Modelling, 8 op
- 802360A: Introduction to inverse problems, 4 op
- 801396A: Introduction to Probability Theory II, 5 op
- 801346A: Introduction to Cryptography, 4 op
- 802364A: Introduction to Mathematical Software, 6 op
- 802322A: Basics in mathematical modelling, 5 op
- 801329A: Mathematics in Teaching, 3 op
- 800104P: Number Systems, 4 op
- 031076P: Differential Equations, 5 op

Minor subjects (vähintään 50 op)

Bachelor studies contains also studies in major and minor subjects. The minimum requirement is that student does either two smaller minor subjects (at least 25 cr each) *OR* one larger minor subject (at least 60 cr).

Minor studies for students in teacher education

The choice of minor subjects defines how students qualify as teachers. Pedagogical studies for teachers forms a natural 30 cr minor subject for those students who are doing teachers studies. The other minor subject should be either physics, chemistry or computer sciences. Any other combinations should be applied separately from the Faculty of Sciences. Notice that when minimum requirements are fulfilled, one is free to choose other minor subjects (taking the study permissions into account).

Remark. Master studies in different programs might contain different requirements for major and minor studies. These requirements should be taken into account when choosing minor studies in Bachelor's degree. More information can be found in the Study Guide.

Physics as a minor subject**Chemistry as a minor subject****Computer sciences as a minor subject****Pedagogical studies****Other minor studies****Other studies**

This part contains all courses which are not minor studies, such as, single courses in different subjects, extra language courses, etc.

Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

802334A: A Second Course in Differential Equations, 5 op
 806119P: A Second Course in Statistics, 5 op
 802359A: Advanced Vector Calculus, 5 op
 802628S: Advanced studies special course, 2 - 18 op
 805398A: An introduction to stochastic modelling, 8 op
 805334A: Analysis of categorical data, 9 op
 801387A: Basic Course on Numerical Analysis, 6 op
 801344A: Basic Course on Numerical Computation, 8 op
 801389A: Basic Geometry, 6 op
 802159P: Basic method in Analysis for Economic Sciences, 5 op
 805380A: Clinical biostatistics, 6 op
 801385A: Complex Analysis I, 4 op
 801386A: Complex Analysis II, 4 op
 805332A: Design of experiments, 9 op
 800105P: Didactics of Mathematics, 5 op
 800345A: Differential Equations I, 4 op
 800346A: Differential Equations II, 4 op
 806353A: Experimental design, 6 op
 801390A: History of Mathematics, 6 op
 806365A: Introduction to Bayesian Statistics, 5 op
 802336A: Introduction to Cryptography, 5 op
 802668S: Introduction to Functional Analysis, 5 op
 806118P: Introduction to Statistics, 5 op
 802363A: Introduction to topology, 6 op
 802332A: Mathematical Problem Solving, 5 op
 802648S: Mathematical Problem Solving, 10 op
 802158P: Mathematics for Economic Sciences, 7 op
 802160P: Matrices and optimization for Economic Sciences, 5 op
 806360A: Mixed Linear Models, 5 op
 805328A: Multivariate analysis, 9 op
 802333A: Permutations, Fields and Galois Theory, 10 op
 800343A: Permutations, Fields and Galois' Theory, 8 op
 805333A: Robust methods, 6 op
 805309A: Statistical methods in epidemiology, 9 op
 806116P: Statistics for Economic Sciences, 5 op
 805339A: The Statistical Foundation of Econometrics, 5 - 6 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuuluvien opintokohteiden kuvaukset

800600S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800697S: Pro Gradu Thesis, 20 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802639S: Special Course for Teachers of Mathematics: Content Planning, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

- 800661S Special course for teachers of mathematics 5.0 op
- 802632S-01 Special course for teachers of mathematics / Lesson plans for teaching mathematics 4.0 op
- 802632S-03 Special course for teachers of mathematics / Other training 3.0 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:

5 ECTS credits

Language of instruction:

Finnish

Timing:

4th or 5th 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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

30h seminar, 103h independent work

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:

Active participation, reporting

Grading:

pass/fail

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

802640S: Special Course for Teachers of Mathematics: High School Mathematics, 3 op

Voimassaolo: 01.06.2015 -

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

802632S-02 Special course for teachers of mathematics / Correcting tests in mathematics 3.0 op

802632S-01 Special course for teachers of mathematics / Lesson plans for teaching mathematics 4.0 op

802632S-03 Special course for teachers of mathematics / Other training 3.0 op

802632S Special course for teachers of mathematics 10.0 op

ECTS Credits:

3 ECTS credits

Language of instruction:

Finnish

Timing:

4th or 5th year, 3rd and 4th period

Learning outcomes:

After completing the course the student is able to

- see the high school mathematics contents from the perspective of the teacher
- connect the mathematics contents to matriculation examination
- mark matriculation exams

Contents:

During the course the students review contents from high school mathematics and learn about the principles of marking the matriculation exam.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h contact teaching, 52h independent study

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:

Active participation

Grading:

Pass/fail

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

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 credits

Language of instruction:

Finnish

Timing:

4th or 5th year, any period

Learning outcomes:

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

Contents:

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

Mode of delivery:

Depends on the practice.

Learning activities and teaching methods:

53h to 133h work depending on the practice.

Target group:

Mathematics subject teacher students

Prerequisites and co-requisites:

Bachelor degree in mathematics or equivalent

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

practice, reporting

Grading:

pass/fail

Person responsible:

Pekka Salmi

Working life cooperation:

Yes. The students teach mathematics in real life situations.

Other information:

-

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

800660S: Group Theory, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Niemenmaa Markku

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish

Timing:

4-5 year of studies. Timing varies.

Learning outcomes:

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

- use different proving techniques related to the theory
- prove the Sylow theorems and deal with their applications
- prove important results in the theory of finite solvable groups

Contents:

Aim: To provide the student with the basics of group theory and its development during the past hundred years. Basics of group theory, permutations, studies on the arithmetical

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 56 h, exercises 28 h.

Target group:

Major students

Prerequisites and co-requisites:

802355A Number theory and groups

802355A Rings, Fields and polynomials

800343A Permutations, fields and Galois' theory

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exam or final exam.

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

Grading:

1-5

Person responsible:

Markku Niemenmaa

Working life cooperation:

-

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.

802646S: Number Theory B, 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.

802653S: Lebesgue Measure and Integration Theory, 5 op**Voimassaolo:** 01.08.2010 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Mikael Lindström**Opintokohteen kielet:** Finnish**Assessment methods and criteria:**Read more about [assessment criteria](#) at the University of Oulu webpage.**802655S: Continued Fractions, 5 op****Voimassaolo:** 01.01.2011 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Language of instruction:**

FI/EN

Recommended or required reading:

G.H. Hardy & E.M. Wright: An Introduction to the Theory of Numbers.
 Kenneth H. Rosen: Elementary number theory and its applications.
 Lisa Lorentzen and Haakon Waadeland: Continued Fractions with Applications (1992).
 Oskar Perron: Die Lehre von den Kettenbrüchen (1913).

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

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

Language of instruction:

FI/EN

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course.

More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding.

When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

First we revise some basics of rings and fields which are needed to proceed ahead field extensions. In particular, divisibility in an integral domain is carefully studied yielding to applications in the theory of polynomial algebra and algebraic integers.

The theory of algebraic numbers is strongly based on polynomial algebra, where the properties of zeros and divisibility of polynomials are considered.

The definition of an algebraic number will be generalized to the algebraic elements of field extensions going forward to algebraic fields. Considered as most important algebraic fields we get number fields which are finitely generated subfields of the field \mathbb{C} 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.

Prerequisites and co-requisites:

Algebra I and II, Linear algebra I and II, Basics in Number Theory (Number theory I)

Recommended or required reading:

I.N. Stewart and D.O. Tall: Algebraic number theory.

Daniel Marcus: Number fields.

J.B. Fraleigh: Abstract algebra.

Michael Artin: Algebra.

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

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 cr

Language of instruction:

Finnish

Timing:

4-5 year

Learning outcomes:

After completing the course, students are able to

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

28h seminar, 12h teaching, 93h independent and group work

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

802666S: Linear Optimization, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

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:

-

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***800660S: Group Theory, 10 op**

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Niemenmaa Markku

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish

Timing:

4-5 year of studies. Timing varies.

Learning outcomes:

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

- use different proving techniques related to the theory
- prove the Sylow theorems and deal with their applications
- prove important results in the theory of finite solvable groups

Contents:

Aim: To provide the student with the basics of group theory and its development during the past hundred years. Basics of group theory, permutations, studies on the arithmetical

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 56 h, exercises 28 h.

Target group:

Major students

Prerequisites and co-requisites:

802355A Number theory and groups

802355A Rings, Fields and polynomials

800343A Permutations, fields and Galois' theory

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exam or final exam.

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

Grading:

1-5

Person responsible:

Markku Niemenmaa

Working life cooperation:

-

800667S: Coding Theory, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800674S: Fourier transform and distributions, 10 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Valeriy Serov**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

801698S: Cryptography, 5 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Tapani Matala-aho**Opintokohteen kielet:** Finnish**Language of instruction:**

Finnish/English

Learning outcomes:

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

Contents:

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

Assessment methods and criteria:

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

802608S: Introduction to Mathematical Software, 4 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Markus Harju**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

802644S: Introduction to Functional Analysis, 10 op

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

Learning outcomes:

If we think of functional analysis as infinite dimensional linear algebra, then the course offers the tools and the ways to handle this infinite dimension. After completing the course successfully, the student will be able to follow almost any material on functional analysis.

Contents:

After recalling some basic definitions on linear algebra and giving the basic definitions concerning normed spaces, we present the uniform boundedness principle and the open mapping theorem. In this first part of the course, the relative compactness of the unit ball in a normed space is studied under the norm topology. Hahn-Banach Theorem is presented in its various forms: algebraic, analytic and geometric, and followed by Krein-Milman Theorem. We end up with the weak topology on normed spaces and the weak* topology on Banach duals. The relative compactness of the unit ball is studied with respect to these two topologies.

Assessment methods and criteria:

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

Person responsible:

Mahmoud Filali

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.

802646S: Number Theory B, 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.

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.

802650S: Fractal Geometry, 10 op

Voimassaolo: 01.01.2010 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opettajat: Esa Järvenpää
Opintokohteen kielet: Finnish

Assessment methods and criteria:

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

802653S: Lebesgue Measure and Integration Theory, 5 op

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

Assessment methods and criteria:

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

802655S: Continued Fractions, 5 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Language of instruction:

FI/EN

Recommended or required reading:

G.H. Hardy & E.M. Wright: An Introduction to the Theory of Numbers.
 Kenneth H. Rosen: Elementary number theory and its applications.
 Lisa Lorentzen and Haakon Waadeland: Continued Fractions with Applications (1992).
 Oskar Perron: Die Lehre von den Kettenbrüchen (1913).

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

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**Language of instruction:**

FI/EN

Learning outcomes:

As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course.

More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding.

When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.

Contents:

First we revise some basics of rings and fields which are needed to proceed ahead field extensions. In particular, divisibility in an integral domain is carefully studied yielding to applications in the theory of polynomial algebra and algebraic integers.

The theory of algebraic numbers is strongly based on polynomial algebra, where the properties of zeros and divisibility of polynomials are considered.

The definition of an algebraic number will be generalized to the algebraic elements of field extensions going forward to algebraic fields. Considered as most important algebraic fields we get number fields which are finitely generated subfields of the field \mathbb{C} 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.

Prerequisites and co-requisites:

Algebra I and II, Linear algebra I and II, Basics in Number Theory (Number theory I)

Recommended or required reading:

I.N. Stewart and D.O. Tall: Algebraic number theory.

Daniel Marcus: Number fields.

J.B. Fraleigh: Abstract algebra.

Michael Artin: Algebra.

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

802659S: Dynamical systems II, 10 op**Voimassaolo:** 01.08.2011 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

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 cr

Language of instruction:

English

Timing:

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

Learning outcomes:

Upon completion the student should be able to:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Major students in mathematics, physics and engineering.

Prerequisites and co-requisites:

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

Recommended optional programme components:

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

Recommended or required reading:

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

- 1) R. Kress, Linear integral equations, Springer-Verlag New York, 1999.
- 2) F. Riesz and B. Sz-Nagy, Functional analysis, Ungar, 1978.

3) A.N. Kolmogorov and S.V. Fomin, Elements of the theory of functions and functional analysis, 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:

Professor, Valery Serov

vserov@cc.oulu.fi

802663S: Introduction to geometric group theory, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

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

Ei opintojaksokuvauksia.

802665S: Numerical Analysis, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

4th or 5th year of studies

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h and exercises 12 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:

-

H326651: Statistics 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.

Compulsory

805642S: Pro gradu thesis, 30 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Assessment methods and criteria:

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

805644S: Maturity test, 0 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

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

805611S Mathematical statistics II 10.0 op

Ei opintojaksokuvauksia.

805620S: Pro Gradu seminar, 8 op**Voimassaolo:** 01.09.2012 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Läärä Esa**Opintokohteen kielet:** Finnish**ECTS Credits:**

10 cr

Language of instruction:

Finnish

Timing:

4.-5. year of studies.

Learning outcomes:

After successful completion of the Pro gradu -seminar the student is able to conduct a small scale statistical investigation and report it both in written form and orally.

Contents:

Under supervision of the leader of the seminar each student conducts a small-scale statistical investigation on a given empirical topic and material, makes a written report from it and presents it orally in seminar sessions. The written report is the M.Sc. thesis, when statistics is the major subject of the student.

Mode of delivery:

Face-to-face teaching, seminars

Learning activities and teaching methods:

Seminars and meetings in two years

Target group:

Major students in statistics

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in statistics

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Participation into seminar sessions, seminar presentation and written paper.

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

Grading:

Fail/Pass

Person responsible:

Esa Läärä

Working life cooperation:

-

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:

Esa Läärä

Working life cooperation:

No

Other information:

-

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

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jari Pääkkilä

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

Ei opintojaksokuvauksia.

H325851: Applied 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.

Compulsory Advanced Studies

800698S: Pro gradu thesis, 30 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800600S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Optional Advance Studies

802647S: Fourier series and the discrete Fourier transform, 10 op

Voimassaolo: 01.01.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: English

Ei opintojaksokuvauksia.

802635S: Introduction to partial differential equations, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

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 \mathbb{R}^n and in bounded domains, potential theory, Green's function, Heat equation in \mathbb{R}^n and in bounded domains, Wave equation in \mathbb{R}^n and in bounded domains, 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

802633S: Statistical Pattern Recognition, 10 op**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Lasse Holmström**Opintokohteen kielet:** Finnish**ECTS Credits:**

10 cr

Language of instruction:

Finnish

Timing:

Spring semester, 3rd and 4th periods.

Learning outcomes:

Upon completing the course the student will

-be familiar with the most common classifiers used in pattern recognition

-be able to apply pattern recognition methods to practical problems

-be able derive some of the basic mathematical results of pattern recognition theory

Contents:

The course focuses on the theory and practice of pattern recognition with emphasis on classifiers and feature extraction

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

42 h of lectures, 28 h of exercises

Target group:

Mathematics, applied mathematics and statistics majors. Other students with a sufficient mathematical background.

Prerequisites and co-requisites:

Calculus in one and several dimensions, linear algebra I and II. Probability theory I. Probability theory II or Random variables and distributions.

Recommended or required reading:

Lecture notes.

Optional reading:

R. O. Duda, P. E. Hart, and D. G. Stork. Pattern Classification. Wiley-Interscience, second edition, 2000.

S. Theodoridis and K. Koutroumbas. Pattern Recognition. Academic Press, 1999.

A. Webb. Statistical Pattern Recognition. Arnold, 1999 (Second edition: John Wiley & Sons Ltd, 2002).

Assessment methods and criteria:

Final exam. In the first exam following the course the student gets credit for the (possible) homework problems he/she has solved during the course.

Grading:

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

Person responsible:

Lasse Holmström

Working life cooperation:

No

Other information:

No

802636S: Information Theory, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Lasse Holmström

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish.

Timing:

Spring semester, 3rd and 4th periods.

Learning outcomes:

Upon completing the course the student will

- be familiar with the central concepts and results of information theory
- be able to solve mathematical problems that arise in information theory
- be able to derive the central results of information theory

Contents:

The course introduces Claude Shannons' mathematical theory of communication, its basic concepts and results. The questions discussed include quantification of the amount of information of an information source, compression of information, coding, communication of coded information through a communication channel and decoding of received messages.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

56 h of lectures, 28 h of exercises.

Target group:

Mathematics, applied mathematics and statistics majors. Other students with a sufficient mathematical background.

Prerequisites and co-requisites:

Calculus in one and several dimensions, linear algebra I and II. Probability theory I. Probability theory II or Random variables and distributions.

Recommended or required reading:

Lecture notes written by the instructor.

Assessment methods and criteria:

Final exam. In the first exam following the course the student gets credit for the homework problems he /she has solved during 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:

Lasse Holmström

Working life cooperation:

-

Other information:

Level: advanced studies.

802629S: Function estimation, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Lasse Holmström

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish

Timing:

Spring semester, 3rd and 4th periods

Learning outcomes:

Upon completing the course the student will be able to

- characterise the basic features non-parametric function estimation methods
- apply such estimation methods to practical problems
- derive some of the basic results of non-parametric function estimation for kernel estimators

Contents:

The course focuses on the theory and practice of non-parametric function estimation with a special emphasis on kernel methods. The particular functions considered are a probability density function and a regression function.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

42 h of lectures, 28 h of exercises

Target group:

Mathematics, applied mathematics and statistics majors. Other students with a sufficient mathematical background.

Prerequisites and co-requisites:

Calculus in one and several dimensions. Probability theory I. Probability theory II or Random variables and distributions.

Recommended optional programme components:

No

Recommended or required reading:

Lecture notes written by the instructor.

Assessment methods and criteria:

Final exam. In the first exam following the course the student gets credit for the homework problems he /she has solved during the course. This is agreed in the beginning of the course.

Grading:

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

Person responsible:

Lasse Holmström

Working life cooperation:

No

Other information:

No

031051S: Numerical Matrix Analysis, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course
Arvostelu: 1 - 5, pass, fail
Opettajat: Marko Huhtanen
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802665S: Numerical Analysis, 5 op

Voimassaolo: 01.06.2015 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

4th or 5th year of studies

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h and exercises 12 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:

-

802666S: Linear Optimization, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Advanced Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**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:

-

H325851: Applied 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.

*Compulsory Advanced Studies***800698S: Pro gradu thesis, 30 op**

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800600S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

*Optional Advance Studies***802647S: Fourier series and the discrete Fourier transform, 10 op**

Voimassaolo: 01.01.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: English

Ei opintojaksokuvauksia.

802635S: Introduction to partial differential equations, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Valeriy Serov

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

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 \mathbb{R}^n and in bounded domains, potential theory, Green's function, Heat equation in \mathbb{R}^n and in bounded domains, Wave equation in \mathbb{R}^n and in bounded domains, 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

802633S: Statistical Pattern Recognition, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Lasse Holmström

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish

Timing:

Spring semester, 3rd and 4th periods.

Learning outcomes:

Upon completing the course the student will

- be familiar with the most common classifiers used in pattern recognition
- be able to apply pattern recognition methods to practical problems
- be able derive some of the basic mathematical results of pattern recognition theory

Contents:

The course focuses on the theory and practice of pattern recognition with emphasis on classifiers and feature extraction

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

42 h of lectures, 28 h of exercises

Target group:

Mathematics, applied mathematics and statistics majors. Other students with a sufficient mathematical background.

Prerequisites and co-requisites:

Calculus in one and several dimensions, linear algebra I and II. Probability theory I. Probability theory II or Random variables and distributions.

Recommended or required reading:

Lecture notes.

Optional reading:

R. O. Duda, P. E. Hart, and D. G. Stork. Pattern Classification. Wiley-Interscience, second edition, 2000.

S. Theodoridis and K. Koutroumbas. Pattern Recognition. Academic Press, 1999.

A. Webb. Statistical Pattern Recognition. Arnold, 1999 (Second edition: John Wiley & Sons Ltd, 2002).

Assessment methods and criteria:

Final exam. In the first exam following the course the student gets credit for the (possible) homework problems he/she has solved during the course.

Grading:

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

Person responsible:

Lasse Holmström

Working life cooperation:

No

Other information:

No

802636S: Information Theory, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Lasse Holmström

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish.

Timing:

Spring semester, 3rd and 4th periods.

Learning outcomes:

Upon completing the course the student will

- be familiar with the central concepts and results of information theory
- be able to solve mathematical problems that arise in information theory
- be able to derive the central results of information theory

Contents:

The course introduces Claude Shannons' mathematical theory of communication, its basic concepts and results. The questions discussed include quantification of the amount of information of an information source, compression of information, coding, communication of coded information through a communication channel and decoding of received messages.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

56 h of lectures, 28 h of exercises.

Target group:

Mathematics, applied mathematics and statistics majors. Other students with a sufficient mathematical background.

Prerequisites and co-requisites:

Calculus in one and several dimensions, linear algebra I and II. Probability theory I. Probability theory II or Random variables and distributions.

Recommended or required reading:

Lecture notes written by the instructor.

Assessment methods and criteria:

Final exam. In the first exam following the course the student gets credit for the homework problems he /she has solved during 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:

Lasse Holmström

Working life cooperation:

-

Other information:

Level: advanced studies.

802629S: Function estimation, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Lasse Holmström

Opintokohteen kielet: Finnish

ECTS Credits:

10 cr

Language of instruction:

Finnish

Timing:

Spring semester, 3rd and 4th periods

Learning outcomes:

Upon completing the course the student will be able to

- characterise the basic features non-parametric function estimation methods
- apply such estimation methods to practical problems
- derive some of the basic results of non-parametric function estimation for kernel estimators

Contents:

The course focuses on the theory and practice of non-parametric function estimation with a special emphasis on kernel methods. The particular functions considered are a probability density function and a regression function.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

42 h of lectures, 28 h of exercises

Target group:

Mathematics, applied mathematics and statistics majors. Other students with a sufficient mathematical background.

Prerequisites and co-requisites:

Calculus in one and several dimensions. Probability theory I. Probability theory II or Random variables and distributions.

Recommended optional programme components:

No

Recommended or required reading:

Lecture notes written by the instructor.

Assessment methods and criteria:

Final exam. In the first exam following the course the student gets credit for the homework problems he /she has solved during the course. This is agreed in the beginning of the course.

Grading:

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

Person responsible:

Lasse Holmström

Working life cooperation:

No

Other information:

No

031051S: Numerical Matrix Analysis, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opettajat: Marko Huhtanen

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802665S: Numerical Analysis, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits

Language of instruction:

English

Timing:

4th or 5th year of studies

Learning outcomes:

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

Contents:

The lecture course is focused to numerical methods for solving the most common basic problems in mathematics. For the methods, convergence, stability and suitability for computer arithmetic are

considered. The course contains numerical solution methods for the following basic problems: systems of nonlinear equations, systems of linear equations, interpolation, integration, derivation and differential equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 24 h and exercises 12 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:

-

802666S: Linear Optimization, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

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:

-

902002Y: English 1 (Reading for Academic Purposes), 2 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Negotiated Education

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Proficiency level:

B2/C1 on the [Common European Framework of Reference](#) scale.

Status:

This course is mandatory for students of the following degree programmes:

Faculty of Science

- Biology
- Chemistry
- Mathematical Sciences
- Physics

Oulu Mining School

- Geosciences degree programme

Faculty of Information Technology and Electrical Engineering

- Department of Information Processing Science

Students in the Department of Geography take English 3.

Engineering students in the following programmes take their English courses in the Faculty of Technology:

Oulu Mining School:

- Mining Technology and Mineral Processing degree programme

Faculty of Information Technology and Electrical Engineering

- Department of Electrical Engineering
- Department of Communications Engineering
- Department of Computer Science and Engineering

Please consult the Faculty Study Guide to establish the language requirements for your own degree program.

Required proficiency level:

English must have been the A1 or A2 language at school or equivalent English skills should have been acquired otherwise.

ECTS Credits:

2 ECTS credits (total work load 54 hours including classroom meetings.)

Language of instruction:

English

Timing:

Biology: 1st year spring term

Chemistry: 1st year autumn term

Geology: 1st year spring term

Information Processing Science: 1st year spring term

Mathematical Sciences (pedagogy): 1st year spring term

Mathematical Sciences: 2nd year autumn term

Physical Sciences: 1st year autumn term

Learning outcomes:

By the end of the course, you are expected to be able to

- have acquired effective vocabulary learning techniques
- be able to distinguish parts of words to infer meanings
- utilize your knowledge of text structure and cohesion markers to understand academic texts
- extract information and learn content from English readings in scientific and professional contexts

Contents:

The course will focus on reading strategies; these include recognizing how texts are organized, identifying key points in a text, and understanding words in context. Vocabulary work in the course will focus on a) academic vocabulary, as used in formal scientific writing, and b) using your knowledge of the meanings of parts of words (affixes) to infer meaning.

Mode of delivery:

Contact teaching

Learning activities and teaching methods:

The scope of the course is 2 op (54 hours student workload).

Target group:

1st year students of Biology, Chemistry, Geology, Information Processing Science, Physics, and Mathematics (pedagogy); 2nd year students of Mathematics

Prerequisites and co-requisites:

-

Recommended optional programme components:

Students are also required to take 902004Y Scientific Communication, which is taken AFTER completion of this course.

Recommended or required reading:

Photocopies will be provided by the teacher and/or required texts will be accessible online or from the university library.

Assessment methods and criteria:

Student work is monitored by continuous assessment. You are required to participate regularly and actively in all contact teaching provided, and successfully complete all required coursework. There will be three monthly tests on material covered so far.

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

Grading:

Pass/Fail

Person responsible:

Karen Niskanen and Patrick Nesbitt

Working life cooperation:

-

Other information:

N.B. Students with grades *laudatur* or *eximia* in their A1 English school-leaving examination can be exempted from this course and will be granted the credits by the Faculty of Science.

902004Y: English 2 (Scientific Communication), 2 op

Voimassaolo: 01.08.1995 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Negotiated Education

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

ay902004Y English 2 (Scientific Communication) (OPEN UNI) 2.0 op

Proficiency level:

B2/C1 on the CEFR scales

Status:

This course is mandatory for all 2nd year students (except **geographers**) who will have English as their foreign language in their B.Sc. degree. This includes the students who were exempted from 'Reading for Academic Purposes'(902002Y). Please consult the faculty study guide to establish the language requirements on your own degree programme.

Required proficiency level:

Students taking this course must have had English as the A1 or A2 language at school or the equivalent English skills should have been acquired otherwise. The course 'Reading for Academic Purposes' (902002Y) is a pre-requisite, unless exempted.

ECTS Credits:

The student workload is 53 hrs work/ 2 ECTS credits.

Language of instruction:

English

Timing:

Biology: 2nd year autumn term

Chemistry: 2nd year spring term

Geology: 2nd year spring term

Information Processing Science : 2nd year autumn term

Mathematics: 2nd year spring term

Physics: 2nd year autumn term

Learning outcomes:

By the end of the course, you are expected:

1. to have demonstrated your use of appropriate strategies and techniques for communicating effectively in English in an academic context.
2. to have demonstrated the ability to prepare and present scientific subjects to your classmates, using appropriate field-related vocabulary.

Contents:

Skills in listening, speaking, and presenting academic topics are practised in the classroom, where there is an emphasis on working in pairs and small groups. Homework tasks include online lecture listening and reading, preparation for classroom discussions and written work to support the classroom learning.

Mode of delivery:

Contact teaching

Learning activities and teaching methods:

Contact teaching 28 hours, homework 28 hours

Target group:

2nd year students of Biology, Chemistry, Geology, Information Processing Science, Mathematics, Physics

Prerequisites and co-requisites:

-

Recommended optional programme components:

Also required: [902002Y Reading for Academic Purposes Englannin kieli 1](#)

Recommended or required reading:

Course materials will be provided by the teacher.

Assessment methods and criteria:

Continuous assessment is based on regular attendance, active participation in all lessons and the successful completion of all homework tasks.

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

Grading:

Pass / fail.

Person responsible:

Karen Niskanen and Patrick Nesbitt

Working life cooperation:

-

Other information:

-

800012Y: Orientation for New Students, 3 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: General Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

901035Y: Second Official Language (Swedish), Oral Skills, 1 op

Voimassaolo: 01.08.2014 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Negotiated Education

Opintokohteen kielet: Swedish

Leikkaavuudet:

- 901061Y Second Official Language (Swedish), Oral Skills 1.0 op
- ay901035Y Second Official Language (Swedish), Oral Skills (OPEN UNI) 1.0 op
- 901004Y Swedish 2.0 op

901034Y: Second Official Language (Swedish), Written Skills, 1 op

Voimassaolo: 01.08.2014 -

Opiskelumuoto: Language and Communication Studies

Laji: Course

Vastuuyksikkö: Negotiated Education

Opintokohteen kielet: Swedish

Leikkaavuudet:

- 901060Y Second Official Language (Swedish), Written Skills 1.0 op
- ay901034Y Second Official Language (Swedish), Written Skills (OPEN UNI) 1.0 op
- 901004Y Swedish 2.0 op

H325090: Optional language and general studies, 0 - 10 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: General Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Electives

800149P: Introduction to LaTeX, 2 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761115P Laboratory Exercises in Physics 1 5.0 op

761115P-03 Laboratory Exercises in Physics 1, Introduction to LaTeX 0.0 op

ECTS Credits:

2 cr

Language of instruction:

Finnish (in english if needed)

Timing:

2-3 year of studies, before making the Bachelor's thesis

Learning outcomes:

After completing the course, student

- is able to describe the principles of LaTeX document preparation system
- can form basic template of LaTeX document and modify it to his/her needs
- knows basic commands when writing mathematical text
- is able to use different environments (e.g. enumerations, equations)
- can recognize and fix errors in LaTeX code
- is able to write Bachelor's and Master's thesis using LaTeX

Contents:

Bachelor's and Master's thesis are written using LaTeX document preparation system. This course introduces basics in LaTeX by giving basic knowledge of the principles of LaTeX.

Mode of delivery:

Lectures/exercises (computer class)

Learning activities and teaching methods:

Face-to-face teaching

Target group:

Major students

Prerequisites and co-requisites:

first year math studies

Recommended optional programme components:

Must be completed before Bachelor's thesis.

Recommended or required reading:

Lecture notes

Tobias Oetiker Hubert Partl, Irene Hyna and Elisabeth Schlegl, *The Not So Short Introduction to LATEX2#*
(<http://tobi.oetiker.ch/lshort/lshort.pdf>)

Kopka, H. and Daly, P. W., *Guide to LaTeX (4th Edition)*, Addison-Wesley Professional, 2003

Assessment methods and criteria:

Participation in lectures/exercises and home work.

Grading:

Pass/Fail

Person responsible:

Markus Harju

Working life cooperation:

-

900070Y: Scientific Communication I, 2 op**Voimassaolo:** 01.08.2011 -**Opiskelumuoto:** Language and Communication Studies**Laji:** Course**Vastuuyksikkö:** Negotiated Education**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

ay900070Y Scientific Communication I (OPEN UNI) 2.0 op

Proficiency level:

-

Status:

This course unit is compulsory for all students undertaking a BA degree in Education, Subject Teacher Education, Primary Teacher Education, Technology Oriented Primary Teacher Education, Creative Arts Oriented Primary Teacher Education and Music Education.

Required proficiency level:

-

ECTS Credits:

2 ECTS credits

Language of instruction:

Finnish

Timing:

1st year of studies

Learning outcomes:

Upon completion of the course unit the student should be able to prepare a verbally and stylistically fluent scientific presentation. The student should be able to assess and revise his/her own texts and apply the conventions and practices of scientific writing to his/her own work, especially to his/her scientific theses or dissertations. The student should be able to recognise his/her strengths and weak points as a communicator.

Contents:

The basics and various types of scientific communication. The basic notions of grammatical correctness and the stylistic and formal conventions demanded by proper scientific discourse. Critical approach to source literature and the most common formal standards (referencing techniques, constructing bibliographies etc.). Throughout the course unit the student analyses and produces texts of various types.

Mode of delivery:

contact teaching

Learning activities and teaching methods:

Contact lessons and group work 16 h. Independent study ca. 34 h.

Target group:

Students of the Faculty of Education

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

the Material in the Optima learning environment,
 Hirsjärvi, S., Remes, P. & Sajavaara, P. (2009). Tutki ja kirjoita. Helsinki: Tammi.
 Kemppainen, T. & Lomama, T. (2002). Ensi askelia tieteen tiellä. Oulun yliopisto. Teos on saatavilla myös internetissä.
 Lonka, I., Lonka, K., Karvonen, P. & Leino, P. (2006). Taitava kirjoittaja. Opiskelijan opas. Helsinki: Yliopistopaino.

Assessment methods and criteria:

Active participation in teaching, independent study and completion of given assignments.
 Read more about [assessment criteria](#) at the University of Oulu webpage.

Grading:

pass / fail

Person responsible:

Toropainen, Outi

Working life cooperation:

-

Other information:

-

030005P: Information Skills, 1 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Faculty of Technology

Arvostelu: 1 - 5, pass, fail

Opettajat: Sassali, Jani Henrik, Ursula Heinikoski

Opintokohteen kielet: Finnish

Leikkaavuudet:

030004P Introduction to Information Retrieval 0.0 op

ECTS Credits:

1 ECTS credit

Language of instruction:

Finnish

Timing:

2nd or 3rd year

Learning outcomes:

Students know the different phases of information retrieval process and basic techniques of scientific information retrieval. They will find the most important reference databases of their discipline and know how to evaluate information sources and retrieval results.

Contents:

Retrieval of scientific information, the retrieval process, key databases of the discipline, and evaluation of information retrieval and information sources.

Mode of delivery:

Blended teaching: classroom training, web-based learning material and exercises in Optima environment, a final assignment on a topic of the student's own choice

Learning activities and teaching methods:

Training sessions 8h, group working 7h, self-study 12h

Target group:

Compulsory for all students of the Faculty of Technology, the Faculty of Information Technology and Electrical Engineering and the Faculty of Architecture. In the Faculty of Science compulsory for students of biology, physics, geosciences, chemistry and geography. Optional for students of biochemistry and mathematics.

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Web learning material <https://wiki oulu.fi/display/030005P>.

Assessment methods and criteria:

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

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

Grading:

pass/fail

Person responsible:

Science and Technology Library Tellus, tellustieto (at) oulu.fi

Working life cooperation:

-

Other information:

-

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:

28h lectures, 14h exercises

Target group:

Major students

Prerequisites and co-requisites:

802354A Number theory and groups

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exam or final exam

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

1-5

Person responsible:

Kari Myllylä

Working life cooperation:

-

802162P: Continuity and Limit, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800119P Analysis 1 5.0 op

802155P Continuity and limit 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1. year, 2. period

Learning outcomes:

After completing the course, student is able to derive and proof main results of the course use different types of proof techniques define the limit of function and the continuity of function derive and proof the limit using different proof techniques deduce the continuity of functions using different proof techniques.

Contents:

The main concept of the course are the limit of a real-valued function and the continuity of real-valued function. Interrelations between these concepts are also studied.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h lectures, 14h exercises

Target group:

Main and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

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

Grading:

Failed, 1-5

Person responsible:

Esa Järvenpää

Working life cooperation:

-

Other information:

-

802163P: Derivative, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Esa Järvenpää

Opintokohteen kielet: Finnish

Leikkaavuudet:

800317A Analysis 2 5.0 op

802156P Derivative 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1. year, 3. period

Learning outcomes:

After completing the course, student is able to

- derive and proof main results of the course
- use different types of proof techniques
- use and apply the concept of derivative in different types of problems

Contents:

The course considers the concept of derivative of real-valued function and applies this concept to different types of situations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h lectures, 14 h exercises

Target group:

Pää- ja sivuaineopiskelijat

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction

802155P Limits and continuity

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Esa Järvenpää

Working life cooperation:

No

Other information:

-

802120P: Introduction to Matrices, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

802118P Linear Algebra I 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1. year, autumn

Learning outcomes:

After completing the course the student is able to

- apply arithmetic operations of matrices
- solve system of linear equations by matrix methods and can apply matrix factorizations to find the solution of the system of linear equations.
- recognize the vector space and understands the concepts of basis and dimension of a vector space
- analyse matrices by the parameters, vectors and vector spaces of matrices
- diagonalize matrices and apply diagonalization to the simple problems

Contents:

Vectors and matrices, Systems of linear equations, determinant of a matrix, matrix factorizations, vector spaces, base, dimension, rank of matrix, eigenvalues and eigenvectors of a matrix, diagonalization.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28 h, Exercises and group work 14 h, independent work

Target group:

Major and minor studies

Prerequisites and co-requisites:

802151P Introduction to Mathematical Deduction

Recommended or required reading:

Lecture notes

Grossman, S.I. : Elementary Linear Algebra, David C. Lay: Linear Algebra and Its Applications.

Assessment methods and criteria:

Exercise points and/or exams

Grading:

Fail, 1-5

Person responsible:

Tero Vedenjuoksu

Working life cooperation:

-

Other information:

Homepage in Noppa-portal.

801195P: Introduction to Probability Theory I, 5 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen oppimateriaali:

Tuominen, P., , 1993

Opintokohteen kielet: Finnish

ECTS Credits:

5 ECTS credits.

Language of instruction:

Finnish.

Timing:

Fall semester, 2nd period.

Learning outcomes:

Upon completing the course the student will be able to

- solve simple practical problems associated with probability
- solve simple theoretical problems associated with probability
- derive the basic properties of probability, starting from the axioms

Contents:

The course is an introduction to probability. In the beginning high school level probability is reviewed and after that axiomatic treatment of the theory starts. The central concepts discussed include probability space, conditional probability, independence, and random variable together with its distribution and expected value.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

35 h of lectures, 14 h of exercises.

Target group:

Mathematics, applied mathematics and statistics majors. Other students taking mandatory or optional mathematics courses.

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction

802154P Elementary functions

Recommended optional programme components:

-

Recommended or required reading:

Lectures.

Text book: Pekka Tuominen, "Todennäköisyyslaskenta I", Limes ry, Helsinki.

Assessment methods and criteria:

Two exams covering the two halves of the course are arranged during the course. Another option is to take an exam that covers the whole 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:

Pekka Salmi.

Working life cooperation:

-

Other information:

Level: intermediate studies.

802161P: Introduction to Real Functions, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

802154P Elementary functions 3.0 op

800147P Basic Methods in Mathematics I / appl. 8.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1st year, 1st period

Learning outcomes:

After completing the course the student is able to

- operate with elementary functions
- calculate derivatives and apply them
- use different integration techniques
- apply calculus in problem solving

Contents:

The course concerns real-valued functions of one variable and their calculus. In addition to calculation techniques, effort is made to understand the underlying concepts so that they can be applied in problem solving. The aim of the course is to develop calculation routine as well as deductive skills.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h lectures, 14h exercises, 91h study a part of which may be guided

Target group:

Mathematics major and minor students

Prerequisites and co-requisites:

No

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

1-5, fail

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

806113P: Introduction to Statistics, 5 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Läärä Esa, Hanna Heikkinen

Opintokohteen oppimateriaali:

Wild, Christopher J. , , 2000

Grönroos, Matti (2) , , 2003

Opintokohteen kielet: Finnish

Leikkaavuudet:

806118P Introduction to Statistics 5.0 op

806119P A Second Course in Statistics 5.0 op

806116P Statistics for Economic Sciences 5.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

3rd period. It is recommended to complete the course at the 1st spring semester.

Learning outcomes:

Upon completion of the course, student will be

- able to identify and define the main principles of statistical research, collection of the data and analysis
- able to apply basic methods of descriptive statistics and statistical inference in simple quantitative research using a statistical software

- able to critically evaluate results of the statistical research presented in media
- prepared for teaching statistics in secondary school and high school
- prepared for participating in a group.

Contents:

- the nature and the meaning of statistics
- data and the acquisition of them: observations, variables, measuring and designs of a study
- the descriptive statistics of empirical distributions: tables, graphical presentations and descriptive measures of center, variation and dependence
- the principles and the basic methods of statistical inference: random sample, sample statistics, point estimation, confidence intervals and statistical testing of hypotheses

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 16 h (partly compulsory) / instructed group work (28 h) / independent work 80 h. Group works will be returned. Additional independently implemented learning diary tasks. Independent work contains also preparation for group work and peer assessment.

Target group:

Students of mathematical sciences and other interested students.

Prerequisites and co-requisites:

The recommended prerequisite prior to enrolling for the course is the completion of the courses: 802151P Introduction to mathematical deduction, 802154P Elementary functions, 802155P Continuity and limit ja 801195P Introduction to Probability Theory.

Recommended optional programme components:

After the course, student is able to continue other statistics courses.

Recommended or required reading:

Lecture notes.

Assessment methods and criteria:

This course utilizes continuous assessment. Practical works and learning diaries are assessed weekly. The assessment of the course is based on the learning outcomes of the course. The more detailed assessment criteria is available in the beginning of the course. In addition one compulsory lecture and peer assessment.

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:

Hanna Heikkinen

Working life cooperation:

No

802151P: Introduction to mathematical deduction, 5 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay802151P Introduction to mathematical deduction (OPEN UNI) 5.0 op

ECTS Credits:

5 ECTS

Language of instruction:

Finnish

Timing:

First period at the first semester.

Learning outcomes:

After completing the course, student

- is able to use different methods proving techniques
- is able to use basic set theoretic concepts and definitions
- is able to define and apply basic definitions related to functions

Contents:

The course is an introduction to mathematical deduction and introduces different types of proof techniques. The course covers the concepts familiar from upper secondary school studies more profoundly. Main concepts in this course are basic set theory and functions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h, exercises 18h

Target group:

Major and minor students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

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

Grading:

Pass/Fail

Person responsible:

Tero Vedenjuoksu

Working life cooperation:

-

Other information:

Course homepage: <https://noppa.oulu.fi/noppa/kurssi/802151p/etusivu>

802320A: Linear Algebra, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

802119P Linear Algebra II 5.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd year, 1st period

Learning outcomes:

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

- apply the definition of linear space and concepts associated with linear spaces such as basis
- work with linear mappings and their matrix representations
- apply the definition of inner product space and concepts associated with inner product spaces such as orthogonality
- prove results related to linear spaces

Contents:

The aim of the course is to provide the student with the knowledge needed in almost all later courses in mathematics: abstract vector spaces and subspaces, linear independence and bases, inner product spaces, linear mappings and concepts associated with linear mappings such as kernel, eigenvalues and eigenvectors.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Mathematics majors and minors students

Prerequisites and co-requisites:

802120P Introduction to Matrices

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

1-5, fail

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

802354A: Number Theory and Groups, 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:**

ay802354A Number Theory and Groups (OPEN UNI) 5.0 op

800333A Algebra I 8.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1. year, 3. period

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 includes basics in arithmetics and algebraic structures, such as, congruence, residue classes, prime numbers, Euclidean algorithm, the fundamental theorem of arithmetic, Euler-Fermat formula, groups and morphisms. 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:

28h lectures, 14h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Midterm exam or final exam

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

Grading:

1-5

Person responsible:

Kari Myllylä

Working life cooperation:

-

802164P: Series and Integral, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800318A Analysis 3 5.0 op

802353A Series and Integrals 6.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1st year, 4th period

Learning outcomes:

After completing the course, the student is able to

- operate with series
- define and calculate Riemann integrals
- formulate the Fundamental Theorem of Calculus and apply it to evaluate integrals

Contents:

The course is continuation for the courses Continuity and Limit and Derivative. The goal is the same as in the prerequisite courses, that is, to develop mathematical thinking and extend the knowledge of mathematical analysis. The contents of the course are series and Riemann integral. A central result is the Fundamental Theorem of Calculus that connects the Riemann integral to antiderivative.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Mathematics major and minor students

Prerequisites and co-requisites:

802162P Continuity and Limit

802163P Derivative

Recommended optional programme components:

-

Recommended or required reading:

lecture notes

Assessment methods and criteria:

Final exam

Grading:

1-5, fail

Person responsible:

Mahmoud Filali

Working life cooperation:

No

Other information:

-

H325050: Subject teacher's orientation module, 0 - 100 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic and Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory studies

802357A: Euclidean Spaces, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Maarit Järvenpää

Opintokohteen kielet: Finnish

Leikkaavuudet:

802352A Euclidean Topology 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

Subject teachers: 2. year 2. period

Learning outcomes:

After passing the course the student

- will be able to define basic topological concepts
- will be able to handle sequences
- will be able to justify basic properties of continuous vector valued functions

Contents:

Sequences, continuity and limit of a vector valued function, basic topological concepts

Mode of delivery:

Contact teaching

Learning activities and teaching methods:

28 hours of lectures, 14 hours of exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

802151P Introduction to mathematical deduction,
802161P Introduction to real functions,
802162P Continuity and limits

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Maarit Järvenpää

Working life cooperation:

-

Other information:

-

801323A: Seminar, 6 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800331A Proseminar 10.0 op

ECTS Credits:

6 cr

Language of instruction:

Finnish (also English)

Timing:

2.-3. year of studies

Learning outcomes:

After completing the Bachelor's thesis, student

- is able to form a clear and logical
- is able to concentrate to important and essential details in the subject of thesis
- gain experience presenting mathematical concept and research studies.

Contents:

Proseminar (Bachelor's thesis) is a small mathematical study based on literature. Student is familiarized to write mathematical texts and obtain information using literature. Thesis includes a oral presentation from the subject of the thesis.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Seminars and own work

Target group:

Major students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies.

Recommended optional programme components:

Maturity test is written from the topic of Bachelor's thesis.

Recommended or required reading:

-

Assessment methods and criteria:

Opinnäytetyö

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

Grading:

Pass/Fail

Person responsible:

Maarit Järvenpää

Working life cooperation:

-

800300A: Maturity test, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

0 cr

Language of instruction:

Finnish/Swedish

Timing:

Third year

Learning outcomes:

Maturity test

Contents:

Students must take a written maturity test to demonstrate their language skills and how well they know the topic of their thesis. The maturity test is taken in the language in which the student has received his or her education in Finland. If the student has received his or her education in a language other than Finnish or Swedish, the degree programme determines the language of the maturity test. In such cases only the contents of the maturity test is evaluated, not the language.

Mode of delivery:

Maturity test written in examination room.

Learning activities and teaching methods:

Maturity test

Target group:

Major students

Prerequisites and co-requisites:

Bachelor's degree (or similar)

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Maturity test

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

Grading:

Pass/Fail

Person responsible:

Supervisor of thesis

Working life cooperation:

-

Optional studies (min 5 ECTS credits)

H325035: Optional intermediate studies in mathematics, 0 - 180 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Electives

800329A: Topology, 8 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mahmoud Filali

Opintokohteen oppimateriaali:

Vala K., Suominen K., , 1990

Opintokohteen kielet: Finnish

ECTS Credits:

8 cr

Language of instruction:

English (also Finnish)

Timing:

Second year or later. Fall/spring term

Learning outcomes:

On successful completion of this course, the student will be able to follow more advanced topology and analysis.

Contents:

The course presents the very basics of topology that mathematics students should know. It starts with elementary set theory, then it goes on covering metric spaces including Baire's theorem; topological spaces and convergence in topological spaces; separation axioms including Urysohn's lemma and Tietze extension theorem; compact spaces including Tyconoff theorem; and ends with connected spaces.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 hours lecture, 28 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended optional programme components:

-

Recommended or required reading:

S. Willard: General Topology;
K. Suominen & K. Vala: Topologia;
R. Engelking: Outline of General Topology.

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Mahmoud Filali

Working life cooperation:

-

802362A: Introduction to computational inverse problems, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Orispää

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

36h lectures, 18h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Tapani Matala-aho

Working life cooperation:

-

802331A: Principles to Mathematical Modelling, 8 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802360A: Introduction to inverse problems, 4 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Sari Lasanen

Opintokohteen kielet: Finnish

ECTS Credits:

4 cr

Language of instruction:

Finnish. Alternatively, a book examination in English.

Learning outcomes:

Upon completion, the student will be able to

- recognise several inverse problems
- describe typical properties of inverse problems
- solve simple inverse problems with accurate and inaccurate data

Contents:

1. Examples of inverse problems and their typical properties
2. Well-posed and ill-posed problems
3. Least squares solutions
4. Tikhonov regularization
5. Statistical inverse problems

Learning activities and teaching methods:

Lectures 4x45 min / week. Exercises 2x45 min /week.

Target group:

Suitable for major and minor students.

Prerequisites and co-requisites:

- 802118P Linear Algebra I
- 802119P Linear Algebra II

Also recommended:

- 800322A Multidimensional Analysis (or Analysis II)
- 801396A Introduction to Probability Theory II
- 802352A Euclidian Topology
- 800345A Differential Equations I

Assessment methods and criteria:

Exam.

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

Other information:

This course does not contain numerical programming tasks. Computer-aided computations are contained in a separate course

802362A Introduction to Computational Inverse Problems.

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:

4 cr

Language of instruction:

Finnish

Timing:

2. year, Fall semester

Learning outcomes:

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

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

Contents:

The course is a direct continuation for the course Probability Theory I. The new concepts include for instance the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem as well as two-dimensional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24h lectures, 12h exercises

Target group:

Major- and minor students. Recommended for students aiming to Master's degree with major in statistics or major in mathematics and computer sciences.

Prerequisites and co-requisites:

801195P Introduction to probability I

802352A Euclidean topology

802353A Series and integrals

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Kenneth Nordström.

801346A: Introduction to Cryptography, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Leikkaavuudet:

802336A Introduction to Cryptography 5.0 op

ECTS Credits:

4 cr

Language of instruction:

Finnish

Timing:

2. year or later, Fall term (1. or 2. period)

Learning outcomes:

After completing the course, student

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

27 h lectures, 15 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Tapani Matala-aho

802364A: Introduction to Mathematical Software, 6 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Harju

Opintokohteen kielet: Finnish

ECTS Credits:

6 cr

Language of instruction:

Lecturing language is Finnish, but the main points can be explained also in English if necessary. The software and the majority of course material is also in English.

Timing:

Autumn semester, period one.

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
- 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

- R
- Matlab
- Mathematica

Time permitting, it is also possible to learn other mathematical software depending the interests of the students.

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:

Lecures 22h / Rehearsals 22h / Self-study 60h. 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):

- 802118P Linear Algebra I
- 802119P Linear Algebra II.

Recommended optional programme components:

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

Recommended or required reading:

The 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.

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

Grading:

The course utilizes verbal grading scale "Pass/ fail".

Person responsible:

Mikko Orispää

Working life cooperation:

-

802322A: Basics in mathematical modelling, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen kielet: Finnish

801329A: Mathematics in Teaching, 3 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800146P Introduction to teaching 5.0 op

ECTS Credits:

3 cr/ 81 hours of work

Language of instruction:

Finnish

Timing:

1st year, periods 3 and 4

Learning outcomes:

The student can reflect critically on the learning and teaching of mathematics. The student can analyze the connection between mathematics at school and at university.

Contents:

Learning and teaching mathematics are thought about and discussed. The course consists of reflective exercises and seminar meetings where the exercises are discussed. A student analyzes the connection between mathematics at school and at university. A student writes a learning journal.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24 h seminar meetings, 57 h self-study and group work.

Target group:

Mathematics teacher students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Active participation, learning journal, group work

Grading:

Pass/Fail

Person responsible:

Riikka Palkki

Working life cooperation:

-

Other information:

-

800104P: Number Systems, 4 op

Voimassaolo: 01.03.2011 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800347A Number systems 5.0 op

Ei opintojaksokuvauksia.

031076P: Differential Equations, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031076P Differential Equations (OPEN UNI) 5.0 op

800320A Differential equations 5.0 op

031017P Differential Equations 4.0 op

Ei opintojaksokuvauksia.

H326635: Optional intermediate studies in statistics, 0 - 180 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Electives

805324A: Time series analysis, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jussi Klemelä

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.

805308A: Analysis of longitudinal data, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen oppimateriaali:

Peter J. Diggle et al., , 2002

Hsiao, Cheng , , 2003

McCulloch, Charles E. , , 2001

Fitzmaurice, Garrett M. , , 2004

Opintokohteen kielet: Finnish

ECTS Credits:

5/6 cr

Language of instruction:

Finnish

Timing:

Every second year.

Learning outcomes:

After finishing the course a student can apply pooled ordinary least squares, generalized least squares, random effects methods, and fixed effects methods.

Contents:

1. Introduction: data types, omitted variables.
2. Mathematical tools: conditional expectation, basic asymptotic theory.
3. Basics of ordinary least squares.
4. Estimating systems of equations by ordinary least squares and by generalized least squares, panel data and seemingly unrelated regression as examples, simultaneous exogeneity and strict exogeneity, consistency and asymptotic normality, homoskedasticity and heteroskedasticity.
5. Pooled ordinary least squares for panel data, aggregated time effect, dummy variables, testing serial correlation and heteroskedasticity.
6. Unobserved effects model: random effects and fixed effects.
7. Random effects methods: random effects structure of the covariance matrix.
8. Fixed effects methods: fixed effects transformation, the use of dummy variables, first differencing transformation.
9. Comparison of estimators.

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 economics and mathematical sciences.

Prerequisites and co-requisites:

Basic Mathematics for Economics 1 and 2, Basic Methods in Statistics 1, Introduction to Econometrics.

Recommended or required reading:

J. M. Wooldridge: *Econometric Analysis of Cross Section and Panel Data* (The MIT Press).

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:

The course is organized every two years.

The home page of the course is <http://cc.oulu.fi/~jklemela/panel/>

805349A: Likelihood Inference, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year of B.Sc. studies, spring term

Learning outcomes:

After successful completion of the course the student can describe the basic principles of likelihood inference, derive likelihood functions of models with few parameters, compute likelihood quantities basen on them, and interpret results such obtained.

Contents:

Statistical model and observation data; likelihood function, log-likelihood, score, information; maximum likelihood estimation, relative likelihood, likelihood interval and likelihood region, profile likelihood; normal approximation of log-likelihood; use of R environment in inferential problems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Introduction to Probability Theory I, Basic Methods of Data Analysis

Recommended optional programme components:

Is needed in nearly all intermediate and advanced courses in statistics

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805350A: Estimation and Test Theory, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

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

Recommended optional programme components:

Needed in nearly all intermediate and advanced courses of statistics

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject.

Prerequisites and co-requisites:

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

Recommended optional programme components:

Prerequisite to the course Generalized Linear Models

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805630S Generalized Linear Models 5.0 op

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year of studies in B.Sc. programme

Learning outcomes:

After successful completion of the course the student can describe the basic concepts and assumptions of generalized linear models as well as main principles of regression modelling, and can also apply these methods in analysis of experimental and observational data.

Contents:

Generalized linear regression models for continuous, binary and count outcomes; formulation of the model, selection of variables and interpretation of parameters; fitting the models, estimating the parameters and prediction by the method of maximum likelihood; model criticism and diagnostics; use of R environment and SAS software in modelling.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Linear regression; Basic methods in data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Dobson, A.J., Barnett, A.J. An Introduction to Generalized Linear Models, Third Edition. Chapman & Hall/CRC, 2008. Aitkin, M., Francis, B., Hinde, J., Darnell, R. Statistical Modelling in R. Oxford University Press, 2009. Madsen, H., Thyregod, P. Introduction to General and Generalized Linear Models. Chapman & Hall/CRC, 2010

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:

Mikko Sillanpää

Working life cooperation:

No

Other information:

805353A: Statistical Software, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805340A Statistical Software 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3. year studies. Fall semester. Timing varies.

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Major and minor students

Prerequisites and co-requisites:

806112P Basic methods of data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Home works

Grading:

Numerical grading 1-5 (or fail)

Person responsible:

Hanna Heikkinen

Working life cooperation:

No

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:

4 cr

Language of instruction:

Finnish

Timing:

2. year, Fall semester

Learning outcomes:

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

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

Contents:

The course is a direct continuation for the course Probability Theory I. The new concepts include for instance the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem as well as two-dimensional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24h lectures, 12h exercises

Target group:

Major- and minor students. Recommended for students aiming to Master's degree with major in statistics or major in mathematics and computer sciences.

Prerequisites and co-requisites:

801195P Introduction to propability I
 802352A Euclidean topology
 802353A Series and integrals

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Kenneth Nordström.

H325051: Mathematics orientantion module, 0 - 100 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic and Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

*Compulsory***802335A: Introduction to Real Analysis, 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 credits

Language of instruction:

Finnish

Timing:

1st year, 4th period

Learning outcomes:

After completing the course the student is able to

- apply the definition of limit in several different settings
- apply Cauchy criterion
- solve problems related to the topology of the real line
- explain the difference between uniform and pointwise convergence

Contents:

The aim of the course is to deepen the understanding of limits, convergence and approximation. Convergence on the real line and related results are considered in detail. The students understanding of continuity is deepened. Cauchy sequences and completeness form one of the central topics. Finally, function sequences and series are studied as well as uniform and pointwise convergence.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Mathematics majors (obligatory for mathematics majors except for subject teacher students)

Prerequisites and co-requisites:

802162P Continuity and Limit

802163P Derivative

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

802351A: Vector Calculus, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800328A Calculus of several variables 5.0 op

800322A Analysis II 8.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1st or 2nd year, 3rd period

Learning outcomes:

After completing the course the student is able to - operate functions of several variables - apply derivatives of functions of several variables - calculate multiple integrals

Contents:

The course concerns calculus of severable variables. The central concepts of the course are partial derivative, gradient, divergence, curl and multiple integral. Integral theorems related to functions of several variables are also presented. The course offers basic tools for further courses in analysis as well as for applications.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h lectures, 14h exercises, 91h study a part of which may be guided

Target group:

Mathematics major and minor students

Prerequisites and co-requisites:

802161P Introduction to Real Functions

802120P Introduction to Matrices

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

1-5, fail

Person responsible:

Mahmoud Filali

Working life cooperation:

No

Other information:

-

802358A: Metric Spaces, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

802356A Metric Topology 5.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd year, 2nd period

Learning outcomes:

After the course the student is able to

- define metric spaces
- give examples of metric spaces
- define elementary topological concepts (open and closed sets, accumulation point, etc)
- apply the definitions from elementary topology in examples and proofs

Contents:

The goal of the courses is to expand student's knowledge and understanding of continuity and to introduce to other topological concepts in the setting of metric spaces. Course considers basic topology of n -dimensional Euclidean space and introduces also other metric spaces as examples. Central concepts are open and closed sets, compactness and completeness.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Mathematics majors (obligatory for mathematics majors except for subject teacher students)

Prerequisites and co-requisites:

802357A Introduction to Real Analysis

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

801323A: Seminar, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800331A Proseminar 10.0 op

ECTS Credits:

6 cr

Language of instruction:

Finnish (also English)

Timing:

2.-3. year of studies

Learning outcomes:

After completing the Bachelor's thesis, student

- is able to form a clear and logical
- is able to concentrate to important and essential details in the subject of thesis
- gain experience presenting mathematical concept and research studies.

Contents:

Proseminar (Bachelor's thesis) is a small mathematical study based on literature. Student is familiarized to write mathematical texts and obtain information using literature. Thesis includes a oral presentation from the subject of the thesis.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Seminars and own work

Target group:

Major students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies.

Recommended optional programme components:

Maturity test is written from the topic of Bachelor's thesis.

Recommended or required reading:

-

Assessment methods and criteria:

Opinnäytetyö

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

Grading:

Pass/Fail

Person responsible:

Maarit Järvenpää

Working life cooperation:

-

800300A: Maturity test, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

0 cr

Language of instruction:

Finnish/Swedish

Timing:

Third year

Learning outcomes:

Maturity test

Contents:

Students must take a written maturity test to demonstrate their language skills and how well they know the topic of their thesis. The maturity test is taken in the language in which the student has received his or her education in Finland. If the student has received his or her education in a language other than Finnish or Swedish, the degree programme determines the language of the maturity test. In such cases only the contents of the maturity test is evaluated, not the language.

Mode of delivery:

Maturity test written in examination room.

Learning activities and teaching methods:

Maturity test

Target group:

Major students

Prerequisites and co-requisites:

Bachelor's degree (or similar)

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Maturity test

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

Grading:

Pass/Fail

Person responsible:

Supervisor of thesis

Working life cooperation:

-

Electives

H325035: Optional intermediate studies in mathematics, 0 - 180 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800329A: Topology, 8 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Mahmoud Filali**Opintokohteen oppimateriaali:****Vala K., Suominen K., , 1990****Opintokohteen kielet:** Finnish**ECTS Credits:**

8 cr

Language of instruction:

English (also Finnish)

Timing:

Second year or later. Fall/spring term

Learning outcomes:

On successful completion of this course, the student will be able to follow more advanced topology and analysis.

Contents:

The course presents the very basics of topology that mathematics students should know. It starts with elementary set theory, then it goes on covering metric spaces including Baire's theorem; topological spaces and convergence in topological spaces; separation axioms including Urysohn's lemma and Tietze extension theorem; compact spaces including Tyconoff theorem; and ends with connected spaces.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 hours lecture, 28 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended optional programme components:

-

Recommended or required reading:

S. Willard: General Topology;

K. Suominen & K. Vala: Topologia;

R. Engelking: Outline of General Topology.

Assessment methods and criteria:

Final exam, or mid-term exams

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

1-5

Person responsible:

Mahmoud Filali

Working life cooperation:

-

802362A: Introduction to computational inverse problems, 5 op

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

Ei opintojaksokuvauksia.

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

36h lectures, 18h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Tapani Matala-aho

Working life cooperation:

-

802331A: Principles to Mathematical Modelling, 8 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802360A: Introduction to inverse problems, 4 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Sari Lasanen

Opintokohteen kielet: Finnish

ECTS Credits:

4 cr

Language of instruction:

Finnish. Alternatively, a book examination in English.

Learning outcomes:

Upon completion, the student will be able to

- recognise several inverse problems

- describe typical properties of inverse problems
- solve simple inverse problems with accurate and inaccurate data

Contents:

1. Examples of inverse problems and their typical properties
2. Well-posed and ill-posed problems
3. Least squares solutions
4. Tikhonov regularization
5. Statistical inverse problems

Learning activities and teaching methods:

Lectures 4x45 min / week. Exercises 2x45 min /week.

Target group:

Suitable for major and minor students.

Prerequisites and co-requisites:

- 802118P Linear Algebra I
- 802119P Linear Algebra II

Also recommended:

- 800322A Multidimensional Analysis (or Analysis II)
- 801396A Introduction to Probability Theory II
- 802352A Euclidian Topology
- 800345A Differential Equations I

Assessment methods and criteria:

Exam.

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

Other information:

This course does not contain numerical programming tasks. Computer-aided computations are contained in a separate course

802362A Introduction to Computational Inverse Problems.

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:

4 cr

Language of instruction:

Finnish

Timing:

2. year, Fall semester

Learning outcomes:

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

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

Contents:

The course is a direct continuation for the course Probability Theory I. The new concepts include for instance the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem as well as two-dimensional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24h lectures, 12h exercises

Target group:

Major- and minor students. Recommended for students aiming to Master's degree with major in statistics or major in mathematics and computer sciences.

Prerequisites and co-requisites:

801195P Introduction to probability I

802352A Euclidean topology

802353A Series and integrals

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Kenneth Nordström.

801346A: Introduction to Cryptography, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Leikkaavuudet:

802336A Introduction to Cryptography 5.0 op

ECTS Credits:

4 cr

Language of instruction:

Finnish

Timing:

2. year or later, Fall term (1. or 2. period)

Learning outcomes:

After completing the course, student

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

27 h lectures, 15 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Tapani Matala-aho

802364A: Introduction to Mathematical Software, 6 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Harju

Opintokohteen kielet: Finnish

ECTS Credits:

6 cr

Language of instruction:

Lecturing language is Finnish, but the main points can be explained also in English if necessary. The software and the majority of course material is also in English.

Timing:

Autumn semester, period one.

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
- 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

- R
- Matlab
- Mathematica

Time permitting, it is also possible to learn other mathematical software depending the interests of the students.

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:

Lecures 22h / Rehearsals 22h / Self-study 60h. 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):

- 802118P Linear Algebra I
- 802119P Linear Algebra II.

Recommended optional programme components:

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

Recommended or required reading:

The 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.

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

Grading:

The course utilizes verbal grading scale "Pass/ fail".

Person responsible:

Mikko Orispää

Working life cooperation:

-

802322A: Basics in mathematical modelling, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen kielet: Finnish

801329A: Mathematics in Teaching, 3 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800146P Introduction to teaching 5.0 op

ECTS Credits:

3 cr/ 81 hours of work

Language of instruction:

Finnish

Timing:

1st year, periods 3 and 4

Learning outcomes:

The student can reflect critically on the learning and teaching of mathematics. The student can analyze the connection between mathematics at school and at university.

Contents:

Learning and teaching mathematics are thought about and discussed. The course consists of reflective exercises and seminar meetings where the exercises are discussed. A student analyzes the connection between mathematics at school and at university. A student writes a learning journal.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24 h seminar meetings, 57 h self-study and group work.

Target group:

Mathematics teacher students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Active participation, learning journal, group work

Grading:

Pass/Fail

Person responsible:

Riikka Palkki

Working life cooperation:

-

Other information:

-

800104P: Number Systems, 4 op

Voimassaolo: 01.03.2011 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800347A Number systems 5.0 op

Ei opintojaksokuvauksia.

031076P: Differential Equations, 5 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay031076P Differential Equations (OPEN UNI) 5.0 op

800320A	Differential equations	5.0 op
031017P	Differential Equations	4.0 op

Ei opintojaksokuvauksia.

H326635: Optional intermediate studies in statistics, 0 - 180 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Electives

805324A: Time series analysis, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jussi Klemelä

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.

805308A: Analysis of longitudinal data, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen oppimateriaali:

Peter J. Diggle et al. , , 2002

Hsiao, Cheng , , 2003

McCulloch, Charles E. , , 2001

Fitzmaurice, Garrett M. , , 2004

Opintokohteen kielet: Finnish

ECTS Credits:

5/6 cr

Language of instruction:

Finnish

Timing:

Every secon year.

Learning outcomes:

After finishing the course a student can apply pooled ordinary least squares, generalized least squares, random effects methods, and fixed effects methods.

Contents:

1. Introduction: data types, omitted variables.
2. Mathematical tools: conditional expectation, basic asymptotic theory.
3. Basics of ordinary least squares.
4. Estimating systems of equations by ordinary least squares and by generalized least squares, panel data and seemingly unrelated regression as examples, simultaneous exogeneity and strict

exogeneity, consistency and asymptotic normality, homoskedasticity and heteroskedasticity.

5. Pooled ordinary least squares for panel data, aggregated time effect, dummy variables, testing serial correlation and heteroskedasticity.

6. Unobserved effects model: random effects and fixed effects.

7. Random effects methods: random effects structure of the covariance matrix.

8. Fixed effects methods: fixed effects transformation, the use of dummy variables, first differencing transformation.

9. Comparison of estimators.

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 economics and mathematical sciences.

Prerequisites and co-requisites:

Basic Mathematics for Economics 1 and 2, Basic Methods in Statistics 1, Introduction to Econometrics.

Recommended or required reading:

J. M. Wooldridge: Econometric Analysis of Cross Section and Panel Data (The MIT Press).

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:

The course is organized every two years.

The home page of the course is <http://cc.oulu.fi/~jklemela/panel/>

805349A: Likelihood Inference, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year of B.Sc. studies, spring term

Learning outcomes:

After successful completion of the course the student can describe the basic principles of likelihood inference, derive likelihood functions of models with few parameters, compute likelihood quantities basen on them, and interpret results such obtained.

Contents:

Statistical model and observation data; likelihood function, log-likelihood, score, information; maximum likelihood estimation, relative likelihood, likelihood interval and likelihood region, profile likelihood; normal approximation of log-likelihood; use of R environment in inferential problems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Introduction to Probability Theory I, Basic Methods of Data Analysis

Recommended optional programme components:

Is needed in nearly all intermediate and advanced courses in statistics

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805350A: Estimation and Test Theory, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

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

Recommended optional programme components:

Needed in nearly all intermediate and advanced courses of statistics

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805351A: Linear Regression, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject.

Prerequisites and co-requisites:

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

Recommended optional programme components:

Prerequisite to the course Generalized Linear Models

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805352A: Generalized Linear Models, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805630S Generalized Linear Models 5.0 op

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year of studies in B.Sc. programme

Learning outcomes:

After successful completion of the course the student can describe the basic concepts and assumptions of generalized linear models as well as main principles of regression modelling, and can also apply these methods in analysis of experimental and observational data.

Contents:

Generalized linear regression models for continuous, binary and count outcomes; formulation of the model, selection of variables and interpretation of parameters; fitting the models, estimating the parameters and prediction by the method of maximum likelihood; model criticism and diagnostics; use of R environment and SAS software in modelling.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Linear regression; Basic methods in data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Dobson, A.J., Barnett, A.J. An Introduction to Generalized Linear Models, Third Edition. Chapman & Hall/CRC, 2008. Aitkin, M., Francis, B., Hinde, J., Darnell, R. Statistical Modelling in R. Oxford University Press, 2009. Madsen, H., Thyregod, P. Introduction to General and Generalized Linear Models. Chapman & Hall/CRC, 2010

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:

Mikko Sillanpää

Working life cooperation:

No

Other information:

-

805353A: Statistical Software, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805340A Statistical Software 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3. year studies. Fall semester. Timing varies.

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Major and minor students

Prerequisites and co-requisites:

806112P Basic methods of data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Home works

Grading:

Numerical grading 1-5 (or fail)

Person responsible:

Hanna Heikkinen

Working life cooperation:

No

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:**

4 cr

Language of instruction:

Finnish

Timing:

2. year, Fall semester

Learning outcomes:

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

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

Contents:

The course is a direct continuation for the course Probability Theory I. The new concepts include for instance the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem as well as two-dimensional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24h lectures, 12h exercises

Target group:

Major- and minor students. Recommended for students aiming to Master's degree with major in statistics or major in mathematics and computer sciences.

Prerequisites and co-requisites:

801195P Introduction to probability I
802352A Euclidean topology
802353A Series and integrals

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Kenneth Nordström.

H326650: Statistics orientation module, 0 - 100 op

Voimassaolo: 01.08.2015 -

Opiskelumuoto: Basic and Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Compulsory

802351A: Vector Calculus, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800328A Calculus of several variables 5.0 op

800322A Analysis II 8.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

1st or 2nd year, 3rd period

Learning outcomes:

After completing the course the student is able to - operate functions of several variables - apply derivatives of functions of several variables - calculate multiple integrals

Contents:

The course concerns calculus of severable variables. The central concepts of the course are partial derivative, gradient, divergence, curl and multiple integral. Integral theorems related to functions of several variables are also presented. The course offers basic tools for further courses in analysis as well as for applications.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h lectures, 14h exercises, 91h study a part of which may be guided

Target group:

Mathematics major and minor students

Prerequisites and co-requisites:

802161P Introduction to Real Functions

802120P Introduction to Matrices

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

1-5, fail

Person responsible:

Mahmoud Filali

Working life cooperation:

No

Other information:

-

806112P: Basic Methods of Data Analysis, 10 op**Opiskelumuoto:** Basic Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Jari Päckilä**Opintokohteen oppimateriaali:****Armitage, P. , , 2002****Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805305A Introduction to Regression and Analysis of Variance 5.0 op

ECTS Credits:

10 cr

Language of instruction:

Finnish

Timing:

The course is held in the autumn semester, during periods 1 and 2.

Learning outcomes:

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

- analyze continuous and categorical response in the most common experimental and observational studies
- critically evaluate chosen model
- use some statistical software

Contents:

Skills for performing statistical analyses and inferences on the basis of data obtained in common experimental and observational studies are expanded and deepened. Topics included are e.g. (1) principles of collection, description, and modelling of, and inference on statistical data; (2) basic methods of analysing continuous outcome variables, like comparison of groups, analysis of variance, regression analysis, residuals and model diagnostics, nonparametric methods, treatment of correlated and lifetime (censored) observations; (3) and basic methods of analysing binary, categorical and count data.

Mode of delivery:

Face-to-face teaching.

Learning activities and teaching methods:

56h lectures, 42h exercises, self-study.

Target group:

Major and minor students.

Prerequisites and co-requisites:

For major students:

801195P Introduction to Probability Theory I, 806113P Introduction to statistics, 802118P Linear algebra I, 802154P Elementary functions, 802155P Limits and continuity, 802156P Derivative

For minor students: 806109P Basic Methods in Statistics I

Recommended optional programme components:

To be completed before 805310A Statistical inference I, 806359A Regression modelling and other studies in statistics.

Recommended or required reading:

Lecture notes.

Assessment methods and criteria:

Intermediate (2) or final exam.

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

The course utilizes a numerical grading scale 1-5 / fail.

Person responsible:

Jari Pääkkilä

Working life cooperation:

-

805331A: Project seminar I, 6 op**Voimassaolo:** 23.04.2007 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

6 cr

Language of instruction:

Finnish

Timing:

3. year of studies (fall or spring)

Learning outcomes:

After successful completion of the project seminar the student is able to conduct a small scale statistical investigation and report it both in written form and orally.

Contents:

Under supervision of the leader of the seminar each student conducts a small-scale statistical investigation on a given empirical topic and material, makes a written report from it and presents it orally in seminar sessions. The written report is the B.Sc. thesis, when statistics is the major subject of the student.

Mode of delivery:

Seminars

Learning activities and teaching methods:

Seminar sessions (20 h) and independent work.

Target group:

Major and minor students

Prerequisites and co-requisites:

Basic methods of data-analysis

Recommended optional programme components:

Maturity test is written of the subject of proseminar.

Recommended or required reading:

-

Assessment methods and criteria:

Seminar (written) and presentation

Grading:

Pass/Fail

Person responsible:

Jari Pääkkilä

Working life cooperation:

-

800300A: Maturity test, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

0 cr

Language of instruction:

Finnish/Swedish

Timing:

Third year

Learning outcomes:

Maturity test

Contents:

Students must take a written maturity test to demonstrate their language skills and how well they know the topic of their thesis. The maturity test is taken in the language in which the student has received his or her education in Finland. If the student has received his or her education in a language other than Finnish or Swedish, the degree programme determines the language of the maturity test. In such cases only the contents of the maturity test is evaluated, not the language.

Mode of delivery:

Maturity test written in examination room.

Learning activities and teaching methods:

Maturity test

Target group:

Major students

Prerequisites and co-requisites:

Bachelor's degree (or similar)

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Maturity test

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

Grading:

Pass/Fail

Person responsible:

Supervisor of thesis

Working life cooperation:

-

Electives

H326635: Optional intermediate studies in statistics, 0 - 180 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Study module

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

Electives

805324A: Time series analysis, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Jussi Klemelä

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.

805308A: Analysis of longitudinal data, 5 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen oppimateriaali:****Peter J. Diggle et al.**, , 2002**Hsiao, Cheng** , , 2003**McCulloch, Charles E.** , , 2001**Fitzmaurice, Garrett M.** , , 2004**Opintokohteen kielet:** Finnish**ECTS Credits:**

5/6 cr

Language of instruction:

Finnish

Timing:

Every second year.

Learning outcomes:

After finishing the course a student can apply pooled ordinary least squares, generalized least squares, random effects methods, and fixed effects methods.

Contents:

1. Introduction: data types, omitted variables.
2. Mathematical tools: conditional expectation, basic asymptotic theory.
3. Basics of ordinary least squares.
4. Estimating systems of equations by ordinary least squares and by generalized least squares, panel data and seemingly unrelated regression as examples, simultaneous exogeneity and strict exogeneity, consistency and asymptotic normality, homoskedasticity and heteroskedasticity.
5. Pooled ordinary least squares for panel data, aggregated time effect, dummy variables, testing serial correlation and heteroskedasticity.
6. Unobserved effects model: random effects and fixed effects.
7. Random effects methods: random effects structure of the covariance matrix.
8. Fixed effects methods: fixed effects transformation, the use of dummy variables, first differencing transformation.
9. Comparison of estimators.

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 economics and mathematical sciences.

Prerequisites and co-requisites:

Basic Mathematics for Economics 1 and 2, Basic Methods in Statistics 1, Introduction to Econometrics.

Recommended or required reading:

J. M. Wooldridge: Econometric Analysis of Cross Section and Panel Data (The MIT Press).

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:

The course is organized every two years.

The home page of the course is <http://cc.oulu.fi/~jklemela/panel/>**805349A: Likelihood Inference, 5 op****Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year of B.Sc. studies, spring term

Learning outcomes:

After successful completion of the course the student can describe the basic principles of likelihood inference, derive likelihood functions of models with few parameters, compute likelihood quantities basen on them, and interpret results such obtained.

Contents:

Statistical model and observation data; likelihood function, log-likelihood, score, information; maximum likelihood estimation, relative likelihood, likelihood interval and likelihood region, profile likelihood; normal approximation of log-likelihood; use of R environment in inferential problems.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Introduction to Probability Theory I, Basic Methods of Data Analysis

Recommended optional programme components:

Is needed in nearly all intermediate and advanced courses in statistics

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805350A: Estimation and Test Theory, 5 op**Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805310A Statistical Inference I 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

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

Recommended optional programme components:

Needed in nearly all intermediate and advanced courses of statistics

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805351A: Linear Regression, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject.

Prerequisites and co-requisites:

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

Recommended optional programme components:

Prerequisite to the course Generalized Linear Models

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

Fail, 1-5

Person responsible:

Esa Läärä

Working life cooperation:

No

Other information:

-

805352A: Generalized Linear Models, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805630S Generalized Linear Models 5.0 op

806359A Regression modelling 10.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd or 3rd year of studies in B.Sc. programme

Learning outcomes:

After successful completion of the course the student can describe the basic concepts and assumptions of generalized linear models as well as main principles of regression modelling, and can also apply these methods in analysis of experimental and observational data.

Contents:

Generalized linear regression models for continuous, binary and count outcomes; formulation of the model, selection of variables and interpretation of parameters; fitting the models, estimating the parameters and prediction by the method of maximum likelihood; model criticism and diagnostics; use of R environment and SAS software in modelling.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Students having statistics as the major or a minor subject

Prerequisites and co-requisites:

Linear regression; Basic methods in data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Dobson, A.J., Barnett, A.J. An Introduction to Generalized Linear Models, Third Edition. Chapman & Hall/CRC, 2008. Aitkin, M., Francis, B., Hinde, J., Darnell, R. Statistical Modelling in R. Oxford University Press, 2009. Madsen, H., Thyregod, P. Introduction to General and Generalized Linear Models. Chapman & Hall/CRC, 2010

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:

Mikko Sillanpää

Working life cooperation:

No

Other information:

-

805353A: Statistical Software, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805340A Statistical Software 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3. year studies. Fall semester. Timing varies.

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Major and minor students

Prerequisites and co-requisites:

806112P Basic methods of data-analysis

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Home works

Grading:

Numerical grading 1-5 (or fail)

Person responsible:

Hanna Heikkinen

Working life cooperation:

No

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:**

4 cr

Language of instruction:

Finnish

Timing:

2. year, Fall semester

Learning outcomes:

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

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

Contents:

The course is a direct continuation for the course Probability Theory I. The new concepts include for instance the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem as well as two-dimensional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24h lectures, 12h exercises

Target group:

Major- and minor students. Recommended for students aiming to Master's degree with major in statistics or major in mathematics and computer sciences.

Prerequisites and co-requisites:

801195P Introduction to propability I

802352A Euclidean topology

802353A Series and integrals

Assessment methods and criteria:

Final exam

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

1-5

Person responsible:

Kenneth Nordström.

H326601: Optional basic studies in statistics, 0 - 100 op**Voimassaolo:** 01.08.2015 -**Opiskelumuoto:** Basic Studies**Laji:** Study module**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

H325035: Optional intermediate studies in mathematics, 0 - 180 op**Voimassaolo:** 01.08.2010 -**Opiskelumuoto:** Intermediate Studies**Laji:** Study module**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

*Electives***800329A: Topology, 8 op****Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Mahmoud Filali**Opintokohteen oppimateriaali:****Vala K., Suominen K., , 1990****Opintokohteen kielet:** Finnish**ECTS Credits:**

8 cr

Language of instruction:

English (also Finnish)

Timing:

Second year or later. Fall/spring term

Learning outcomes:

On successful completion of this course, the student will be able to follow more advanced topology and analysis.

Contents:

The course presents the very basics of topology that mathematics students should know. It starts with elementary set theory, then it goes on covering metric spaces including Baire's theorem;

topological spaces and convergence in topological spaces; separation axioms including Urysohn's lemma and Tietze extension theorem; compact spaces including Tyconoff theorem; and ends with connected spaces.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 hours lecture, 28 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended optional programme components:

-

Recommended or required reading:

S. Willard: General Topology;

K. Suominen & K. Vala: Topologia;

R. Engelking: Outline of General Topology.

Assessment methods and criteria:

Final exam, or mid-term exams

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

Grading:

1-5

Person responsible:

Mahmoud Filali

Working life cooperation:

-

802362A: Introduction to computational inverse problems, 5 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mikko Orispää

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

36h lectures, 18h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

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

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

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

Grading:

1-5

Person responsible:

Tapani Matala-aho

Working life cooperation:

-

802331A: Principles to Mathematical Modelling, 8 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Mathematics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802360A: Introduction to inverse problems, 4 op

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

ECTS Credits:

4 cr

Language of instruction:

Finnish. Alternatively, a book examination in English.

Learning outcomes:

Upon completion, the student will be able to

- recognise several inverse problems
- describe typical properties of inverse problems
- solve simple inverse problems with accurate and inaccurate data

Contents:

1. Examples of inverse problems and their typical properties
2. Well-posed and ill-posed problems
3. Least squares solutions
4. Tikhonov regularization
5. Statistical inverse problems

Learning activities and teaching methods:

Lectures 4x45 min / week. Exercises 2x45 min /week.

Target group:

Suitable for major and minor students.

Prerequisites and co-requisites:

- 802118P Linear Algebra I
- 802119P Linear Algebra II

Also recommended:

- 800322A Multidimensional Analysis (or Analysis II)
- 801396A Introduction to Probability Theory II
- 802352A Euclidian Topology
- 800345A Differential Equations I

Assessment methods and criteria:

Exam.

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

Other information:

This course does not contain numerical programming tasks. Computer-aided computations are contained in a separate course

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:**

4 cr

Language of instruction:

Finnish

Timing:

2. year, Fall semester

Learning outcomes:

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

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

Contents:

The course is a direct continuation for the course Probability Theory I. The new concepts include for instance the moments of a distribution, the probability generating function, the Law of Large Numbers, the Central Limit Theorem as well as two-dimensional distributions.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24h lectures, 12h exercises

Target group:

Major- and minor students. Recommended for students aiming to Master's degree with major in statistics or major in mathematics and computer sciences.

Prerequisites and co-requisites:

801195P Introduction to probability I

802352A Euclidean topology

802353A Series and integrals

Assessment methods and criteria:

Final exam

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

1-5

Person responsible:

Kenneth Nordström.

801346A: Introduction to Cryptography, 4 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail

Opettajat: Tapani Matala-aho

Opintokohteen kielet: Finnish

Leikkaavuudet:

802336A Introduction to Cryptography 5.0 op

ECTS Credits:

4 cr

Language of instruction:

Finnish

Timing:

2. year or later, Fall term (1. or 2. period)

Learning outcomes:

After completing the course, student

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

27 h lectures, 15 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Tapani Matala-aho

802364A: Introduction to Mathematical Software, 6 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Markus Harju

Opintokohteen kielet: Finnish

ECTS Credits:

6 cr

Language of instruction:

Lecturing language is Finnish, but the main points can be explained also in English if necessary. The software and the majority of course material is also in English.

Timing:

Autumn semester, period one.

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
- 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

- R
- Matlab
- Mathematica

Time permitting, it is also possible to learn other mathematical software depending the interests of the students.

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 22h / Rehearsals 22h / Self-study 60h. 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):

- 802118P Linear Algebra I
- 802119P Linear Algebra II.

Recommended optional programme components:

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

Recommended or required reading:

The 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.

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

Grading:

The course utilizes verbal grading scale "Pass/ fail".

Person responsible:

Mikko Orispää

Working life cooperation:

-

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen kielet: Finnish

801329A: Mathematics in Teaching, 3 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800146P Introduction to teaching 5.0 op

ECTS Credits:

3 cr/ 81 hours of work

Language of instruction:

Finnish

Timing:

1st year, periods 3 and 4

Learning outcomes:

The student can reflect critically on the learning and teaching of mathematics. The student can analyze the connection between mathematics at school and at university.

Contents:

Learning and teaching mathematics are thought about and discussed. The course consists of reflective exercises and seminar meetings where the exercises are discussed. A student analyzes the connection between mathematics at school and at university. A student writes a learning journal.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

24 h seminar meetings, 57 h self-study and group work.

Target group:

Mathematics teacher students

Prerequisites and co-requisites:

-

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Active participation, learning journal, group work

Grading:

Pass/Fail

Person responsible:

Riikka Palkki

Working life cooperation:

-

Other information:

-

800104P: Number Systems, 4 op**Voimassaolo:** 01.03.2011 -**Opiskelumuoto:** Basic Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800347A Number systems 5.0 op

Ei opintojaksokuvauksia.

031076P: Differential Equations, 5 op**Voimassaolo:** 01.08.2015 -**Opiskelumuoto:** Basic Studies**Laji:** Course**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

ay031076P Differential Equations (OPEN UNI) 5.0 op

800320A Differential equations 5.0 op

031017P Differential Equations 4.0 op

Ei opintojaksokuvauksia.

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset**802334A: A Second Course in Differential Equations, 5 op****Voimassaolo:** 01.06.2015 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800346A Differential Equations II 4.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

2nd year or later, 2nd period

Learning outcomes:

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 28h, exercises 14h

Target group:

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

Prerequisites and co-requisites:

Differential equations, Complex analysis

Recommended optional programme components:

-

Recommended or required reading:

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

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Markus Harju

Working life cooperation:

No

Other information:

-

806119P: A Second Course in Statistics, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

806113P Introduction to Statistics 5.0 op

806109P Basic Methods in Statistics I 9.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

4th period

Learning outcomes:

Upon completion of the course, student will be able to

- analyze continuous and categorical response in the most common experimental and observational studies
- critically evaluate scientific articles
- implement and interpret analyses of a statistical software concerning issues of the course.

Contents:

- Skills for performing statistical analyses and inferences on the basis of data obtained in common experimental and observational studies are expanded and deepened
- statistical literacy of scientific articles with quantitative methods

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Total 50 h face-to-face teaching including lectures and exercise (partly computer exercises). Independent work 83 h.

Target group:

Minor students

Prerequisites and co-requisites:

The recommended prerequisite prior to enrolling for the course is the completion of the course: 806118P Introduction to Statistics or 806116P Statistics for Economic Sciences.

Recommended optional programme components:

After the course, student is able to continue other statistics courses.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exams and/or final exam and possible homework.

Grading:

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

Person responsible:

Jari Pääkkilä

Working life cooperation:

No

Other information:

-

802359A: Advanced Vector Calculus, 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 credits

Language of instruction:

Finnish

Timing:

2nd year, 4th period

Learning outcomes:

After completing the course the student is able to

- use derivative as a linear mapping
- formulate and apply Inverse function theorem and Implicit function theorem
- define and calculate Riemann integral in higher dimensions

Contents:

The aim of the course is to deepen the understanding of calculus of severable variables. The derivative is treated as a linear mapping. The central results are the Inverse Function Theorem and the Implicit Function Theorem. In the course the Riemann integral is defined in higher dimension and related basic results are proved

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Mathematics majors

Prerequisites and co-requisites:

802351A Vector Calculus

802164P Series and Integral

802163P Derivative

802358A Metric spaces (or 802357A Eukclidean spaces)

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

Fail, 1-5

Person responsible:

Pekka Salmi

Working life cooperation:

No

Other information:

-

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.

805398A: An introduction to stochastic modelling, 8 op

Voimassaolo: - 01.09.2012

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Läärä Esa

Opintokohteen oppimateriaali:

Severini, Thomas A. , , 2005

Mood, Alexander M. , , 1974

Giri, Narayan C. , , 1975

Opintokohteen kielet: Finnish

Assessment methods and criteria:

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

805334A: Analysis of categorical data, 9 op

Voimassaolo: - 28.02.2011

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen oppimateriaali:

Agresti, Alan , , 1990

Christensen, Ronald , , 1990

McCullagh, Peter , , 1989

McCulloch, Charles E. , , 2001

Opintokohteen kielet: Finnish

ECTS Credits:

9 cr

Learning outcomes:

A student who has successfully completed the course is supposed to

- be familiar with generalized linear models and to be able to use them when studying discrete data
- be able to model the behaviour of ordinal dependent variables
- be able to make use of so-called mixed models while studying discrete or ordinal data

Contents:

The course deals with the analysis of contingency tables and with models for qualitative and ordinal dependent variables. Models for truncated dependent variables are also briefly touched. A majority of these models can be interpreted as generalised linear models (GLIM). This is why the essentials of the GLIM-theory and the corresponding phraseology is presented. So-called generalised mixed linear models (including random effects) and the estimation of their parameters by the GEE and the ML methods are also discussed. The course can be taken either as a graduate course or as an undergraduate course. It consists of 52 hours of lectures and 36 hours of exercises in the computer lab.

Assessment methods and criteria:

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

Person responsible:

Markku Rahiala

801387A: Basic Course on Numerical Analysis, 6 op

Voimassaolo: 01.03.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen oppimateriaali:

Atkinson, Kendall , , 1993

Opintokohteen kielet: Finnish

ECTS Credits:

6 cr

Language of instruction:

Finnish.

Timing:

Autumn semester.

Learning outcomes:

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

- implement efficient numerical algorithms for solving basic numerical problems
- approximate the error of numerical results.

Contents:

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

Mode of delivery:

As face-to-face teaching.

Learning activities and teaching methods:

Lectures 56h / Group work 24 h.

Target group:

All students.

Prerequisites and co-requisites:

No recommended prior courses.

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:

Ward Cheney, David Kincaid: "Numerical Mathematics and Computing"

Lecture notes (in Finnish).

Assessment methods and criteria:

Two intermediate exams.

Final exam.

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

Grading:

1 - 5.

Person responsible:

Erkki Laitinen

801344A: Basic Course on Numerical Computation, 8 op

Voimassaolo: 01.03.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Erkki Laitinen

Opintokohteen oppimateriaali:

Haataja Juha, Rahola J., Ruokolainen J., , 1998

Opintokohteen kielet: Finnish

ECTS Credits:

8 cr

Language of instruction:

Finnish

Timing:

Spring.

Learning outcomes:

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

- solve basic numerical problems using Fortran programming
- exploit the Unix computers and software libraries for solving numerical problems.

Contents:

On the course students train programming of numerical algorithms using Fortran programming language in Unix (Linux) operating system. On the course, DISLIN subroutine library is used for the visualization of the numerical calculation results. The course contains following topics: Fortran95 programming language, Unix operating system, DISLIN graphical subroutine library.

Mode of delivery:

Face-to-face teaching / distance teaching.

Learning activities and teaching methods:

Lectures, Group working and practical work (Self-study) (40 h + 10 h + 20 h).

Target group:

Major and minor students

Recommended optional programme components:

-

Recommended or required reading:

Unix User guide, Fortran 2003 manual, Dislin manual, lecture notes.

Assessment methods and criteria:

This course utilizes continuous assessment and final work.

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

Grading:

Passed / not passed.

Person responsible:

Erkki Laitinen

Working life cooperation:

-

801389A: Basic Geometry, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

801399A Geometry 5.0 op

ECTS Credits:

6 cr

Language of instruction:

Finnish

Timing:

After the second year at the earliest

Learning outcomes:

After completing the course, a student

- understands the fundamental concepts and results of Euclidean geometry
- can construct basic geometric proofs
- can perform compass-and-straightedge constructions
- can solve basic geometric problems related to applications

Contents:

The course focuses on basic geometric concepts and results familiar from school from an axiomatic angle. We construct geometric theory starting from a set of basic axioms systematically with theorems and their proofs. Most results in the course are familiar to students from junior high and high school, but the course offers a deeper understanding to the founding mathematics behind geometry curriculum in schools, and the birth of axiomatic mathematics.

The majority of the course is dedicated to planar geometry. We also learn to perform classical compass-and-straightedge constructions. Towards the end of the course we extend our examination to three dimensions. In solid geometry we focus on the relations between lines and planes in space and properties of three-dimensional solids. At the end of the course we briefly look into non-Euclidean geometries.

Learning activities and teaching methods:

Summer course

36 hours of face-to-face teaching

Independent studying in groups

In addition an optional research project

Prerequisites and co-requisites:

Mandatory first year courses.

Recommended or required reading:

Lecture notes of Matti Lehtinen and extra material.

Assessment methods and criteria:

Final exam and an optional research project.

If a student only attends (and passes) the final exam, the course is completed as a 6 ECTS A-course (intermediate). Students can also choose to do an additional research project. After passing the final exam and writing a short research project about some topic in geometry, the course is completed as a 6 ECTS S-course (advanced). If the student already has the course completed, it is possible to write the research project as a separate 3 ECTS S-course (advanced).

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

Grading:

1-5, fail

Person responsible:

Emma Leppälä

Other information:

Course website in Noppa.

802159P: Basic method in Analysis for Economic Sciences, 5 op

Voimassaolo: 01.06.2014 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

802153P Basic Mathematics for Economics 1 b 4.0 op

800118P Basic Mathematics for Economics II 7.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

3. period. It is recommended to complete the course at the 1-2th spring semester.

Learning outcomes:

After completing the course, student is able to

- handle functions of several variable
- recognizes the usefulness of partial derivative and is able to apply it in practice
- solve different types of optimization problems
- define and use integral and calculate, for instance, different surface areas.
- calculate with complex numbers
- solve differential equations
- solve difference equations

Contents:

The aim of the course is to create a base for mathematics used in economics. The essential item of the course are the basic operations of matrices and their utilization in mathematical exercises. The course starts on basics and proceeds to solve simultaneous equations with multiple variables and demanding optimization problems with constraints. Those problems that are more difficult than the ones presented in the courses 802158P Mathematics for Economic Sciences and 802159P Basic method in Analysis for Economic Sciences, are now solved with matrices. The student will familiarize herself with regression analysis and Input-Output-Analysis. Some linear optimization and differentiation with vectors are also presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h, exercises 14h.

Target group:

Students in Oulu Business School.

Prerequisites and co-requisites:

The courses 802158P Mathematics for Economic Sciences and 802159P Basic method in Analysis for Economic Sciences.

Recommended optional programme components:

After the course, student is able to continue other mathematics courses directed to the students in Oulu Business School.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exams and/or final exam

Grading:

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

Person responsible:

Kari Myllylä

Working life cooperation:

-

805380A: Clinical biostatistics, 6 op**Voimassaolo:** - 01.09.2012**Opiskelumuoto:** Basic Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Läärä Esa**Opintokohteen kielet:** Finnish**Assessment methods and criteria:**Read more about [assessment criteria](#) at the University of Oulu webpage.**801385A: Complex Analysis I, 4 op****Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen oppimateriaali:****Lang, Serge, , 1999****Spiegel, Murray R., , 1964****Opintokohteen kielet:** Finnish**ECTS Credits:**

4 cr

Learning outcomes:

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

- know the basic properties of algebraic and topological structure of complex numbers
- know the basic properties of complex functions
- be able to apply theory of complex numbers to different fields of pure and applied mathematics

Contents:

The course deals basic theory of complex numbers. After a brief introduction to algebraic properties of complex numbers, such basic results as polar coordinate representation, De Moivre formulas and topology on complex plane will be considered. For the complex functions the concepts of limit, continuity and derivative will be studied. Some basic properties of analytic functions will be considered and Cauchy-Riemann formulas will be proved. Finally basic theory of pathintegral of complex functions will be studied.

Assessment methods and criteria:Read more about [assessment criteria](#) at the University of Oulu webpage.**Person responsible:**

Valeriy Serov

801386A: Complex Analysis II, 4 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen oppimateriaali:****Lang, Serge, , 1999****Spiegel, Murray R., , 1964****Opintokohteen kielet:** Finnish**ECTS Credits:**

4 cr

Learning outcomes:

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

- derive and prove core results of complex analysis
- apply theory of complex analysis to many structures of analysis

Contents:

The course deals with fundamental results on complex analysis such as Cauchy integral theorem and Cauchy integral formulas. As application some important corollaries of them will be proved such as Liouville Theorem, Fundamental theorem of algebra and Maximum principle. Further, after brief introduction to power series the presentation of analytic functions by using power series will be studied. After Laurent representation of complex functions theory of residues will be considered and as application this theory will be used to calculate certain type of definite integrals.

Assessment methods and criteria:

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

Person responsible:

Valeriy Serov

805332A: Design of experiments, 9 op

Voimassaolo: - 31.07.2007

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

800105P: Didactics of Mathematics, 5 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay800105P Didactics of Mathematics (OPEN UNI) 5.0 op

Ei opintojaksokuvauksia.

800345A: Differential Equations I, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen oppimateriaali:

Boyce, William E., , 2005

Nagle, R. Kent, , 1996

Zill, Dennis G., , 2001

Opintokohteen kielet: Finnish

Leikkaavuudet:

800320A Differential equations 5.0 op

ECTS Credits:

4 cr

Language of instruction:

Finnish

Timing:

2. year or later, 3. period

Learning outcomes:

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

- recognize the concerning differential equation and choose the proper method and solve it
- notice the conditions that guarantee the uniqueness of the solution
- understand what implicit solution means

Contents:

The course consist ordinary differential equations. First order differential equations like separable, homogeneous, linear, exact and those that can be transform to them with suitable substitutions are studied and solved by algebraic methods (for example separation of variables). Iterative methods and numerical methods are applied in some cases to obtained an approximate solution or a numerical solution. Higher order linear differential equations with constant coefficients that appear in applications are considered and also second order linear differential equations with continuous coefficients. The basis of how to solve finite systems of differential equations is given. Power series method is applied to solve some second order linear differential equations like Legendre equation.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

30 h lectures, 16 h exercises

Target group:

Major- and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended optional programme components:

-

Recommended or required reading:

Boyce and Di Prima: Elementary Differential Equations and Boundary Value Problems, Wiley, Anton: Calculus, Wiley. R. Kent Nagle & E. B. Saff: Fundamentals of Differential Equations and Boundary Value Problems, Addison-Wesley, 1996 C. Henry & David E. Penney: : Differential Equations and Boundary Value Problems, Prenticw Hall, 2000 Dennis G. Zill & Michael R. Cullen: Differen-tial Equations with Boundary Value Prob-lems, Brooks/Cole, 2001.

Assessment methods and criteria:

Final exam

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

1-5

Person responsible:

Martti Kumpulainen

Working life cooperation:

-

800346A: Differential Equations II, 4 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen oppimateriaali:****Nagle, R. Kent, , 1996****Folland, Gerald B., , 1992****Zill, Dennis G., , 2001****Opintokohteen kielet:** Finnish**Leikkaavuudet:**

802334A A Second Course in Differential Equations 5.0 op

ECTS Credits:

4 cr

Language of instruction:

Finnish

Timing:

2. year or later, 4. 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
- proof the basic properties of Bessel functions, Legendre polynomials and Hermite polynomials
- calculate the Fourier-series of a given piecewise continuous function
- 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 consist second order ordinary differential equation that are important in applications and partial differential equations like heat and wave eqautions. Method of Frobenius is introduced to solve second order ordinary differential equation. Some special functions (like Gamma function and Bessel functions) are considered and also orthogonal polynomials (Legendre polynomials and Hermite polynomials). The basics how to calculate Fourier-series for a piecewise continuous function is given. Last, basics of integral transformations (Laplace-transformation and Fourier-transformation) are studied, and how to apply them and the method of separation of variable in some cases to heat and wave equations.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

30 h lectures, 16 h exercises.

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics

Recommended optional programme components:

-

Recommended or required reading:

R. Kent Nagle & E. B. Saff, Fundamentals of Differential Equations and Boundary Value Problems, Addison-Wesley, 1996; Dennis G. Zill & Michael R. Cullen: Differential Equations with Boundary Value Problems, Brooks /Cole, 2001, Strauss: Partial Dfffferential Equations. An Introduction, Wiley 1992 . Enrique A. Gonzales-Velasco, E. Gonzales-Velasco: Fourier Anaysis and Boundary Value Problems, Academic Press, 1995 Gerald B. Folland: Fourier Analysis and Its Applications, Brooks / Cole, 1996.

Assessment methods and criteria:

Final exam

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

1-5

Person responsible:

Martti Kumpulainen

Working life cooperation:

-

806353A: Experimental design, 6 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805319A Experimental design 5.0 op

805663S Experimental design 5.0 op

Ei opintojaksokuvauksia.

801390A: History of Mathematics, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Matti Lehtinen

Opintokohteen oppimateriaali:

Boyer, Carl B., , 1994

Boyer, Carl B., , 1994

Fauvel John, Gray J., , 1990

Opintokohteen kielet: Finnish

Leikkaavuudet:

800332A History of Mathematics 5.0 op

ECTS Credits:

6 cr

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.

Assessment methods and criteria:

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

806365A: Introduction to Bayesian Statistics, 5 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

805313A Bayesian analysis 5.0 op

805665S Bayesian analysis 5.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

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

Learning outcomes:

After successful completion of the course the student is able to describe the basic concepts and main principles of Bayesian inference, derive analytically posterior distributions from a conjugate priors, compute summaries of posterior distributions by simulation, apply the Bayesian paradigm in data analysis, and interpret and report results of such analyses.

The course can be taken either as an intermediate level (A) or an advanced level (S) module, and only one of these options will be accepted to the study attainment register.

Contents:

Bayesian and frequentist statistics; prior and posterior distributions; conjugate distributions; point estimation and posterior intervals; Bayes factor and testing; simulation of posterior distribution by MCMC methods using Jags language and R environment; generalised linear and hierarchical models

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

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

Target group:

Major and minor students

Prerequisites and co-requisites:

Basic methods of data-analysis

Recommended optional programme components:

-

Recommended or required reading:

-

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Esa Läärä

Working life cooperation:

-

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:

2. year or later

Learning outcomes:

After completing the course, student

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

Contents:

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

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28 h lectures, 14 h exercises

Target group:

Major and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

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

Grading:

1-5, fail

Person responsible:

Tapani Matala-aho

Working life cooperation:

No

802668S: Introduction to Functional Analysis, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Ei opintojaksokuvauksia.

806118P: Introduction to Statistics, 5 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay806118P Introduction to Statistics (OPEN UNI) 5.0 op

806113P Introduction to Statistics 5.0 op

ECTS Credits:

5 ECTS credits

Language of instruction:

Finnish

Timing:

3rd period

Learning outcomes:

After completing the course, student will be able to

- consider issues influencing to data collection
- describe data by appropriate methods (tables, statistics and graphical presentations)
- evaluate the effect size of the sample to the margin of error for instance in Gallup polls and in different market researches
- interpret output of a statistical software.

Contents:

- collecting data, e.g. sampling
- variables and measuring
- descriptive statistical methods and their selection
- margin of error of estimator for population mean and proportion
- statistical literacy
- basic analysis of data using statistical software

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Total 50 h face-to-face teaching including lectures and exercise (partly computer exercises). Independent work 83 h.

Target group:

Minor students

Recommended optional programme components:

After the course, student is able to continue other statistics courses.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exams and/or final exam and possible homework.

Grading:

Fail, 1-5

Person responsible:

Jari Pääkkilä

Working life cooperation:

No

Other information:

-

802363A: Introduction to topology, 6 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Mahmoud Filali

Opintokohteen kielet: Finnish

ECTS Credits:

5 cr

Language of instruction:

English (also in Finnish)

Timing:

2.-3. year studies. Timing varies.

Learning outcomes:

After completing the course, student is able to participate fully for more advanced courses in topology and analysis.

Contents:

Course includes basic definitions and results in metric spaces. Keywords are: interior, closure, convergence in metric spaces, continuity in metric spaces, Baire's theorem, compactness, contraction, implicit function theorem. Course takes known and classical results in real analysis and generalizes them to metric spaces.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

28h lectures, 14h exercises

Target group:

Major studies

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Final exam

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

Grading:

1-5

Person responsible:

Mahmoud Filali

Working life cooperation:

-

802332A: Mathematical Problem Solving, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Peter Hästö

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802648S: Mathematical Problem Solving, 10 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802158P: Mathematics for Economic Sciences, 7 op

Voimassaolo: 01.06.2014 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Myllylä

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay802158P Mathematics for Economic Sciences (OPEN UNI) 7.0 op

ECTS Credits:

7 cr

Language of instruction:

Finnish

Timing:

1. period. It is recommended to complete the course at the 1th autumn semester.

Learning outcomes:

After completing the course, student is able to

- define and apply basic mathematical concept such as rationals, absolute value, power and root function
- handle different types of functions and knows their special properties
- solve different equations and inequalities
- define the concepts of limit and continuity of a function
- calculate limits in case of different functions
- calculate and apply derivative, and knows the relevance of the concept
- use all mathematical concepts covered by the course in different problems related to economics (interest, investments, optimization and indices).

Contents:

Course aims to build a solid background to mathematics in later economics courses. Course begins with a revision of concepts familiar from high school such as sequences, rationals, absolute value and powers. After that we focus on different types of functions such as polynomials, rational functions, exponential functions and logarithm. Different types of equations and inequalities, containing the functions mentioned above, are solved. Main concepts in the course are also limit of a function, continuity and derivative and their applications. Nämä käsitteet tullaan esittelemään kaikille kurssilla käsiteltäville funktiotyypeille.

After the more mathematical part, the focus is turned on economical applications (such as interests, optimization, investments, indeces).

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 56h, exercises 28h.

Target group:

Students in Oulu Business School

Prerequisites and co-requisites:

None

Recommended optional programme components:

After the course, student is able to continue other mathematics courses directed to the students in Oulu Business School.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exams and/or final exam

Grading:

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

Person responsible:

Kari Myllylä

Working life cooperation:

-

802160P: Matrices and optimization for Economic Sciences, 5 op

Voimassaolo: 01.06.2014 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Kari Myllylä

Opintokohteen kielet: Finnish

Leikkaavuudet:

800118P Basic Mathematics for Economics II 7.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

4. period. It is recommended to complete the course at the 1-2 spring semester.

Learning outcomes:

After completing the course the student

- masters the basic operations and properties of matrices
- knows how to utilize matrices with solving simultaneous equations, optimization and constructing different models
- knows the basics of linear optimization
- is prepared to utilize the aforementioned items with his/her subsequent courses.

Contents:

The aim of the course is to create a base for mathematics used in economics. The essential item of the course are the basic operations of matrices and their utilization in mathematical exercises. The course starts on basics and proceeds to solve simultaneous equations with multiple variables and demanding optimization problems with constraints. Those problems that are more difficult than the ones presented in the courses 802158P Mathematics for Economic Sciences and 802159P Basic method in Analysis for Economic Sciences, are now solved with matrices. The student will familiarize herself with regression analysis and Input-Output-Analysis. Some linear optimization and differentiation with vectors are also presented.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures 30h, exercises 14h.

Target group:

Students in Oulu Business School

Prerequisites and co-requisites:

The courses 802158P Mathematics for Economic Sciences and 802159P Basic method in Analysis for Economic Sciences

Recommended optional programme components:

After the course, student is able to continue other mathematics courses directed to the students in Oulu Business School.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exams and/or final exam

Grading:

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

Person responsible:

Kari Myllylä

Working life cooperation:

-

806360A: Mixed Linear Models, 5 op

Voimassaolo: 01.01.2013 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

805328A: Multivariate analysis, 9 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

802333A: Permutations, Fields and Galois Theory, 10 op

Voimassaolo: 01.06.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

800323A Field extensions 5.0 op

800343A Permutations, Fields and Galois' Theory 8.0 op

ECTS Credits:

10 ECTS credits

Language of instruction:

Finnish

Timing:

2. year or later. Timing varies.

Learning outcomes:

After having finished the course, the student knows how to compute with permutations and how to construct permutation groups and field extensions. In addition, the student can solve equations of degree three and four and has some understanding about why solving the equation of degree five is not that simple.

Contents:

First we shall have a look at permutations and related group structures such as symmetric and alternating groups. After this we get to know some properties of finite fields and polynomials and proceed to the theory and practice of field extensions. At the end of the course, we see how to solve equations of degree three and four. The elements of Galois theory are given in order to see that there is no general formula for the solution of equations of degree five.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Lectures (56h) and exercises (28h)

Target group:

Major and minor studies

Prerequisites and co-requisites:

Compulsory mathematics studies

Recommended optional programme components:

-

Recommended or required reading:

Lecture notes and I.N.Herstein: Abstract Algebra , Prentice Hall, 1996.

Assessment methods and criteria:

Final exam

Grading:

1-5

Person responsible:

Markku Niemenmaa

800343A: Permutations, Fields and Galois' Theory, 8 op**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opettajat:** Niemenmaa Markku**Opintokohteen oppimateriaali:****Herstein, I. N.**, , 1996**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

800323A Field extensions 5.0 op

802333A Permutations, Fields and Galois Theory 10.0 op

ECTS Credits:

8 cr

Language of instruction:

Finnish

Timing:

2. year or later. Periods 3-4 (Spring term)

Learning outcomes:

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

- compute with permutations and deal with their applications
- solve equations of third and fourth degree
- work with the structures of different finite fields

Contents:

The aim is to introduce three main topics which are related to each other: Elementary number theory: division algorithm, greatest common divisor, prime numbers and congruences. Group theory: group axioms, subgroups. Lagrange's theorem, homomorphisms and factor groups. Commutative ring theory: fields, polynomial rings, quotient rings and finite fields.

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

56 h lectures, 28 h exercises

Target group:

Major- and minor students

Prerequisites and co-requisites:

Compulsory basic and intermediate studies in mathematics.

Recommended optional programme components:

-

Recommended or required reading:

I. N. Herstein: Abstract Algebra, Prentice Hall, Inc., 1996.

Assessment methods and criteria:

Final exam, mid-term exams

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

Grading:

1-5

Person responsible:

Markku Niemenmaa

Working life cooperation:

-

805333A: Robust methods, 6 op

Voimassaolo: - 31.07.2007

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

805309A: Statistical methods in epidemiology, 9 op

Voimassaolo: 01.06.2009 -

Opiskelumuoto: Intermediate 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

Assessment methods and criteria:

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

806116P: Statistics for Economic Sciences, 5 op

Voimassaolo: 01.06.2014 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Field of Mathematics

Arvostelu: 1 - 5, pass, fail

Opettajat: Hanna Heikkinen

Opintokohteen kielet: Finnish

Leikkaavuudet:

ay806116P Statistics for Economic Sciences (OPEN UNI) 5.0 op

806113P Introduction to Statistics 5.0 op

806109P Basic Methods in Statistics I 9.0 op

ECTS Credits:

5 cr

Language of instruction:

Finnish

Timing:

1st period. It is recommended to complete the course at the 2nd autumn semester.

Learning outcomes:

After completing the course, student will be able to

- consider issues influencing to data collection
- describe data by appropriate methods (tables, statistics and graphical presentations)
- evaluate the effect size of the sample to the margin of error for instance in Gallup polls and in different market researches
- interpret output of a statistical software.

Contents:

- collecting data, e.g. sampling
- variables and measuring
- descriptive statistical methods and their selection
- margin of error of estimator for population mean and proportion
- statistical literacy
- basic analysis of data using statistical software

Mode of delivery:

Face-to-face teaching

Learning activities and teaching methods:

Total 53 h face-to-face teaching including lectures and exercise (partly computer exercises). Independent work 80 h.

Target group:

Students in Oulu Business School.

Prerequisites and co-requisites:

-

Recommended optional programme components:

When studying according to old degree requirements it is possible to complete the course: 806109P Basic Methods in Statistics I (9 ECTS). After the course, student is able to continue other statistics courses directed to the students in Oulu Business School.

Recommended or required reading:

Lecture notes

Assessment methods and criteria:

Mid-term exams and/or final exam and possible homework.

Grading:

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

Person responsible:

Hanna Heikkinen

Working life cooperation:

-

Other information:

This course compensates the course 806109P Basic Methods in Statistics I (9 ECTS) of the old degree requirements. An appropriate additional course (at least 4 ECTS) is also required.

805339A: The Statistical Foundation of Econometrics, 5 - 6 op**Voimassaolo:** 01.06.2010 -**Opiskelumuoto:** Intermediate Studies**Laji:** Course**Vastuuyksikkö:** Field of Mathematics**Arvostelu:** 1 - 5, pass, fail**Opintokohteen oppimateriaali:****Hayashi, Fumio** , , 2000**Gourieroux, Christian** , , 1995**Gourieroux, Christian** , , 1995**Harvey, Andrew C.** , , 1990**Opintokohteen kielet:** Finnish**Leikkaavuudet:**

805683S The Statistical Foundation of Econometrics 5.0 op

ECTS Credits:

5/6 cr

Language of instruction:

Finnish

Timing:

Every second year.

Learning outcomes:

The course familiarizes students with applications of statistical models when inferences are made on economic phenomena. The principles of statistical inference on economic phenomena are the same as those of general statistical inference but there are some special issues that make the inference different in economics than in other application areas of statistics. After finishing the course, a student can apply both linear regression and nonlinear regression and a student is able to apply the generalized method of moments as well as the method of instrumental variables. A student can diagnose the validity of the assumptions of the linear regression model and tune his inferences accordingly.

Contents:

The course starts with the study of the linear regression model, and covers asymptotic inference related to the linear regression model, tests of the parameter restrictions and tests of a structural change. Besides linear regression, also nonlinear regression and the generalized method of moments is covered, as well as inference based on instrumental variables and problems stemming from measurement errors.

Inference under heteroscedasticity and autocorrelated disturbances is included. The basic theory of time series analysis (cointegration and autoregressive conditional heteroscedasticity) and the basic theory of panel data is included.

Learning activities and teaching methods:

Besides lectures, there are partly compulsory exercises.

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

Target group:

Students of economics and mathematical sciences.

Prerequisites and co-requisites:

Basic Mathematics for Economics 1 and 2, Basic methods in statistics 1, Introduction to Econometrics.

Recommended optional programme components:

-

Recommended or required reading:

J. M. Wooldridge: Analysis of Cross Section and Panel Data (The MIT Press).

Assessment methods and criteria:

Examination

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

Grading:

1 - 5

Person responsible:

Jussi Klemelä

Other information:

The course is organized every second years. The course was organized at spring 2014.

The home page of the course is <http://cc.oulu.fi/~jklemela/econometrics/>

Recommended literature: William H. Greene: Econometric Analysis (Prentice Hall)

