# Opasraportti

## Mathematics and Statistics as a minor subject (2014 - 2015)

## Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

802337A: Advanced Problem Solving, 2 - 6 op
802330A: Algebra tutorial, 1 op
806330A: Analysis of Market Risk, 5 op
806117P: Analysis of continuous response variable, 5 op
805308A: Analysis of longitudinal data, 5 op
802329A: Analysis tutorial, 1 op
801387A: Basic Course on Numerical Analysis, 6 op
801344A: Basic Course on Numerical Computation, 8 op
801389A: Basic Geometry, 6 op
806109P: Basic Methods in Statistics I, 9 op
806112P: Basic Methods of Data Analysis, 10 op
805165P: Basic Principles of Statistics, 9 op
802159P: Basic method in Analysis for Economic Sciences, 5 op
802328A: Basics in Number Theory, 5 op
802322A: Basics in mathematical modelling, 5 op
801385A: Complex Analysis I, 4 op
801386A: Complex Analysis II, 4 op
802155P: Continuity and limit, 4 op
802156P: Derivative, 4 op
800105P: Didactics of Mathematics, 5 op
800345A: Differential Equations I, 4 op
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802154P: Elementary functions, 3 op
802352A: Euclidean Topology, 4 op
806353A: Experimental design, 6 op
801390A: History of Mathematics, 6 op
806365A: Introduction to Bayesian Statistics, 5 op
801346A: Introduction to Cryptography, 4 op
800149P: Introduction to LateX, 2 op
802364A: Introduction to Mathematical Software, 6 op
801195P: Introduction to Probability Theory I, 5 op
801396A: Introduction to Probability Theory II, 5 op
806354A: Introduction to Sampling Methods, 4 op
806113P: Introduction to Statistics, 5 op
802362A: Introduction to computational inverse problems, 5 op
802360A: Introduction to inverse problems, 4 op
802151P: Introduction to mathematical deduction, 5 op
802118P: Linear Algebra I, 4 op
802119P: Linear Algebra II, 5 op
806308A: Linear Models, 10 op
802332A: Mathematical Problem Solving, 5 op
802158P: Mathematics for Economic Sciences, 7 op

802157P: Mathematics in teaching, 2 op
802160P: Matrices and optimization for Economic Sciences, 5 op
802363A: Metric Spaces, 6 op
802356A: Metric Topology, 5 op
806360A: Mixed Linear Models, 5 op
800322A: Multidimensional analysis, 8 op
800104P: Number Systems, 4 op
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800343A: Permutations, Fields and Galois' Theory, 8 op
802331A: Principles to Mathematical Modelling, 8 op
806359A: Regression modelling, 10 op
802355A: Rings, Fields and Polynomials, 5 op
802353A: Series and Integrals, 6 op
805310A: Statistical Inference I, 10 op
805340A: Statistical Software, 4 op
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806357A: Statistical finance, 5 op
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805324A: Time series analysis, 5 op
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# Opintojaksojen kuvaukset

## Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

### 802337A: Advanced Problem Solving, 2 - 6 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

### 802330A: Algebra tutorial, 1 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Peter Hästö
**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

### 806330A: Analysis of Market Risk, 5 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Jussi Klemelä

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

806630S    Market Risk Analysis    5.0 op

**ECTS Credits:**
5 cr
**Language of instruction:**
Finnish
**Timing:**
Every second year.
**Learning outcomes:**
The student knows how to estimate the unconditional value-at-risk using empirical quantiles, parametric modeling, semiparametric modeling, and extreme value theory. The student knows also how to estimate the conditional value-at-risk using GARCH models. Student knows how to apply statistical software to make the calculations.
**Contents:**
The course is an introduction to the quantitative risk management of a portfolio of stocks. The course introduces various risk measures, extreme value theory, and modeling of financial time series. The course covers:
1. Conditional and unconditional loss distribution,
2. Value-at-Risk and other risk measures,
3. standard methods of estimating Value-at-Risk: multivariate normal modeling, historical simulation/empirical quantiles, and the Monte Carlo method,
4. Modeling of distributions: multivariate distributions, normal mixture distributions, spherical and elliptical distributions, and dimension reduction,
5. Modeling of financial time series: ARMA models, GARCH models, and volatility models,
6. Copulas and measures of dependence,
7. Extreme value theory: block maxima and threshold exceedance methods.
**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, students of finance and economics.
**Prerequisites and co-requisites:**
Basic knowledge of statistics.
**Recommended optional programme components:**
The course is suitable together with the course "Statistical Finance".
**Recommended or required reading:**
McNeil, A. J., Frey, R., and Embrechts, P. (2005).Quantitative Risk Management: Concepts, Techniques and Tools,Princeton Series in Finance, 608 pp.
**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 home page of the course is http://cc.oulu.fi/~jklemela/marketrisk/
The course is lectured every second year.


# 806117P: Analysis of continuous response variable, 5 op

**Voimassaolo:** 01.06.2014 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

806109P    Basic Methods in Statistics I    9.0 op

**ECTS Credits:**
5 cr
**Language of instruction:**
Finnish
**Timing:**
2nd period. It is recommended to complete the course at the 2nd autumn semester.
**Learning outcomes:**
Upon completion of the course, student will be able to
- critically evaluate scientific articles
- analyse continuous response variables in the most common economic research
- implement and interpret analyses of a statistical software concerning issues of the course.
**Contents:**
- statistical literacy of scientific articles with quantitative methods
- basic analyses of continuous response variables, like t-test, analysis of variance, regression analysis and analysis of covariance.
**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:**
The recommended prerequisite prior to enrolling for the course is the completion of the course: 806116P Statistics for Economic Sciences.
**Recommended optional programme components:**
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:**
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# 805308A: Analysis of longitudinal data, 5 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**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/](http://cc.oulu.fi/~jklemela/panel/)


# 802329A: Analysis tutorial, 1 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Peter Hästö
**Opintokohteen kielet:** Finnish


Ei opintojaksokuvauksia.


# 801387A: Basic Course on Numerical Analysis, 6 op

**Voimassaolo:** 01.03.2011 -
**Opiskelumuoto:** Intermediate Studies

**Laji:** Course
**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
**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 programmin
-  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

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

  801399A    Geometry    5.0 op

**ECTS Credits:**
6 cr
**Learning outcomes:**
On successful completion of this course, the student will be able to
- prove simple geometric claims
- solve simple geometric problems with the help of ruler and compass
- solve basic applied problems of school geometry
**Contents:**
School geometry (801389A) The course presents the core material in Finnish junior high school and high school geometry courses. It is mainly meant for those students who study to become mathematics, physics and chemistry teachers. The first part of this course is classic Euclidean plane geometry and the second part is solid geometry. Students become familiar with geometric proof and how to solve simple geometric problems with the help of ruler and compass. Geometric results are used to solve problems. The second part considers spatial geometry and starts with how lines and planes can situate in ordinary three dimensional space. Basic geometric properties of solids like cube, ball and cone are considered and methods how to calculate their surface aries and volumes are presented.
**Assessment methods and criteria:**
Read more about assessment criteria at the University of Oulu webpage.
**Person responsible:**
Martti Kumpulainen

## 806109P: Basic Methods in Statistics I, 9 op

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Jari Päkkilä

**Opintokohteen oppimateriaali:**
**Grönroos, Matti (2)** , , 2003
**Heikkilä, Tarja** , , 1998
**Helenius, Hans** , , 1989
**Ranta, Esa (2)** , , 1991
**Wild, Christopher J.** , , 2000
**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 806119P | A Second Course in Statistics | 5.0 op |
| 806116P | Statistics for Economic Sciences | 5.0 op |
| 806117P | Analysis of continuous response variable | 5.0 op |
| ay806109P | Basic Methods in Statistics I (OPEN UNI) | 9.0 op |

**ECTS Credits:**
9 cr
**Language of instruction:**
Finnish
**Timing:**
The course is held in the spring semester, during periods III and IV.
**Learning outcomes:**
On successful completion of this course, the student will be able to
- use basic methods of collecting and describing data
- apply methods of statistical inference in some simple situations
- interpret listing of some statistical software
**Contents:**
Principles of collecting data and describing data with suitable tables, graphs and numerical measures are treated. The basic idea of estimation and statistical tests will be presented as well as some of the most common used confidence intervals and statistical tests. One aim is also to give basic knowledge from some statistical software.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
52 h lectures, 46 h exercises (including 10 h computer exercises), self-study.
**Target group:**
Minor student
**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
**Assessment methods and criteria:**
Mid-term exams (2) or final exam.
**Grading:**
The course utilizes a numerical grading scale 1-5 / fail
**Person responsible:**
Jari Päkkilä

## 806112P: Basic Methods of Data Analysis, 10 op

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Jari Päkkilä

**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 categorial 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 Päkkilä
    **Working life cooperation:**
    -

# 805165P: Basic Principles of Statistics, 9 op

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish

Ei opintojaksokuvauksia.

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

**Voimassaolo:** 01.06.2014 -
**Opiskelumuoto:** Basic Studies
**Laji:** Course
**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 usefullness 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:**
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# 802328A: Basics in Number Theory, 5 op

**Voimassaolo:** 01.06.2011 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Tapani Matala-aho

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

**ECTS Credits:**
5 cr
**Language of instruction:**
Finnish/English
**Timing:**
2.-3. year of studies. Timing varies.
**Learning outcomes:**
As usual in my mathematical studies I shall be able to solve problems arising from the subject and to prove essential theorems starting from the given definitions using the tools applied in the course. More detailed; For example, when I pass the course with the grade 1/5, I shall recognize most definitions and I am able to solve closely related problems. Also I am able to rewrite short proofs with some understanding. When I pass the course with the grade 5/5, then I shall understand well the given definitions with the proofs of the theorems deduced from them. Further, I am able to solve challenging problems which demand independent deductions with several stages and applications of appropriate tools.
**Contents:**
In our lectures we consider arithmetical properties of the common numbers involved in studing mathematics and in particular number theory. Also the methods will get a special interest. Examples of the numbers under the research will be binomials, continued fractions, sums of powers and some numbers sharing a name with the mathematicians Bernoulli, Euler, Fermat, Fibonacci, Heron, Lucas, Mersenne, Neper, Pythagoras, Stirling, Wilson and Wolstenholme. From the tools we mention congruences of rational numbers and polynomials, difference operators, generating series, irrationality considerations, matrix presentations, recurrences and telescopes.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
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:**
-

# 802322A: Basics in mathematical modelling, 5 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Erkki Laitinen
**Opintokohteen kielet:** Finnish

# 801385A: Complex Analysis I, 4 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Valeriy Serov
**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 algebrai and toplogical 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 derivate 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
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Valeriy Serov

**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 fundamendal 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 presentaion of analtic functions by using power series will be studied. After Laurent repsentation of complex functions theory of residues will be considered and as applicatio this theory wiil 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


# 802155P: Continuity and limit, 4 op

**Voimassaolo:** 01.08.2012 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Esa Järvenpää

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 800119P | Analysis 1 | 5.0 op |
| 802162P | Continuity and Limit | 5.0 op |
| 801111P | Basic Methods in Mathematics I / math | 10.0 op |
| 800147P | Basic Methods in Mathematics I / appl. | 8.0 op |

**ECTS Credits:**
4 cr
**Language of instruction:**
Finnish
**Timing:**
1. year, 1. 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:**
1-5
**Person responsible:**
Esa Järvenpää.
**Working life cooperation:**
-

# 802156P: Derivative, 4 op

**Voimassaolo:** 01.08.2012 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Maarit Järvenpää

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 800317A | Analysis 2 | 5.0 op |
| 802163P | Derivative | 5.0 op |
| 801111P | Basic Methods in Mathematics I / math | 10.0 op |

**ECTS Credits:**
4 cr
**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
- 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 oif situations.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
28h lectures, 14 h exercises
**Target group:**
Major and minor students
**Prerequisites and co-requisites:**
802151P Introduction to mathematical deduction
802154P Elementary functions
802155P Limits and continuity

**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:**
1-5
**Person responsible:**
Maarit Järvenpää
**Working life cooperation:**
-

## 800105P: Didactics of Mathematics, 5 op

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**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

**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

**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 Diffferential 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:**
-


# 802154P: Elementary functions, 3 op

**Voimassaolo:** 01.08.2012 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Maarit Järvenpää

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 802161P | Introduction to Real Functions | 5.0 op |
| 801111P | Basic Methods in Mathematics I / math | 10.0 op |
| 800147P | Basic Methods in Mathematics I / appl. | 8.0 op |

**ECTS Credits:**
3 cr
**Language of instruction:**
Finnish
**Timing:**
1. year, 1. period
**Learning outcomes:**
After completing the course, student is able to
- prove essential result in the course
- use and apply different types of proof techniques
- handle elementary functions
**Contents:**
Course introduces basic concepts and definitions related to real-valued functions. Definitions and proofs are essential part of the course.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
21h luentoja, 10 h harjoituksia
**Target group:**
Major 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:**
1-5
**Person responsible:**

Maarit Järvenpää
**Working life cooperation:**
-


# 802352A: Euclidean Topology, 4 op

**Voimassaolo:** 01.08.2010 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Maarit Järvenpää
**Opintokohteen kielet:** Finnish
**Leikkaavuudet:**

| | | |
|---|---|---|
| 802357A | Euclidean Spaces | 5.0 op |
| 802356A | Metric Topology | 5.0 op |

**ECTS Credits:**
4 ECTS credits
**Language of instruction:**
Finnish
**Timing:**
First year, 3. period
**Learning outcomes:**
After the course student is able to
- define elementary topological concepts (open and closed sets, accumulation point, etc)
- handle sequences of real numbers
- proof fundamental theorems related to continuous functions
**Contents:**
The courses goal is to expand students knowledge and understanding of continuous functions. Course considers basic topology of n-dimensional Euclidean space. Important concepts are, for instance, open and closed sets, compactness and completeness.
**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:**
802154P Elementary functions
802155P Limit and continuity
802156P Derivative
**Recommended optional programme components:**
-
**Recommended or required reading:**
-
**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:**
Maarit Järvenpää
**Working life cooperation:**
-


# 806353A: Experimental design, 6 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course
**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
**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
**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:**
-


# 801346A: Introduction to Cryptography, 4 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

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

**Contents:**
The course considers some traditianl 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


## 800149P: Introduction to LateX, 2 op

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**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. enumertions, 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 LATEX2ℰ* ( 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:**

-

## 802364A: Introduction to Mathematical Software, 6 op

**Voimassaolo:** 01.08.2010 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**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:**
-

# 801195P: Introduction to Probability Theory I, 5 op

**Voimassaolo:** 01.01.2011 -
**Opiskelumuoto:** Basic Studies
**Laji:** Course
**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.

# 801396A: Introduction to Probability Theory II, 5 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**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 stocastic 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 distibutions.
**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.


# 806354A: Introduction to Sampling Methods, 4 op

**Voimassaolo:** 01.01.2010 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Läärä Esa
**Opintokohteen kielet:** Finnish


Ei opintojaksokuvauksia.


# 806113P: Introduction to Statistics, 5 op

**Voimassaolo:** 01.01.2011 -
**Opiskelumuoto:** Basic Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Hanna Heikkinen, Läärä Esa
**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

# 802362A: Introduction to computational inverse problems, 5 op

**Voimassaolo:** 01.08.2010 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Mikko Orispää
**Opintokohteen kielet:** Finnish


Ei opintojaksokuvauksia.


## 802360A: Introduction to inverse problems, 4 op

**Voimassaolo:** 01.08.2010 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**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.


## 802151P: Introduction to mathematical deduction, 5 op

**Voimassaolo:** 01.08.2009 -
**Opiskelumuoto:** Basic Studies
**Laji:** Course
**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 in an introduction to mathematical deduction and introduces different types of proof techniques. The course covers the concepts familiar from upper secondary school studies more profound way. 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


# 802118P: Linear Algebra I, 4 op

**Voimassaolo:** 16.10.2012 -
**Opiskelumuoto:** Basic Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opintokohteen oppimateriaali:**
**Lay, David C.** , , 2003
**Opintokohteen kielet:** Finnish
**Leikkaavuudet:**

802120P    Introduction to Matrices    5.0 op

**ECTS Credits:**
4 cr
**Language of instruction:**
Finnish

**Timing:**
First semester, 2. period
**Learning outcomes:**
On successful completion of this course, the student will be able to
- solve linear systems of equations ja apply them to linear algebraic problems
- know matrices and their basic properties
- know basic properties of linear spaces
**Contents:**
The aim is to familiarise the student with the basics of linear algebra: systems of linear equations, vector space $R^n$ and matrix algebra.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
35 h lectures, 21 h 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 exams or final exam
Read more about assessment criteria at the University of Oulu webpage.
**Grading:**
1-5
**Person responsible:**
Tero Vedenjuoksu
**Working life cooperation:**
-


# 802119P: Linear Algebra II, 5 op

**Opiskelumuoto:** Basic Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opintokohteen oppimateriaali:**
**Lay, David C.** , , 2003
**Opintokohteen kielet:** Finnish
**Leikkaavuudet:**

   802320A    Linear Algebra    5.0 op

   **ECTS Credits:**
   5 ECTS credits
   **Language of instruction:**
   Finnish
   **Timing:**
   First year, 4. period
   **Learning outcomes:**
   On successful completion of this course, the student will be able to
   - basic properties of inner product spaces
   - linear mappings, their matrix representation, and eigen values
   - determinants and apply them to problems relating to matrices and linear mappings
   **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, Determinants, Eigenvalues and Eigenvectors, Hermitian matrices and quadratic forms.
   **Mode of delivery:**
   Face-to-face teaching
   **Learning activities and teaching methods:**

35 h lectures, 21 h exercises
**Target group:**
Major and minor students
**Prerequisites and co-requisites:**
802119P Linear algebra I
**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:**
Esa Järvenpää
**Working life cooperation:**
-

# 806308A: Linear Models, 10 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Leena Ruha

**Opintokohteen oppimateriaali:**
**Draper, Norman Richard** , , 1980
**Cook, R. Dennis** , , 1999
**Sen, Ashish** , , 1997
**Opintokohteen kielet:** Finnish

**ECTS Credits:**
10 cr
**Learning outcomes:**
On successful completion of this course, the student will be able to
- understand both the potentials and the limitations of regression models
- apply regression models as well as variance and covariance analyses while studying continuous dependent variables
- diagnose specification errors in linear models
**Contents:**
The course starts with an introduction to models postulating conditional distributions for continuous dependent variables and to the expectations of these conditional distributions, the so-called regression functions. Special attention will be paid to families of models that allow a meaningful formulation in terms of regression functions, linear with respect to the parameters. The estimation and testing theory concerning these models will be presented fairly thoroughly, but the main emphasis of the course still lies on the practical side: The limitations in the applicability of regression models will be made very clear and the use of both graphics and tests in model diagnostics get very much attention. Other graphical representations, helpful in understanding the information content of the data are also presented. Much time will also be devoted to cases, where the observational units can be divided into groups or categories according to some qualitative factors ("analysis of variance" and "analysis of covariance"). The course is compulsory for a curriculum in statistics and consists of 52 hours of lectures and 42 hours of excercises in the computer lab.
**Person responsible:**
Markku Rahiala

# 802332A: Mathematical Problem Solving, 5 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Peter Hästö

**Opintokohteen kielet:** Finnish


# 802158P: Mathematics for Economic Sciences, 7 op

**Voimassaolo:** 01.06.2014 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**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 indeces).
**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 fuctions, 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:**
-


## 802157P: Mathematics in teaching, 2 op

**Voimassaolo:** 01.08.2012 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

800146P     Introduction to teaching     5.0 op


**ECTS Credits:**
2 cr
**Language of instruction:**
Finnish
**Timing:**
1st year, periods 3 and 4
**Learning outcomes:**
The student can reflect critically on the learning of mathematics.
**Contents:**
Learning and teaching mathematics are thought about and discussed.
The course consists of reflective exercises and seminar meetings where the exercises are discussed.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
16 h seminar meetings, 37 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
**Grading:**
pass/fail
**Person responsible:**
Pekka Salmi


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

**Voimassaolo:** 01.06.2014 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**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:**
-


# 802363A: Metric Spaces, 6 op

**Voimassaolo:** 01.08.2010 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**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:**

-


# 802356A: Metric Topology, 5 op

**Voimassaolo:** 01.01.2012 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Esa Järvenpää

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 802358A | Metric Spaces | 5.0 op |
| 802352A | Euclidean Topology | 4.0 op |

**ECTS Credits:**

5 cr

**Language of instruction:**

Finnish

**Timing:**

1. year, 3. period

**Learning outcomes:**

After the course student is able to

- define elementary topological concepts (open and closed sets, accumulation point, etc)
- handle sequences of real numbers
- proof fundamental theorems related to continuous functions


**Contents:**

The courses goal is to expand students knowledge and understanding of continuous functions. Course considers basic topology of n-dimensional Euclidean space. Important concepts are, for instance, open and closed sets, compactness and completeness.

**Mode of delivery:**

Face-to-face teaching

**Learning activities and teaching methods:**

32h lectures, 18h exercises

**Target group:**

Major students (who are aiming to Master's degree in mathematics (research oriented line))

**Prerequisites and co-requisites:**

802154P Elementary functions

802155P Limit and continuity
802156P Derivative

**Assessment methods and criteria:**
Final exam
**Grading:**
1-5
**Person responsible:**
Esa Järvenpää


# 806360A: Mixed Linear Models, 5 op

**Voimassaolo:** 01.01.2013 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opintokohteen kielet:** Finnish


Ei opintojaksokuvauksia.


# 800322A: Multidimensional analysis, 8 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Pekka Salmi
**Opintokohteen kielet:** Finnish
**Leikkaavuudet:**

| | | |
|---|---|---|
| 800328A | Calculus of several variables | 5.0 op |
| 802351A | Vector Calculus | 5.0 op |

**ECTS Credits:**
8 cr
**Language of instruction:**
Finnish
**Timing:**
Second year, periods 1-2
**Learning outcomes:**
On successful completion of this course, the student will be able to
- differentiate multivariate functions
- apply the derivative to minimization problems
- define and use multidimensional integrals
**Contents:**
The course deals with multidimensional real calculus.
The course provides an introduction to vector-valued functions of one variable, their derivatives and path integrals.
The central notion of the course is the derivative of vector-valued function of several variables
(including the gradient of a real-valued function of several variables). In the course we develop the Riemann integral of a real-valued function of two variables. The course provides basic tools for advanced courses in analysis and for applications (such as physics).
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
56 h lectures, 28 h exercises, 129 h self-study.
**Target group:**
Major and minor students in mathematics.
**Prerequisites and co-requisites:**

Linear algebra I
Linear algebra II
Euclidean topology
Series and integrals

**Recommended optional programme components:**
-
**Recommended or required reading:**
- Baxandall, Liebeck: Vector calculus, Oxford University Press, 1986.
- lecture notes.
**Assessment methods and criteria:**
Midterm exams or final exam
Read more about assessment criteria at the University of Oulu webpage.
**Grading:**
0-5
**Person responsible:**
Pekka Salmi.
**Working life cooperation:**
No

# 800104P: Number Systems, 4 op

**Voimassaolo:** 01.03.2011 -

**Opiskelumuoto:** Basic Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 800347A | Number systems | 5.0 op |

**ECTS Credits:**
4 cr
**Language of instruction:**
Finnish
**Timing:**
Autumn semester, period I. Recommended to complete the course at the first or second autumn semester.
**Learning outcomes:**
Having completed the course, the student is able to
- define and construct the most common number systems
- list and use the basic arithmetic operations in number systems

**Contents:**
The course considers the basics of arithmetic and algebra in the setting of the most common number systems (natural numbers, integers, rationals and reals). The course begins with the construction of natural numbers and continues, through integers and rational numbers, to the construction of real numbers.

**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
Lectures 28 h, exercises 14 h, self-study 66 h
**Target group:**
Major and minor students
**Prerequisites and co-requisites:**
802151P Introduction to mathematical deduction
**Recommended optional programme components:**
For first year students, recommended to be completed simultaneously with the course "802155P Continuity and Limit".
**Recommended or required reading:**
Lecture notes
**Assessment methods and criteria:**
Final exam

**Grading:**
1-5, fail
**Person responsible:**
Jukka Kauppi
**Working life cooperation:**
-


# 802354A: Number Theory and Groups, 5 op

**Voimassaolo:** 01.08.2010 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**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 numbres, 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:**
-


# 800343A: Permutations, Fields and Galois' Theory, 8 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**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:**
-


# 802331A: Principles to Mathematical Modelling, 8 op

**Voimassaolo:** 01.08.2009 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish


Ei opintojaksokuvauksia.

# 806359A: Regression modelling, 10 op

**Voimassaolo:** 01.08.2012 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Läärä Esa

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

805351A     Linear Regression     5.0 op

805352A     Generalized Linear Models     5.0 op

**ECTS Credits:**
10 cr
**Language of instruction:**
Finnish
**Timing:**
2. year, periods 2-3
**Learning outcomes:**
After successful completion of the course the student is able to describe the basic concepts and assumptions of generalized linear models, as well as main principles of regression modelling, and is also able to apply these methods in the analysis of experimental or observational data.
**Contents:**
Generalized linear regression models for continuous, binary and count responses; model formulation, selection of variables and interpretation of parameters; fitting of models, estimation of 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 (56 h), calculation and computation practicals (28 h), independent work.
**Target group:**
Major and minor students
**Prerequisites and co-requisites:**
Compulsory basic and intermediate studies in mathemtics (core studies), 801396A Introduction to propability II, 806112P Basic methods of data-analysis, and 805310A Statistical inference I
**Assessment methods and criteria:**
Final exam
Read more about [assessment criteria](#) at the University of Oulu webpage.
**Grading:**
1-5
**Person responsible:**
Esa Läärä
**Working life cooperation:**
-

# 802355A: Rings, Fields and Polynomials, 5 op

**Voimassaolo:** 01.08.2010 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**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, polynomial rings, ideals, integral domains, fields, finite fields, field extensions and quotient field. 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:**
-

# 802353A: Series and Integrals, 6 op

**Voimassaolo:** 01.08.2010 -

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Peter Hästö

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| | | |
|---|---|---|
| 800318A | Analysis 3 | 5.0 op |
| 802164P | Series and Integral | 5.0 op |

**ECTS Credits:**
6 ECTS credits
**Language of instruction:**
Finnish (possible also in English)
**Timing:**
First year, 4. period
**Learning outcomes:**
After completing the course, student is able to

- operate with real series
- separate the concept of continuity and uniform continuity
- define and calculate Riemann integrals
- derive and operate function sequences and function series
- calculate derivate and integrate function series

**Contents:**
The course is a continuum for the courses Limits and continuity and Derivative. Basic topological methods (presented in Euclidean Topology) are heavily used in proofs and methods involving continuous functions. The goal is the same as in the prerequisite courses, that is, to develop mathematical thinking and extend the knowledge of mathematical analysis.
**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
30h exercises, 14h exercises
**Target group:**
Major and minor students
**Prerequisites and co-requisites:**
802154P Elementary functions
802155P Limit and continuity
802156P Derivative
802352A Euclidean topology

**Recommended optional programme components:**
-
**Recommended or required reading:**
Lecture notes
**Assessment methods and criteria:**
Midterm exams or final exam
Read more about assessment criteria at the University of Oulu webpage.
**Grading:**
1-5
**Person responsible:**
Peter Hästö
**Working life cooperation:**
-


# 805310A: Statistical Inference I, 10 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen oppimateriaali:**
**Pawitan, Yudi** , , 2001
**Sprott, D. A.** , , 2000
**Kalbfleisch, J. G.** , , 1985
**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

| 805349A | Likelihood Inference | 5.0 op |
| 805350A | Estimation and Test Theory | 5.0 op |

**ECTS Credits:**
10 cr
**Language of instruction:**
Finnish
**Timing:**
2. or 3. year spring semester (periods 3-4).
**Learning outcomes:**

After successful completion of the course the student is able to describe the main principles of frequentist statistical inference, derive likelihood functions and from these compute point and interval estimates, test statistics and P-values for models with few parameters, as well as to interpret results such obtained.

**Contents:**
Statistical model and observed data; likelihood function, log-likelihood, score and information; construction and properties of point and interval estimates; likelihood ratio, score and Wald statistics and their asymptotic sampling distributions; jackknife and bootstrap methods; elements of Bayesian inference; Use of R environment in inferential tasks.

**Mode of delivery:**
Face-to-face teaching
**Learning activities and teaching methods:**
Lectures (56 h), calculation and computation practicals (28 h), and independent work.
**Target group:**
Major and minor students
**Prerequisites and co-requisites:**
Introduction to propability I
Basic methods of data-analysis
**Recommended optional programme components:**
Requirement for further studies in statistics.
**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:**
Hyon-Jung Kim-Ollila
**Working life cooperation:**
-

# 805340A: Statistical Software, 4 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

805353A    Statistical Software    5.0 op

**ECTS Credits:**
4 cr
**Language of instruction:**
English
**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 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:**
34 h lectures and computer class exercises.
**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:**
Home work
Read more about [assessment criteria](#) at the University of Oulu webpage.
**Grading:**
1-5
**Person responsible:**
Hyon-Jung Kim-Ollila
**Working life cooperation:**
-


# 806361A: Statistical analysis with missing data, 5 op

**Voimassaolo:** 01.01.2013 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opintokohteen kielet:** Finnish


Ei opintojaksokuvauksia.


# 806357A: Statistical finance, 5 op

**Voimassaolo:** 01.08.2010 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**Arvostelu:** 1 - 5, pass, fail
**Opettajat:** Jussi Klemelä
**Opintokohteen kielet:** Finnish


**ECTS Credits:**
5 cr
**Language of instruction:**
Finnish
**Timing:**
Every second year.
**Learning outcomes:**
On a successful completion of this course, the student is familiar with the basic concepts of derivative pricing and knows how to calculate the Black-Scholes price of a stock option. In addition, after completion of the course, the student knows how to calculate a Markowotz portfolio, how to evaluate the return and the risk of a portfolio, and knows how to calculate performance measures for a portfolio.
**Contents:**
1. Introduction: The main asset classes and derivative types.
2. The main concepts needed to price futures and options, arbitrage pricing and pricing with statistical arbitrage, the arbitrage free price of futures, the put-call-parity.
3. Pricing of options in the single period and multiperiod binary model, Black-Scholes pricing, and pricing in incomplete models.
4. The basic methods for choosing and evaluating a portfolio, Markowitz theory for the portfolio choice, maximization of the expected utility, and the maximization of the conditional expected utility.
**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, students of finance and economics.

**Prerequisites and co-requisites:**
Basic knowledge of statistics and probability.
**Recommended optional programme components:**
The course is suitable together with the course "Market Risk Analysis".
**Recommended or required reading:**
Lecture notes
**Assessment methods and criteria:**
Examination
**Grading:**
1 - 5
**Person responsible:**
Jussi Klemelä
**Working life cooperation:**
-
**Other information:**
The home page of the course is http://cc.oulu.fi/~jklemela/stafin/
The course is lectured every second year.
Additional literature:
Franke, J., Härdle, W., and Hafner, C. M. (2004).
Statistics of Financial Markets, Springer.
Bouchaud, J.-P. and Potters, M. (2003).
Theory of Financial Risk and Derivative Pricing,
Cambridge University Press.
Ruppert, D. (2004). Statistics and Finance, Springer.


# 805309A: Statistical methods in epidemiology, 9 op

**Voimassaolo:** 01.06.2009 -
**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**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
**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 A    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

**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)


# 805324A: Time series analysis, 5 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**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.


# 800329A: Topology, 8 op

**Opiskelumuoto:** Intermediate Studies
**Laji:** Course
**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:**
-


# 802327A: Tutoring, 4 op

**Opiskelumuoto:** Intermediate Studies

**Laji:** Course

**Arvostelu:** 1 - 5, pass, fail

**Opettajat:** Kari Myllylä

**Opintokohteen kielet:** Finnish

**Leikkaavuudet:**

   800324A    Practical training    5.0 op

Ei opintojaksokuvauksia.