Bachelor and Master of Science degrees in Mathematics and Statistics at University of Helsinki

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department web-page:

http://mathstat.helsinki.fi/index.en.html

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University of Helsinki: some facts

Founded 1640 at Turku (Finland), moved to Helsinki in 1828

Faculties: 11 (at 4 campuses) Employees: 7.700 [teachers and researchers \approx 3.800]

Registered degree students: \approx 38.800

Bachelor / Master: 32.300 • Doctoral:
5.600

Degrees (2006): • Bachelors: 1217 • Masters: 2.358 • Doctoral degrees: 377 **Note:** Master degree main one in all subjects

university web-page:

http://www.helsinki.fi/university/index.html

Mathematics and Statistics: facts

• *joint* department of Faculties of Science and Social Sciences since 2004 (Note: by law Statistics **degrees only** from Social Sciences before 2004)

Employees: \approx 170

- Teaching staff (prof., univ. lect. etc.): 45
- Postdoc researchers: 45
- Fulltime doctoral students: 70

University research evaluation: 7/7 (highest mark)

Research in numbers (2006): 132 refereed papers (in journals, conference proceedings) External research funding > 50% of total budget

Annual admission of new majors

Mathematics: $\approx 180 + 35 = 215$ Statistics: • (Science) 30 • (Social Sciences) 30. Total admission (stats): 60 Comment: largest in Finland Admission criteria: part matriculation exams (end of high school), part entrance exams

Registered Master students (2006): \approx 1.600

• (Science) 1426 • (Social Sciences) 184 Doctoral students (2006): 126 [of these \approx 70 financed fulltime (external research funding)]

Awarded degrees per year (average):

Masters: • (Science) $\approx 52 - 56$ • (Social Sciences) $\approx 6 - 7$ Ph.Ds: ≈ 10

Students minoring in mathematics / statistics provide \geq 50 % of total credits

Degree Programs Master Degree: Mathematics 3 + 2 years (by statute)

Mathematics Curriculum (specializations): * Algebra and Topology * Analysis * Mathematical Physics * Mathematical Logic

Teachers' Education Curriculum

Applied Mathematics Curriculum (specializations):

 * Biomathematics * Applied Analysis * Stochastics * Computer-aided Mathematics * Actuarial and Financial Mathematics

Master Degree: Statistics 3 + 2 years (by statute)

Statistics Curriculum (specializations): * Time Series Analysis and Econometry * Biometry * Measurement and Survey Methodology

Bachelor Degree: Mathematics (180 cr) 3 years (by statute)

Abbreviation: cr = ECTS credit

Basic Studies in Mathematics (25 cr)
* Analysis I and II (10 + 10 cr) * Linear
Algebra and Matrices I (5 cr)

Basic and Intermediate Studies in Mathematics (80 cr)
Obligatory part: * Basic Studies (as above;
25 cr) * Written Exercise in Analysis (2 cr)
* Bachelor Thesis (6 cr)

Elective courses (from): \star Linear Algebra and Matrices II (5 cr) \star Topology I (10 cr) \star Algebra I (10 cr) \star Vector Analysis (10 cr) \star Differential Eqs I and II (5 + 5 cr) \star Logic I (10 cr) \star Stochastic Processes (6 cr) \star Measure and Integral (6 cr) \star Introduction to Discrete Mathematics (5 cr) \star Introduction to Probability (5 cr) \star Introduction to Statistical Inference (5 cr) \star Course in Statistical Inference (10 cr) \star Geometry (10 cr) \star History of Mathematics (3 cr) \star Combinatorics (5 cr) \star Graph Theory (5 cr) \star Matematical Methods (10 cr) \star Introduction to Statistics (4 - 10 cr) [\star Other courses by agreement (2 - 10 cr)]

Other studies (all Bachelor students)

Minor Subject Studies (at least 50 cr) * Recommended minor subjects incl. Statistics, Computer Science, Physical Sciences, Chemistry

 Students in Teachers' Education should have at least 25 cr of pedagogical studies

Further studies (at least 16 cr).* Language studies, basic computer skills, work orientation and practice

Master Degree: Mathematics (120 cr) + 2 years (by statute)

Mathematics Curriculum. Advanced Studies (90 cr)

Obligatory all specializations: * Master Thesis, incl. related specialized course (40 cr)

(a) **Algebra and Topology** * Intermediate studies incl. Topology I; Measure and Integral; Algebra I

* Real Analysis I (6 cr)

* At least 2 courses from Algebra II (10 cr),
 Linear Algebra II (10 cr), Topology II (10 cr)

* *Elective* courses (recommended e.g. from): Algebraic Topology; Manifolds and Lie Groups; Transformation Groups; Topological Groups; Number Theory; Function Theory I; Riemannian Surfaces (b) **Analysis** * Intermediate studies incl. Vector Analysis; Topology I; Measure and Integral

* Real Analysis I (6 cr)

* *Elective* courses (recommended e.g. from): Functional Analysis; Function Theory I; Function Theory II; PDEs; Real Analysis II; Probability Theory; Variational Calculus

(c) Mathematical Physics * Intermediate
 studies incl. Vector Analysis; Topology I;
 Measure and Integral

* Real Analysis I (6 cr)

* *Elective* courses (recommended e.g. from): Introduction to Mathematical Physics; Functional Analysis; Function Theory I; PDEs; Differential Geometry; Probability Theory; Stochastic Processes; Topology II; Algebra III; Function Theory II; Real Analysis II; Riemannian Geometry; Principal Vector Bundles and Yang-Mills Theory (d) *Mathematical Logic* * Intermediate studies incl. Logic I; Combinatorics and Graphs (or Discrete Mathematics II)

* Mathematical Logic (10 cr)

At least 20 cr from: Algebra II (10 cr),
Measure and Integral (6 cr), Real Analysis I (6 cr), Topology II (10 cr)

* One of the following courses: Basic Set Theory; Model Theory; Computability; Finite Model Theory; Non-standard Analysis; Axiomatic Set Theory

* *Elective* advanced courses (cr \geq 90)

Teachers' Education Curriculum. Advanced Studies (70 cr) * Intermediate studies incl. Algebra I; Topology I; Introduction to Probability; Geometry

Other recommended courses: Differential Eqs I and II, Combinatorics and Graph Theory.

* Advanced Course for Teachers (12 cr)

Master Thesis, incl. specialized courses (40 cr)

* Further elective courses (until $cr \ge 70$) **Note:** on-site teacher training (35 cr) **Note:** second teaching subject (60 cr) Applied Mathematics Curriculum. Advanced Studies (90 cr) *Obligatory all specializations*: * Master Thesis, incl. related specialized course (40 cr)

(a) *Biomathematics* * Intermediate studiesincl. Vector Analysis; Measure and Integral;Differential Eqs I and II

* Advanced Course in Applied Analysis (6 cr)
* Mathematical Modelling (10 cr)

* At least 15 cr from: Mathematics of Infectious Diseases (10 cr), Mathematical Population Biology (10 cr), Biological and Biomedical Applications of PDEs (10 cr), Adaptive Dynamics (5 cr), Evolution and the Theory of Games (5 cr)

* *Elective* courses (recommended e.g. from): Qualitative Theory of ODEs; Functional Analysis; PDEs; Operator Semigroups; Stochastic Processes; Function Theory I; Real Analysis I (b) Applied Analysis * Intermediate studies
 incl. Vector Analysis; Measure and Integral;
 Differential Eqs I and II

* Advanced Course in Applied Analysis (6 cr)

* PDEs (10 cr)

* *Elective* courses

- (recommended *theoretical* ones e.g. from):
Function Theory I; Real Analysis I; Numerical Analysis; Functional Analysis; Theory of Distributions; Pseudodifferential Operators.
- (recommended *applied* ones e.g. from): Inverse Problems; Introduction to Math Problems for Industry; Math Problems for Industry; Spline Approximation; Numerical Solutions of Differential Eqs; Stochastic Processes; Testing of Statistical Hypotheses

(c) Stochastics * Intermediate studies incl.
Introduction to Probability; Introduction to
Statistical Inference; Stochastic Processes
* Probability Theory (10 cr)

* *Elective* advanced courses in stochastics or statistics. [To be agreed with coordinating teachers]

(d) Computer-aided Mathematics \star Intermediate studies incl. Mathematical Methods; Measure and Integral. Minor subjects incl. \geq 60 cr from Computer Science.

* Advanced Course in Applied Analysis (6 cr)
* Numerical Methods and C/C++ Language (10 cr).

* *Elective* courses (recommanded e.g. from): Symbolic Computing; Introduction to Math Problems for Industry, Math Problems for Industry; PDEs, Real Analysis I and II, Stochastic Processes; Computability, Discrete Mathematics II. [Also: certain courses from Computer Science possible]

Note: earlier also **joint** Master program with Computer Science, but discontinued [too small interest in CS] (e) Actuarial and Financial Mathematics * Intermediate studies incl. Linear Algebra and Matrices II; Vector Analysis; Differential Eqs I; Introduction to Probability; Introduction to Statistical Inference; Stochastic Processes.

* Probability Theory (10 cr)

* At least 20 cr of courses in risk theory, financial mathematics or mathematical economics.

★ *Elective* advanced courses in mathematics, applied mathematics and / or statistics. [To be agreed with coordinating teachers].

Note: Bachelor or Master degree should contain Statistics as minor subject, incl. Introduction to Probability; Course in Statistical Inference; Linear Models

Note: separate actuarian exam for licence

Statistics Degrees

Note: *joint* requirements for Faculties of Science and Social Sciences (since 2004/05) leading to M.Sc. or M.Soc.Sc.

Bachelor Degree: Statistics (180 cr)

Statistics as Major Subject (70 cr)

* Introduction to Probability and Statistics
(5 + 5 cr) * Course in Data Analysis (8 cr)
* Probability (10 cr) * Course in Statistical Inference (10 cr) * Linear Models (10 cr)
* *Elective* special courses (each 3 - 10 cr; recommended e.g. from): Applications of Linear Models; Bayesian Inference; Statistical Computing; Measuring and Collecting of Statistical Data; Sampling Methods; Stationary Time Series.

- * Proseminar (4 cr)
- * Bachelor Thesis (6 cr)

Other studies (all Bachelor students in Statistics)

Minor Subject Studies (at least 50 cr) * Obligatory Mathematics (at least 30 cr): Analysis I and II (10 + 10 cr), Linear Algebra and Matrices I and II (5 + 5 cr). Further recommended courses: Vector Analysis, Stochastic Processes, Stochastic Analysis, Probability Theory

Further studies (at least 16 cr).* Language studies, basic computer skills, work orientation and practice

Master Degree: Statistics (120 cr) Note: main 3+2 years degree

Advanced Studies in Statistics (85 cr) *Obligatory studies.* * Advanced Course in Statistical Inference (10 cr) * Studies preparing for Master Thesis (20 cr), e.g. seminars and specialized courses * Master thesis (40 cr) * *Elective* courses (each 3 - 10 cr), depending on specialization (below)

(a) Time Series Analysis and Econometry
* Stationary Time Series * Multivariate Time
Series * Non-Stationary Time Series * Nonlinear Time Series * Regression analysis *
Econometry

* Other suitable courses incl.: Applications of Linear Models; Nonlinear Regression Analysis; Multivariate Methods; also Stochastic Processes; Stochastic Analysis; Probability Theory. (b) *Biometry* * Lines (b1) - (b3) below in Biometry include both obligatory courses and recommended elective ones.

Recommended *general* courses for (b1) - (b3) incl.: Generalized Linear Models; Hierarchical Bayesian Models, Statistical Computing; Graphical Statistical Models and Causal Inference, Experimental Design and Variance Analysis; Statistical Methods of Longitudinal Studies. Also: Stochastic Processes, Stochastic Analysis, Probability Theory.

(b1) Medical Statistics

 Life-Time Analysis * Epidemiological Research Methods

(b2) Environmental Statistics

* Spatial Statistics * Sampling Methods
(b3) *Bioinformatics and Statistical Genetics** Statistical Methods in Bioinformatics **Note:** also Master's Program in *Bioinformatics matics* coordinated by Computer Science. Admission: 15 students / year, see web-page http://www.helsinki.fi/bioinfo/ (c) Measurement and Survey Methodology
* Measurement and Collecting of Statistical
Data * Survey Methodology I and II * Sampling Methods * Applications of Linear Models
* Multivariate Methods * Analysis of Frequency Data

* Other suitable courses incl.: Hierarchical Models, Generalized Linear Models, Experimental Design and Variance Analysis. Also: Probability, Matrix Calculus.

European Master's Degree program Bayesian Statistics and Decision Analysis (116
118 cr) [joint between 7 universities].
Admission (Helsinki): 8 students / year
Compulsory studies: * Elementary Bayesian
Analysis * Probability and Stochastic Processes * Computational Methods in Statistics
* Statistical Software Tools

* Generalized Linear Models * Hierarchical
 Models * Seminar * Master Thesis * Elective
 courses

Experiences (Helsinki)

• graduated Masters by curriculum in Science (1999-2006)

Mathematics 29,1 % *Teacher Education
46,5 % * Applied Mathematics 20,7 % *
Computer-aided Mathematics 3,4 % (2001-06 only)

Comments: M.Sc. in Statistics only possible from 2004/05, but on average 6 M.Soc.Sc. in Statistics per year

• *why this diversity*? Some factors:

- university and departmental **funding** correlates with number of **graduated** students (Masters or Doctors)

need to attract widely "dispersed" interests of students (diverse degree profiles help?)
need to optimize use of research strengths of staff

Problems and challenges (Helsinki)

 significant drop-out rates (Maths and Statistics; also Physics, Chemistry, CS), in part because of misuse of student social benefits

- actual study time \approx 6.0 - 6.5 years

- recruitment problems in Statistics (less popular and visible as subject)
- evidence: well-tested choices more popular? Early specialization less attractive?

- advertisement of new programs

- (im)balance between planning and available resources (do all relevant courses exist?)

- specializations may disappear with retirements or movements of staff

- quite *small common core element* of mathematics or statistics degrees [very different from Spain]

too much diversity makes choices difficult
 for students [Helsinki: flexible interpretations]
 too many changes within short time

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