# Chosen Topics in Mathematics and Statistics 7.5 credits

Valda nedslag inom matematik och statistik 7.5 hp

Third cycle

Syllabus is adopted by the Research and Education Board (2022-01-18) and is valid for students admitted for the spring semester 2022.

## Prerequisites and Conditions of Admission

General entry requirements for third-cycle studies and basic courses in single Variable Calculus 7.5 credits, Linear Algebra 7.5 credits and Mathematical Statistics 7.5 credits.

## Course Objectives

The Phd student is expected to acquire a working knowledge of state-of-the-art mathematical and statistical methods for contributing to their respective field of research.

Following successful completion of the course the student should be able to:

*Knowledge and understanding*

- recall main concepts of vector calculus, label matrix classes and define their properties
- explain the concept of a sigma-algebra, a measure, the Lebesgue measure, Radon-Nikodym theorem
- account for concepts in likelihood and Bayesian inference

*Skills and ability*

- relate linear algebra concepts to elements of data processing and physical systems modelling
- solve ordinary differential equations analytically and numerically
- derive the maximum likelihood estimator, the likelihood ratio statistic, regression models and apply approximations due to the Central Limit Theorem.

*Judgement and approach*

- identify elements of vectors and matrices in some machine learning algorithms and other research-relevant areas
- choose adequate methods for solving mathematical and statistical problems and assess aspects of reasonability of results
- select appropriate methods to solve ordinary differential equations

## Primary Contents

The course is divided into three parts: (1) Linear algebra, (2) Mathematical analysis, (3) Probability theory and statistics. It consists of a narrative to concepts like matrix and vector operations, systems of linear equations, linear independence, subspaces, bases and projections, linear models, least-square problems, determinants, linear transforms, eigenvalues and eigenfunctions, matrix decompositions, sigma-algebra, measure, the Lebesgue measure applied to Fourier transform, the Radon-Nikodym theorem, ordinary differential equations, system of linear ODE, stability of solution, the Central Limit Theorem, regression analysis, likelihood function, maximum likelihood estimator, likelihood ratio statistic, Bayesian inference.

## Teaching Formats

The teaching will be given in English in the form of lectures, discussions, exercise classes and a project seminar.

## Examination

The overall grades of Fail or Pass will be awarded for the course.
The examination consists of assignments and a project. The assignments should be solved in a written report. The project should be presented both orally at a project seminar and in a written report.

| Name of the test | | Grading |
|---|---|---|
| Assignment I | 1 credits | U/G |
| Assignment II | 1 credits | U/G |
| Assignment III | 1 credits | U/G |
| Written Project Report | 3 credits | U/G |
| Oral Project Presentation | 1,5 credits | U/G |

If a disabled doctoral student has been granted learning support through a decision by Halmstad University, the examiner may decide on an adapted or alternative form of assessement for this student.

**Course Evaluation**

Course evaluation is part of the course. This evaluation should offer guidance in the future development and planning of the course. Course evaluations should be documented and made available to the students.

## Course Literature

Axler, S. Measure. *Integration, & Real analysis*. Latest Edition, Springer

Halmos, P.R. *Measure Theory*. Latest Edition, Springer

Apostol, T. M*athematical Analysis*. Latest Edition, Addison-Wesley

Hogg, R.V., McKean, J.W. and Craig, A.T. *Introduction to mathematical statistics*. Latest Edition, Pearson

Strang, G. *Introduction to Linear Algebra*. 5th ed. Wellesley, MA: Wellesley-Cambridge Press, 2016.

Journal papers from the scientific literature