Courses in Mathematical statistics
at Lund University
 Academic year 2014/2015
Intermediate and advanced (A) courses in Mathematical statistics 2014/15 and autumn 2015

Year 4 (autumn)

- FMSF10/MASC04 Stationary stochastic processes
- FMSN15/MASC03 Markov processes
- FMS065 Statistical methods for safety analysis
- MASM14 Mathematical foundations of probability (A)

Year 4 (spring)

- FMS051/MAFM17 Time series analysis (A)
- FMSN20/MASM25 Spatial statistics with image analysis (A)
- FMSN35/MAFM26 Linear and non-linear spectral analysis (A) (2016)
- FMSN30(N40)/MAFM22 Linear and logistic regression (with data gathering) (A)
- FMS155/MAFM15 Statistical modelling of extreme values (A)

Year 5 (autumn)

- FMSN25/MAFM24 Valuation of derivative assets (A)
- MASM12 Non-linear time series (A)
- FMSN15/MAFM23 Statistical modelling of multivariate extreme values (A)

Course Prerequisites:

- ASSUMES Stationary and Markov
- REQUIRES a basic course
- ASSUMES Stationary OR Markov and REQUIRES a basic course
- ASSUMES Time series and REQUIRES Stationary and Markov
- REQUIRES Stationary OR Markov
- REQUIRES Extreme values
- REQUIRES a basic course
Courses Academic Year 2014/15

Intermediate courses (G2)

FMSF05/MASC01: Probability theory, 7.5 ECTS Credits
Period: Spring semester, halftime 1st half.
Pre-requisites: 45 ECTS credits in mathematics and a basic course in mathematical statistics.
LTH strict req.: A basic course in Mathematical Statistics (FMS012, 032, 035, 086, 140).
LTH-programmes: BME, F, I, Pi.
Description: Basic probability theory, random variables in one and several dimensions, multivariate Gaussian distribution, convergence of random variables and distributions, conditional distributions. Moment generating functions and characteristic functions.

MASC02: Inference theory, 7.5 ECTS Credits
Period: Spring semester, halftime 2nd half, NOT GIVEN SPRING 2015.
Pre-requisites: 45 ECTS credits in mathematics and a basic course in mathematical statistics.
LTH-programmes: none.
Description: Factorization Theorem, exponential families, Rao-Blackwell’s theorem, ancillary estimators, Cramér Rao’s inequality, Neyman-Pearson’s Lemma, permutation tests, interrelations between hypothesis testing and confidence intervals, asymptotic methods, maximum likelihood estimators, standard errors, marginal, conditional and penalized likelihood, likelihood ratio, Wald scores method, Baysian inference, sequential tests, inference for finite populations.

FMSF15/MASC03: Markov processes, 7.5 ECTS Credits
Period: Autumn semester, halftime 1st half.
Pre-requisites: 45 ECTS credits in mathematics and a basic course in mathematical statistics
LTH strict req.: -.
LTH-programmes: BME, C, D, E, F, I, Pi.

FMSF10/MASC04: Stationary stochastic processes, 7.5 ECTS Credits
Period: Autumn semester, halftime 1st half.
Pre-requisites: A basic course in mathematical statistics and knowledge in complex and linear analysis.
LTH strict req.: -.
LTH-programmes: BME, C, D, E, F, I, M, MWIR, Pi.

**FMS072/MASC05: Design of Experiments, 7.5 ECTS Credits**
**Period:** Spring semester, halftime 2nd half.
**Pre-requisites:** 45 ECTS credits in mathematics and a basic course in mathematical statistics
**LTH strict req.:** -.
**LTH-programmes:** BME, D, E, F, MLIV, MWIR, N, Pi, W.
**Description:** The course gives theory and methodology of how to model, design and evaluate experiments. Important concepts are: Simple comparative experiments. Analysis of variance; transformations, model validation and residual analysis. Factorial design with fixed, random and mixed effects. Additivity and interaction. Complete and incomplete designs. Randomized block designs. Latin squares and confounding. Regression analysis and analysis of covariance. Response surface methodology. Off-line quality control and Taguchi methods.

**FMS065: Statistical Methods for Safety Analysis, 7.5 ECTS Credits**
**Period:** Autumn semester, halftime 1st half.
**Pre-requisites:** a basic course in mathematical statistics or statistics
**LTH strict req.:** -.
**LTH-programmes:** BME, C, Pi, RH.
**Description:** The course presents notions and ideas from the foundations of a statistical treatment of risks. The emphasis lies on an understanding of the theory and methods presented. Hence the focus is put on applications within the field of risk and safety analysis. A review of elementary concepts in probability and statistics; maximum likelihood method, goodness of fit tests. Introduction to bootstrap and Bayesian statistics. Intensities, Poisson modelling and estimation. Some concepts from safety and reliability analysis. Estimation of quantiles. Introduction to extreme values statistics.
Advanced courses (A)

FMS091/MASM11: Monte Carlo methods for stochastic inference, 7.5 ECTS Credits
Period: Spring semester, halftime 1st half.
Pre-requisites: Stationary stochastic processes and Markov processes.
LTH strict req.: Either FMSF10 Stationary stochastic processes or FMSF15 Markov processes.
LTH-programmes: BME, D, F, I, Pi.
Literature: Computer Intensive Methods, Lund 2004

MASM12: Non-linear Time Series Analysis, 7.5 ECTS Credits
Period: Autumn semester, quartertime whole semester.
Pre-Requisits: Stationary stochastic processes, Times series analysis.
LTH-programmes: none.
Description: The graduate course in Advanced Time Series Analysis has its target audience amongst students with technical or natural science background and with adequate basic knowledge in mathematical statistics. The primary goal to give a thorough knowledge on modeling dynamic systems. A special attention is paid to non-linear and non-stationary systems, and the use of stochastic differential equations for modeling physical systems. The course is given in cooperation with DTU (Danish technical university, Lyngby)

MASM14: Mathematical Foundations of Probability, 7.5 ECTS Credits
Period: Autumn semester, halftime 2nd half.
Pre-requisites: 60 ECTS credits in mathematics. Knowledge of probability theory at the level of MASC01 is desirable.
LTH-programmes: none.
Description: The course extends and deepens basic knowledge in Probability Theory. Central topics are existence and uniqueness of measures defined on sigma fields, integration theory, Radon-Nikodyn derivatives and conditional expectation, weak convergence of probability measures on metric spaces.

FMS155/MASM15: Statistical Modelling of Extreme Values, 7.5 ECTS Credits
Period: Spring semester, halftime 2nd half,
Pre-requisites: A basic course in mathematical statistics.
LTH strict req.: A basic course in Mathematical statistics (FMS012, 032, 035, 086, 140).
LTH-programmes: D, F, I, Pi.
Description: Extreme value theory concerns mathematical modelling of extreme events. Recent developments have introduced very flexible and theoretically well-motivated semi-parametric models for extreme values which are now at the stage where they can be used to address important technological
problems on handling risks in areas such as large insurance claims or large fluctuations in financial data (volatility), climatic changes, wind engineering, hydrology, flood monitoring and prediction and structural reliability. In many applications of extreme value theory, predictive inference for unobserved events in the main interest. One wishes to make inference about events over a time period much longer than for which data is available. Statistical modelling of extreme events has been the subject of much practical and theoretical work in the last few years. The course will give an overview of a number of different topics in modern extreme value theory including the following: (i) statistical methods for extreme event, (ii) some examples of applications of the theory in large insurance claims due to wind storms, flood monitoring and pit corrosion, (ii) exercises on detailed step-by-step use of extreme value modelling, and (iv) discussion of some open problems in the field.

FMS051/MASTM17: Time series analysis, 7.5 ECTS Credits
Period: Autumn semester, halftime 2nd half,
Pre-requisites: A course in stationary stochastic processes.
LTH strict req.: Basic course in Mathematical Statistics (FMS012, 032, 035, 086, 140).
LTH-programmes: BME, C, D, E, F, I, Pi.
Description: Stationary and nonstationary processes, ARIMA processes, seasonal variation, prediction, filtering and reconstruction in transfer function models and state space models, parameter and structure estimation by least squares, maximum likelihood and predictive error methods, spectral analysis, recursive estimation, adaptive techniques, robustness and outlier detection, multivariate time series, spectral density estimation.

FMS161/MASTM18: Financial statistics, 7.5 ECTS Credits
Period: Autumn semester, halftime 2nd half.
Pre-requisites: A course in Stationary stochastic processes and Time series analysis.
LTH strict req.: FMSF10 Stationary stochastic processes.
LTH-programmes: F, I, Pi.
Description: Modelling and estimation in nonlinear dynamical stochastic models for financial systems, models in in continuous and discrete time, GARCH-models, stochastic differential equations, prediction, optimization, risk evaluation, maximum likelihood and moment methods for parameter estimation, kernel based estimation methods, nonlinear filters for filtering and prediction, bootstrap methods

FMSN30/MASTM22: Linear and Logistic Regression, 7.5 ECTS Credits
Period: Spring semester, halftime 2nd half.
Pre-requisites: A basic course in mathematical statistics.
LTH strict req.: A basic course in Mathematical Statistics (FMS012, 032, 035, 086, 140).
LTH programmes: BME, D, F, I, L, M, Pi.
Description: Least squares and maximum-likelihood-method; odds ratios; Multiple linear regression and logistic regression; Matrix formulation; Methods for model validation, residuals, outliers, influential observations, multi co-linearity, change of variables; Choice of regressors, F-test, likelihood-ratio-test; Confidence intervals and prediction. Introduction to: Poisson and Binomial regression.
**FMSN40: Linear and Logistic Regression with Data Gathering, 9 ECTS Credits**

**Period:** Spring semester, halftime 2nd half.

**Pre-requisites:** A basic course in mathematical statistics.

**LTH strict req.:** A basic course in Mathematical Statistics (FMS012, 032, 035, 086, 140).

**LTH programmes:** 1.


**Description:** Least squares and maximum-likelihood-method; odds ratios; Multiple linear regression and logistic regression; Matrix formulation; Methods for model validation, residuals, outliers, influential observations, multi co-linearity, change of variables; Choice of regressors, F-test, likelihood-ratio-test; Confidence intervals and prediction. Introduction to: Poisson and Binomial regression. As part of the course you should construct a questionnaire or experimental plan for a problem of your choice, collect the data and analyse it using an suitable regression model.

**FMSN15/MASM23: Statistical Modelling of Multivariate Extreme Values, 7.5 ECTS Credits**

**Period:** Autumn term, halftime 2nd half.

**Pre-requisites:** Statistical Modelling of Extreme Values

**LTH strict req.:** FMS155 Statistical Modelling of Extreme Values

**LTH programmes:** F, I, Pi.


**Description:** Weak convergence for normalized extreme values of stochastic vectors, different characterisations of multivariate extreme value distributions, peaks over threshold-model in the multivariate case, different definitions of multivariate generalized Pareto distributions, statistical inference for multivariate extreme values, parametric and semi-parametric methods for multivariate extreme values, use of copula in modelling extreme values, point process characterisation of extreme values, prediction of extreme values, examples of applications of the theory, e.g., estimation of operational risk, climate changes and wind insurances.

**FMSN25/MASM24: Valuation of Derivative Assets, 7.5 ECTS Credits**

**Period:** Autumn term, halftime 1st half.

**Pre-requisites:** A course in stochastic processes

**LTH strict req.:** FMSF10 Stationary stochastic processes or FMSF15 Markov processes

**LTH programmes:** F, I, Pi.


**Description:** The course consists of two related parts. In the first part we will look at option theory in discrete time. The purpose is to quickly introduce fundamental concepts of financial markets such as free of arbitrage and completeness as well as martingales and martingale measures. We will use tree structures to model time dynamics of stock prices and information flows. In the second part we will study alternative models formulated in continuous time. The models we focus on are formulated as stochastic differential equations (SDE:s). Most of the second part is devoted to the probability theory required to understand the SDE models. We go through the underlying theory of Brownian motion, stochastic integrals, Itô’s formula, measure changes and numeraire. We here also apply the theory on valuation of derivatives both for the stock and interest rate market. We derive e.g. the Black-Scholes formula and how replicating portfolios for options are created.
FMSN20/MASM25: Spatial statistics with image analysis, 7.5 ECTS Credits  
**Period:** Autumn semester, halftime 1st half.  
**Pre-requisites:** One of the courses Markov processes (FMSF15/MASC03), Stationary Stochastic Processes (FMSF10/MASC04), Image analysis (FMA170) or equivalent.  
**LTH strict req.:** Either FMSF10 Stationary stochastic processes or FMSF15 Markov processes.  
**LTH programmes:** BME, C, D, E, F, Pi.  
**Literature:** Lindgren F: Image modelling and estimation – A statistical approach, Lund 2002.  
**Description:** Bayesian methods for stochastic modelling, classification and reconstruction. Random fields, Gaussian random fields, Kriging, Markov fields, Gaussian Markov random fields, non-Gaussian observationer. Covariance functions, multivariate techniques. Simulation methods for stochastic inference (MCMC, etc.). Applications in climate, environmental statistics, remote sensing, and spatial statistics.

FMSN35/MASM26: Stationary and Non-stationary Spectral Analysis, 7.5 ECTS Credits  
**Period:** Spring semester, halftime 1st half, NOT GIVEN SPRING 2015.  
**Pre-requisites:** Stationary stochastic processes, Time series analysis  
**LTH strict req.:** FMSF10 Stationary stochastic processes  
**LTH programmes:** C, D, E, F, I, Pi.  
**Literature:** Stoica & Moses, Spectral analysis of signals, Prentice-Hall, 2005.  
Contact Info

All our courses are described on the webpage:

In Swedish, both faculties:
http://www.ctr.maths.lu.se/utbildning/matematisk-statistik-alla-kurser/

In English, both faculties:
http://www.maths.lth.se/education/mathematical-statistics-courses-lth-and-nf/

If you have further questions you are welcome to contact the directors of studies:

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