June 2018

# Lectures and Seminars in Insurance Mathematics and related fields at ETH Zurich

## Autumn Semester 2018

### Life Insurance Mathematics, by Prof. Dr. Michael Koller, #401-3922-00L

The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that, the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

*Place:* Main Building of the ETH Zurich, Auditorium **HG E1.1**
*Time:* Friday, 16.15 to 18.00 h
*Start Date:* 21. September 2018

### Non-Life Insurance: Mathematics and Statistics, by Prof. Dr. Mario Wüthrich, #401-3925-00L

The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences.

The following topics are treated:
- Collective Risk Modeling
- Individual Claim Size Modeling
- Approximations for Compound Distributions
- Ruin Theory in Discrete Time
- Premium Calculation Principles
- Tariffication and Generalized Linear Models
- Bayesian Models and Credibility Theory
- Claims Reserving
- Solvency Considerations

*Script:*
M. V. Wüthrich, Non-Life Insurance: Mathematics & Statistics
http://ssrn.com/abstract=2319328

*Place:* Main Building of the ETH Zurich
*Time:* Monday, 16.15 to 18.00 h, Lecture at Auditorium **HG D7.1**
Tuesday, 13.15 to 15.00 h, Lecture at Auditorium **HG D7.1**
Tuesday, 15.15 to 16.00 h, Exercise session at Auditorium **HG D7.1**
*Start Date:* 18. September 2018

### Financial Risk Management in Social and Pension Insurance, by Dr. Peter Blum, #401-3929-00L

For pension insurance and other forms of social insurance, investment returns are an important source of funding. In order to earn these returns, substantial financial risks must be taken, and these risks represent an important threat to financial stability, in the long term and in the short term.

Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

*Place:* Main Building of the ETH Zurich, Auditorium **HG D7.2**
*Time:* Wednesday, 16:15 to 18:00 h
*Start Date:* 19. September 2018

## Reinsurance Analytics, by Dr. Peter Antal and Dr. Philipp Arbenz, #401-3928-00L

The aim of this course is understanding the following aspects:

- History of reinsurance.
- Role of reinsurance in society and history of catastrophic events.
- Forms of reinsurance (proportional and nonproportional).
- Covered types of business (property, casualty, specialties, life, health).
- Modelling of reinsurance losses through frequency severity models (typical distributions and parameters).
- Rating/Pricing of reinsurance contracts (experience and exposure).
- Modelling of natural catastrophes (methodological approaches and techniques).
- Natural catastrophes in Switzerland (importance, insurance, reinsurance).
- Reinsurance markets and companies.
- Risk profile implications of reinsurance (catastrophe risk, reserving risk, credit risk, basis risk, etc).
- Solvency implications of reinsurance (primary insurance and reinsurance side).
- Solvency 2 modelling (standard models, internal models, FINMA StandRe).
- Alternatives to reinsurance (insurance linked securities, subordinate debt).
- Trigger types of cat bonds (indemnity, modeled loss, industry loss, parametric).

*Place:* Main Building of the ETH Zurich, Auditorium **HG E1.1**
*Time:* Tuesday, 16.15 to 18.00 h
*Start Date:* 18. September 2018

## Mathematical Modelling in Life Insurance, by Dr. Tobias Peter, #401-3927-00L

The course's objective is to provide the students with the understanding and the tools to create mortality tables on their own.

Following main topics are covered:
1. Overview on guarantees & options in life insurance with a real-world example demonstrating their risk
2. Mortality tables
   - Determining raw mortality rates
   - Smoothing of raw mortality rates
   - Trends in mortality rates
   - Lee-Carter model
   - Integration of safety margins
3. Primer on Financial Mathematics
   - Ito integral
   - Black-Scholes and Hull-White model
4. Valuation of Unit linked contracts with embedded options
5. Valuation of Participating contracts

*Place:* Main Building of the ETH Zurich, Auditorium **HG E1.1**
*Time:* Thursday, 16.15 to 18.00 h
*Start Date:* 20. September, 2018

## Mathematical Foundations for Finance, by Prof. Dr. Walter Farkas and Prof. Dr. Martin Schweizer, #401-3913-01L

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It mainly aims at non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. However, mathematicians who want to learn some basic modelling ideas and concepts for quantitative finance (before continuing with a more advanced course) may also find this of interest. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Topics to be covered include:
- financial market models in finite discrete
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula

*Place:* Main Building of the ETH Zurich
*Time:* Monday, 13.15 to 14.00 h, Lecture at Auditorium **HG D1.1**
Tuesday, 12.15 to 14.00 h, Lecture at Auditorium **HG D1.1**
Friday, 08.15 to 10.00 h, Exercise session at Auditorium **HG D7.1**
*Start Date:* 18. September 2018

## Principles of Macroeconomics, by Prof. Dr. Jan-Egbert Sturm, #363-0565-00L

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation

while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

The course webpage https://moodle-app2.let.ethz.ch/course/view.php?id=4599 contains announcements, course information and lecture slides.

*Literature:*
The set-up of the course will closely follow the book of
N. Gregory Mankiw and Mark P. Taylor (2017), Economics, 4th Edition, Cengage Learning EMEA.

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN 978-1-473762008).

*Place:* Main Building of the ETH Zurich, Auditorium **HG E5**
*Time:* Tuesday, 15:15 to 17:00 h
*Start Date:* 18. September 2018

## Applied Analysis of Variance and Experimental Design, by Dr. Lukas Meier, #401-0625-00L

Principles of experimental design, one-way analysis of variance, contrasts and multiple comparisons, multi-factor designs and analysis of variance, complete block designs, Latin square designs, random effects and mixed effects models, split-plot designs, incomplete block designs, two-series factorials and fractional designs, power.

*Literature:*
G. Oehlert: A First Course in Design and Analysis of Experiments, W.H. Freeman and Company, New York, 2000.

*Place:* Main Building of the ETH Zurich
*Time:* Monday, 13:15 to 15:00 h, Lecture at Auditorium **HG G5**
Monday, 15:15 to 17:00 h, Exercise session at Auditorium **HG E1.1**
*Start Date:* 24. September 2018

## Applied Statistical Regression, by Dr. Marcel Dettling, #401-0649-00L

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies. The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression

for binary response variables, binomial regression for grouped data and poisson regression for count data.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

*Literature:*
[1] Faraway (2005): Linear Models with R.
[2] Faraway (2006): Extending the Linear Model with R.
[3] Draper & Smith (1998): Applied Regression Analysis.
[4] Fox (2008): Applied Regression Analysis and GLMs.
[5] Montgomery et al. (2006): Introduction to Linear Regression Analysis.

*Place:* Main Building of the ETH Zurich
*Time:* Monday, 08:15 to 10:00 h, Lecture at Auditorium **HG E1.2**
Monday, 10:15 to 12:00 h, Exercise session at Auditorium **HG E1.2**
*Start Date:* Monday, 24. September 2018

## Stochastic Simulation, by Dr. Fabio Sigrist, #401-3612-00L

This course provides an introduction to statistical Monte Carlo methods. Stochastic simulation (also called Monte Carlo method) is the experimental analysis of a stochastic model by implementing it on a computer. Probabilities and expected values can be approximated by averaging simulated values, and the central limit theorem gives an estimate of the error of this approximation. The course shows examples of the many applications of stochastic simulation and explains different algorithms used for simulation. These algorithms are illustrated with the statistical software R.

- Applications of simulations in various fields (Bayesian statistics, statistical mechanics, operations research, financial mathematics)
- Algorithms for the generation of uniform random variables and random variables with arbitrary distributions (quantile transform, accept-reject, importance sampling)
- The precision of simulations
- Simulation of Gaussian processes and diffusions
- Methods for variance reduction
- Introduction to Markov chain Monte Carlo (Metropolis-Hastings, Gibbs sampler, Hamiltonian Monte Carlo, reversible jump MCMC).

The algorithms introduced in the course are illustrated with the statistical software R.

*Script:* A script will be available in English.

*Literature:*
[1] P. Glasserman, Monte Carlo Methods in Financial Engineering. Springer 2004.
[2] B. D. Ripley. Stochastic Simulation. Wiley, 1987.
[3] Ch. Robert, G. Casella. Monte Carlo Statistical Methods. Springer 2004 (2nd edition).

*Place:* ETH Zurich, Auditorium **ML F 36**
*Time:* Tuesday, 14:15 to 17:00 h
*Start Date:* 18. September 2018

## Convex Optimization in Machine Learning and Computational Finance, by Prof. Dr. Patrick Cherditio and Dr. Michel Baes, #401-3905-68L

**Part 1: Convex Analysis**
Lecture 1: General introduction, convex sets and functions
Lecture 2: Semidefinite cone, Separation theorems (Application to the Fundamental Theorem of Asset Pricing)
Lecture 3: Analytic properties of convex functions, duality (Application to Support Vector

Machines)
Lecture 4: Lagrangian duality, conjugate functions, support functions
Lecture 5: Subgradients and subgradient calculus (Application to Automatic Differentiation and Lexicographic Differentiation)
Lecture 6: Karush-Kuhn-Tucker Conditions (Application to Markowitz portfolio optimization)

**Part 2: Applications**
Lecture 7: Approximation, Lasso optimization, Covariance matrix estimation (Application: a politically optimal splitting of Switzerland)
Lecture 8: Clustering and MaxCut problems, Optimal coalitions and Shapley Value

**Part 3: Algorithms**
Lecture 9: Intractability of Optimization, Gradient Method for convex optimization, Stochastic Gradient Method (Application to Neural Networks)
Lecture 10: Fundamental flaws of Gradient Methods, Mirror Descent Method (Application to Multiplicative Weight Method and Adaboost)
Lecture 11: Accelerated Gradient Method, Smoothing Technique (Application to large-scale Lasso optimization)
Lecture 12: Newton Method and its fundamental drawbacks, Self-Concordant Functions
Lecture 13: Interior-Point Methods

*Place:* Main Building of the ETH Zurich, Auditorium **HG D 7.2**
*Time:* Thursday, 14:15 to 16.00 h
*Start Date:* 20. September 2018

**Trends in Stochastic Portfolio Theory, by Prof. Dr. Martin Larsson, #401-4912-11L**

This course presents an introduction to Stochastic Portfolio Theory, which provides a mathematical framework for studying and exploiting empirically observed regularities of large equity markets. A central goal of the theory is to describe certain forms of arbitrage that arise over sufficiently long time horizons. Since it was first introduced by Robert Fernholz almost 20 years ago, the theory has experienced rapid developments. This course will cover the foundations of Stochastic Portfolio Theory, including topics like relative arbitrage, functional portfolio generation, and capital distribution curves, as well as more recent developments.

*Place:* ETH Zurich, Auditorium **LFW C1**
*Time:* Tuesday, 10:15 to 12.00 h
*Start Date:* 18. September 2018

**Talks in Financial and Insurance Mathematics, by Proff. P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich, #401-5910-00L**

Research Seminar in Financial and Insurance Mathematics.

For the program see http://www.math.ethz.ch/Finance/CoursesTalks/Talks

*Place:* Main Building of the ETH Zurich, Auditorium **HG G43**
*Time:* Thursday, 17.15 to 18.00 h
*Start Date:* Thursday, 20. September 2018

**Additional Lectures at the University of Zurich:**

## Microeconomics of Insurance, by Prof. Dr. Pablo Koch Medina, #2937

This lecture focuses on understanding insurance markets from a microeconomic perspective. Some of the topics covered are: the demand for insurance, the supply of insurance, adverse selection and moral hazard.

*Place:* University of Zurich
*Time:* Tuesday, 08:00 to 09:45 h
*Start Date:* Tuesday, 18. September 2018

## The Economy of Risk in Insurance, by Dr. Michel Dacorogna, #3840

The purpose of the course is to familiarize the student with the modern concepts of insurance in view of their application to pricing, capital management and solvency regulation. Most of those concepts are in line with the financial theory and apply to both P&C and life insurance.

The course is taught in five modules:
1. In a first part, we present the concept of risk and risk measure and the pricing of risk in insurance.
2. Aggregation of risk and dependencies
3. Concept of capital and management of capital
4. Adding time diversification to risk diversification
5. Entreprise risk management towards a holistic approach to risk management.

*Place:* University of Zurich
*Time:* Monday, 08:00 to 09:45 h
*Start Date:* Monday, 17. September 2018

## Introduction to Mathematical Finance, by Dr. Emma Hovhannisyan, #2295

These lectures give an introduction to the most simple mathematical models which are used to describe the evolution of financial markets. These kinds of descriptions have many practical applications. In particular, they are involved in a fundamental way when one needs to give a fair price to options or derivatives. The main part of this course is focused on discrete models, under which the prices of the different assets are supposed to change only at a finite number of times. These models have the advantage that one can study them without dealing too much with technicalities. In the last part of the course, we give an introduction to the most classical (continuous) model, i.e. the Black-Scholes model, which involves a particular random process, called Brownian motion, that is one of the most fundamental objects in probability theory.

*Literature*:
[1] "Introduction to the Mathematics of Finance" by R.J. Williams
[2] "PDE and Martingale Methods in Option Pricing" by Andrea Pascucci

*Place:* University of Zurich, Irchel Campus, Institut für Mathematik
*Time:* Wednesday, 14:00 to 15:45 h
*Start Date:* Wednesday, 19. September 2018

**Addresses of the Lecturers**


Dr. Peter Antal
PartnerRe
peter.antal@math.ethz.ch

Dr. Philipp Arbenz
SCOR
philipp.arbenz@math.ethz.ch

Dr. Michel Baes
D-MATH, ETH Zurich
michel.baes@math.uzh.ch

Dr. Peter Blum
SUVA
peter.blum@math.ethz.ch

Prof. Dr. Patrick Cheridito
D-MATH, ETH Zurich
patrick.cheridito@math.ethz.ch

Dr. Michel Dacorogna
Department of Banking and Finance UZH
michel.dacorogna@uzh.ch

Dr. Marcel Dettling
School of Engineering ZHAW
marcel.dettling@math.ethz.ch

Prof. Dr. Erich Walter Farkas
Department of Banking and Finance UZH
farkas@math.ethz.ch

Dr. Emma Hovhannisyan
Institute of Mathematics UZH
emma.hovhannisyan@math.uzh.ch

Prof. Dr. Pablo Koch Medina
Department of Banking and Finance UZH
pablo.koch@bf.uzh.ch

Prof. Dr. Michael Koller
Prudential plc
michael.koller@math.ethz.ch

Dr. Lukas Meier
D-MATH, ETH Zurich
lukas.meier@stat.math.ethz.ch

Prof. Dr. Martin Larsson
D-MATH, ETH Zurich
martin.larsson@math.ethz.ch

Dr. Tobias Peter
AXA Winterthur
tobias.peter@math.ethz.ch

Prof. Dr. Martin Schweizer
D-MATH, ETH Zürich
martin.schweizer@math.ethz.ch

Dr. Fabio Sigrist
Lucerne School of Business
fabio.sigrist@math.ethz.ch

Prof. Dr. Mete Soner
D-MATH, ETH Zürich
mete.soner@math.ethz.ch

Prof. Dr. Jan-Egbert Sturm
D-MTEC, KOF, ETH Zürich
sturm@kof.ethz.ch

Prof. Dr. Josef Teichmann
D-MATH, ETH Zürich
josef.teichmann@math.ethz.ch

Prof. Dr. Mario Wüthrich
D-MATH, ETH Zürich
mario.wuethrich@math.ethz.ch