## ST 2109: Risk Theory and Management

**Course aim**

To introduce the mathematical aspects of risk theory and quantitative risk management. Specifically, to discuss basic concepts like the loss distribution, risk measurement, risk measures based on the loss distribution, e.g., value at risk or expected shortfall, as well as standard methods to compute market risk. Further to give a basic introduction of extreme value theory and copulas and discuss applications of those in risk theory and insurance analytics.

**Course expected learning outcome(s)**

After the successful completion of this course the students will be able to deal will quantitatively risk models. They will be familiar with the mostly used models, their applicability, as well as their advantages and disadvantages in different situations.

Course status: Core

Credit rating: 9 credits

Total hours spent: 90 hours

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| Activity | Lectures | Tutorials | Assignments | Self Study | Practicals | Total |
| Hour/Semester | 30 | 15 | 15 | 15 | 15 | 90 |

**Course Content**

**Utility theory and insurance**: Introduction, the expected utility model, Classes of utility functions, **Stop-loss reinsurance**

**The individual risk model**: Introduction, Mixed distributions and risks, Convolution, Transforms, Approximations (Normal approximation, Translated gamma approximation, NP approximation). Application: optimal reinsurance.

**Collective risk models**: Compound distributions Convolution formula for a compound cdf, Distributions for the number of claims, Properties of compound Poisson distributions, Panjer’s recursion. Compound distributions and the Fast Fourier Transform, Approximations for compound distributions.

Individual and collective risk model, Loss distributions: properties, estimation, sampling. Techniques to generate pseudo-random samples, Techniques to compute ML-estimates. Poisson claim number distribution, Negative binomial claim number distribution. Gamma claim severity distributions, Inverse Gaussian claim severity distributions. Mixtures/combinations of exponential distributions, Lognormal claim, Pareto claim severities. Stop-loss insurance and approximations. Comparing stop-loss premiums in case of unequal variances.

**Ruin theory**: Introduction, The classical ruin process, Some simple results on ruin probabilities, Ruin probability and capital at ruin, Discrete time model. Reinsurance and ruin probabilities, Beekman’s convolution formula, Explicit expressions for ruin probabilities. Approximation of ruin probabilities.

**Premium principles and Risk measures**: Introduction, Premium calculation from top-down, Various premium principles and their properties. Properties of premium principles, Characterizations of premium principles, Premium reduction by coinsurance. Value-at-Risk and related risk measures.

**Teaching and learning activities**

Lectures, tutorials and practical

**Assessment Methods**

* Coursework: 40% (Two tests each consists of 15% and one assignment/presentation (5%) / at least two quizzes each of 2.5%).
* End of semester examination: 60%

**Reading list**

1.Embrechts et al (2002), **Correlation and dependence in risk management: properties and pitfalls,** Cambridge University Press, Cambridge.

2.A. McNeil, R. Frey, and P. Embrechts (2015), **Quantitative risk management**: second revised ed., Princeton Series in Finance, Princeton University Press, Princeton, NJ.

3.Albrecher, H., and Teugels, J. (2006), **Exponential behavior in the presence of dependence in risk theory**. Journal of Applied Probability.

4.Asmussen, S., and Albrecher, H. (2010), **Ruin proabilities**. Advanced series on Statistical Science and Applied Probability.

5.Cossette, H., Marceau, E., and Marri, F.(2010), **Analysis of ruin measures for the**

**classical compound Poisson risk model with dependence**. Scandinavian Actuarial Journal

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