Module Name
Probability Theory, Stochastic Processes and Network Science

Type of Module	**Module Code**
Advanced Module	AM-PTSPN

Identification Number	**Workload**	**Credit Points**	**Term**	**Offered Every**	**Start**	**Duration**
MN-CS-PTSPN	270 h	9 CP	1. – 3. Semester	variable	both	2 Semester

1	**Course Types**	**Contact Time**	**Private Study**	**Planned Group Size**
	a) Lectures	30 h + 30 h	45 h + 45 h	30 Students
	b) Exercises	15 h + 15 h	45 h + 45 h	

2 Module Objectives and Skills to be Acquired

The Module consists of two courses offered by the Department of Physics.

Probability Theory and Stochastic processes:

Acquaintance with probabilistic concepts and stochastic methods commonly used in the theory of disordered systems and nonequilibrium phenomena, as well as in interdisciplinary applications of statistical physics.

Network Science:

Acquaintance of mathematical and computational methods for networks analysis. Ability to model real-world systems from different areas of science and technology and to apply the mathematical methods. Understanding of how the structure of a network determines its function and stability.

3 Module Content

Probability Theory and Stochastic processes:

- Limit laws and extremal statistics
- Point processes
- Markov chains and birth-death processes
- Stochastic differential equations and path integrals
- Large deviations and rare events

Network Science:

- Mathematical description of networks. Basic tools from graph theory
- Structure of real-world networks: Small-world effect, scale-free networks
- Percolation and network resilience
- Diffusion and Spreading on networks. Applications to epidemiology
- Physics of supply networks, esp. power grids

4 Teaching Methods

Lectures and Exercises

5	**Prerequisites (for the Module)** Formal: None Regarding the Contents: Statistical Mechanics on the bachelor level
6	**Type of Examination** Both courses finish with an examination that is either an oral exam or a term paper
7	**Credits Awarded** The module is passed and credit points are awarded if both examinations are passed.
8	**Compatibility with other Curricula** The course is part of the Master of Science Physics
9	**Proportion of Final Grade** 9/114
10	**Module Coordinator** D. Witthaut, J. Krug, M. Lässig
11	**Further Information** Probability Theory and Stochastic processes: D. Sornette: Critical Phenomena in Natural Sciences (Springer, 2004) N.G.Van Kampen: Stochastic Processes in Physics and Chemistry (Elsevier, 1992) Network Science: M.E.J. Newman, Networks - An Introduction (Oxford University Press 2010)