Module Name **Advanced Statistical Physics**

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

Identification Number	**Workload**	**Credit Points**	**Term**	**Offered Every**	**Start**	**Duration**
MN-P-PN-StatPhysII	270 Hours	9 CP	1. – 3. Semester	WiSe	Winter Term Only	1 Semester

1	**Course Types**	**Contact Time**	**Private Study**	**Planned Group Size**
	a) Lecture	56 h	84 h	15 – 20 Students per problem class
	b) Problem Class	28 h	84 h	
	c) Preparation for exam	--	18 h	

2 Module Objectives and Skills to be Acquired

This course introduces a wide range of concepts used to describe many-particle systems: Stochastic dynamics in and out of equilibrium, exact solutions of lattice models, mean-field theory, the renormalization group, and disordered systems. In particular, the renormalization group provides a unifying language across a wide range of theoretical physics: from quantum field theory and particle physics to statistical physics and condensed matter. Stochastic dynamics is a key concept to describe systems out of equilibrium, for instance transport and traffic phenomena, the dynamics of biomolecules, neural systems, or biological evolution.

3 Module Content

1. Macroscopic and microscopic degrees of freedom
    - conservation laws
    - fast and slow variables
    - elementary continuum mechanics and hydrodynamics
2. Phase transitions and critical phenomena
    - Universality
    - Landau theory
    - relevance of fluctuations
    - field-theoretic approach
3. Scaling and renormalization
4. Dynamics
    - Correlation- and response functions
    - Langevin- and Fokker-Planck equations
    - the Wiener integral
    - nonequilibrium stationary states
5. Disordered systems and glasses

4 Teaching Methods

The module consists of a lecture course, supplemented by a problem class.

5	**Prerequisites (for the Module)** Formally: none Regarding the Contents: Classical theoretical physics; elementary thermodynamics and statistical physics.
6	**Type of Examination** The module is passed by passing a written exam, which is held during the semester and is offered again at the beginning of the following semester. To be accepted for the written exam, students must actively participate in the problem class, solve the homework problems and register for the exam.
7	**Credits Awarded** The module is passed by passing a written exam. The grade given for the module is equal to the grade of the written exam.
8	**Compatibility with other Curricula** As elective subject in other M.Sc. programs
9	**Proportion of Final Grade** 9/114
10	**Module Coordinator** J. Krug, J. Berg
11	**Further Information** Literature: Plischke and Bergersen, Equilibrium statistical physics (World Scientific) Goldenfeld, Lectures on phase transitions and the renormalization group (Westview Press) Chaikin and Lubensky, Principles of condensed matter physics (Cambridge University Press)