**Module title**  
Physics of Complex Systems  

**Abbreviation**  
11-PKS-161-m01  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Module coordinator</strong></td>
<td>Managing Director of the Institute of Theoretical Physics and Astrophysics</td>
</tr>
<tr>
<td><strong>Module offered by</strong></td>
<td>Faculty of Physics and Astronomy</td>
</tr>
<tr>
<td><strong>ECTS</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Method of grading</strong></td>
<td>Only after succ. compl. of module(s)</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1 semester</td>
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<tr>
<td><strong>Module level</strong></td>
<td>graduate</td>
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<tr>
<td><strong>Other prerequisites</strong></td>
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**Contents**

1. Theory of critical phenomena in thermal equilibrium
2. Introduction into the physics out of equilibrium
3. Entropy production and fluctuation
4. Phase transitions away from equilibrium
5. Universality
6. Spin glasses
7. Theory of neural networks

**Intended learning outcomes**

The students acquire in-depth knowledge of a wide variety of concepts and methods essential for a thorough understanding of cooperative phenomena in complex many-particle systems. The main focus includes a thorough understanding of the concepts of entropy, entropy production and universality. The students are prepared for research activities in different areas of physics of complex systems.

**Courses**  
(type, number of weekly contact hours, language — if other than German)

V (2) + R (2)  
Module taught in: German or English

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes)  
- oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).

If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

- Master's degree (1 major) Mathematics (2016)
- Master’s degree (1 major) Physics (2016)
- Master's degree (1 major) Mathematical Physics (2016)
- Master's degree (1 major) Computational Mathematics (2016)
- Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)
<table>
<thead>
<tr>
<th>Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)</th>
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<tbody>
<tr>
<td>Master’s degree (1 major) Computational Mathematics (2019)</td>
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<tr>
<td>Master’s degree (1 major) Mathematics (2019)</td>
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<tr>
<td>Master’s degree (1 major) Physics (2020)</td>
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