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| Course unit English denomination | Renormalization group techniques for equilibrium and nonequilibrium statistical mechanics |
| SS | PHYS-04/A |
| Teacher in charge | Amos Maritan |
| Teaching Hours | 24 |
| Number of ECTS credits allocated | 3 |
| Course period | March - June 2026 |
| Course delivery method | ☒ In presence<br>☐ Remotely<br>☐ Blended |
| Language of instruction | English |
| Mandatory attendance | ☒ Yes (50% minimum of presence)<br>☐ No |
| Course unit contents | This course delves into the theoretical and practical aspects of the Renormalization Group (RG), highlighting its pivotal role in understanding emergent phenomena at large spatiotemporal scales. The main topics covered include:<br>- Motivations and fundamental concepts of RG:<br>Emergent phenomena at large scales and the need for scaling laws to describe both infinite and finite systems.<br>The theoretical framework underpinning RG, with particular emphasis on the Kadanoff-Wilson approach.<br>- RG in equilibrium statistical mechanics:<br>Applications to the Ising model and field theories, focusing on phase transitions and correlation functions.<br>- RG in non-equilibrium statistical mechanics:<br>Analysis of dynamic phenomena via the Langevin equation and interface growth equations. |
| Learning goals | By the end of the course, participants will be able to:<br>1. **Identify the key ingredients** underlying emergent phenomena at large spatiotemporal scales.<br>2. **Construct minimal models** that incorporate these key ingredients.<br>Apply RG techniques in both real space and momentum space to analyze |

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| | complex physical problems |
| Teaching methods | Lectures |
| Course on transversal, interdisciplinary, transdisciplinary skills | ☒ Yes<br>☐ No |
| Available for PhD students from other courses | ☒ Yes<br>☐ No |
| Prerequisites (not mandatory) | |
| Examination methods (if applicable) | Oral exam and project |
| Suggested readings | P. Kopietz, L. Bartosch, and F.Schütz. *Introduction to the functional renormalization group*. Vol. 798. Springer Science & Business Media, 2010.<br>U. C. Täuber, *Critical Dynamics: A Field Theory Approach to Equilibrium and Non-Equilibrium Scaling Behavior*, Cambridge University Press, Cambridge.<br><br>Course notes and various scientific papers |
| Additional information | |

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