

## General Information

<b>Course name</b>	Introduction to exactly solvable models in statistical physics	<b>ECTS Credits</b>	5
		<b>Semester</b>	S

## Aims

To solve exactly the simplest lattice-statistical models, which bring insight into phase transitions, critical and cooperative phenomena.

## Content

The scaling hypothesis and hypothesis of universality. Exact solutions for the one-dimensional Ising model in a zero and non-zero external magnetic field: combinatorial approach and transfer-matrix method. A spontaneous dimerization as a consequence of the magneto-elastic interaction, spin-Peierls instability. Magnetic hysteresis of the Ising spin chain with the magneto-elastic coupling. Accounting for the further-neighbour pair interactions between the distant spins, Dobson's method. The rigorous solution of the Ising model on Bethe lattices within the framework of exact recursion relations. (1.-4. week)

The exact solution for the one-dimensional classical Heisenberg model in a zero external magnetic field, the violation of the third law of thermodynamics. The helimagnetism as a consequence of the geometric frustration of the classical Heisenberg chain with the next-nearest-neighbour interaction. The exact solution for the geometrically frustrated quantum Heisenberg model: valence-bond crystals and the singlet-singlet correlation function as the relevant order parameter. (5.-9. week)

The „six-vertex“ model as the model of ice, KDP-type ferroelectrics and antiferroelectrics. The non-zero residual entropy of the ice and the first-order phase transitions. The „eight-vertex“ model and Suzuki's weak-universality hypothesis. Continuously varying critical exponents of the exactly solved models with the weak-universal critical behaviour. The „eight-vertex“ model as the Ising model with the pair and quartic interactions. (10.-12. week)

## Assessment Methods and Criteria

Exam and/or project.

**Grading Scale (in %):**

- A: 91% - 100%
- B: 81% - 90%
- C: 71% - 80%
- D: 61% - 70%
- E: 51% - 60%
- F: 0% - 50%

**Grading System:**

The University recognises the following six degrees for the evaluation of the study results:

- a) A – excellent (excellent results) (numerical value 1)
- b) B – very good (above average results) (1.5)
- c) C – good (average results) (2)
- d) D – satisfactory (acceptable results) (2.5)
- e) E – sufficient (results meet the minimum criteria) (3)
- f) FX – failed (requires further work) (4)

**Bibliography**

1. R. J. Baxter, Exactly Solved Models in Statistical Mechanics (Academic, New York, 1982).
2. F. Y. Wu, Exactly Solvable Models: A Journey in Statistical Mechanics (World Scientific, Singapore, 2008).
3. J. Strečka, Exactly Solvable Models in Statistical Physics, supportive textbook, (ESF 2005/NP1-051 11230100466, Košice, 2008).