



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	<b>Modeliranje v fiziki mehke snovi</b>
<b>Course title:</b>	<b>Modelling in soft matter physics</b>

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		1. ali 2.	1., 2. ali 4.
PHYSICS, 3 <sup>rd</sup> cycle		1. or 2.	1., 2. or 4.

**Vrsta predmeta / Course type**

Izbirni za vse module  
Optional for all modules

**Univerzitetna koda predmeta / University course code:**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15					165	6

**Nosilec predmeta / Lecturer:**

Samo Kralj

**Jeziki /**

**Languages:**

**Predavanja /**

**Lectures:**

**Vaje / Tutorial:**

slovenski/Slovenian

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Pogojev ni.

Priporočljiva znanja so: predznanje iz klasične in moderne fizike, trdne snovi in iz matematične fizike

**Prerequisites:**

None.

Recommended is preknowledge of classical and modern physics, solid state physics and mathematical methods in physics.

**Vsebina:**

**Content (Syllabus outline):**

- 1) Modeliranje: makroskopski, mezoskopski in semi-mikroskopski modeli
- 2) Tipične eksperimentalne meritve
- 3) Numerično modeliranje
- 4) Fizikalni pojavi: fazno obnašanje in kritični pojavi v sistemih z orientacijsko in translacijsko urejenostjo, neravnovesni pojavi, topološki defekti v mehki snovi, vpliv nereda na fazno in strukturno obnašanje
- 5) Aplikacije

- 1) Modelling: macroscopic, mesoscopic, semi-microscopic models
- 2) Typical experimental measurements
- 3) Numerical modelling
- 4) Physical phenomena: phase behaviour and critical phenomena in systems exhibiting orientational and translational ordering, non-equilibrium behaviour, topological defects in soft materials, impact of disorder on phase and structural ordering
- 5) Applications

### Temeljni literatura in viri / Readings:

- 1) M. Kleman, O.D. Lavrentovich, *Soft Matter Physics*, Springer-Verlag, New York, 2003.
- 2) P. M. Chaikin, T. C. Lubensky, *Principles of Condensed Matter Physics*, Cambridge University Press, Cambridge, England, 1995.
- 3) G. Baumann, *Mathematica for Theoretical Physicists*, Springer-Verlag, Heidelberg, 1993.
- 4) R.L. Zimmerman, F.I. Olness, *Mathematica for Physicists*, Addison Wesley, New York, 2002.
- 5) K.F. Riley, M.P. Hobson, S.J. Bence, *Mathematical Methods for Physics and Engineering*, 3<sup>rd</sup> edition, Cambridge University Press, Cambridge, 2006
- 6) A. Hobson, There are no particles, there are only fields, *Am. J. Phys.* **81** (3), 211-243 (2013).

### Cilji in kompetence:

Študenti pridobijo poglobljeno znanje s področja modeliranja v fiziki mehkih sistemov. Mehka snov se predstavi kot poligon fundamentalne fizike.

### Objectives and competences:

Students acquire advanced knowledge on modeling in physics of soft systems. Soft materials are presented as a testbed of fundamental physics.

### Predvideni študijski rezultati:

Znanje in razumevanje:  
Razumevanje procesov v mehkih snovi.

### Intended learning outcomes:

Knowledge and understanding:  
Understanding of processes in soft systems.

Prenesljive/ključne spretnosti in drugi atributi:

Rešitev problemov z matematičnimi orodji, numeričnimi metodami, univerzalnosti v fiziki in celosten pristop k reševanju problemov.

Transferable/Key Skills and other attributes:

Solving of problems with mathematical tools, numerical methods, universalities in physics and gained global approach on solving a problem.

**Metode poučevanja in učenja:**

Predavanja, seminar, reševanje odprtih problemov.

**Learning and teaching methods:**

Lectures, seminar, solving open problems.

**Načini ocenjevanja:**

Seminar.  
Ustni izpit.

Delež (v %) /

Weight (in %)

**Assessment:**

Seminar.  
Oral exam.

**Reference nosilca / Lecturer's references:**

1. MESAREC, Luka, KURIOZ, Pavlo, IGLIČ, Aleš, GÓŹDŹ, Wojciech, KRALJ, Samo. Curvature-controlled topological defects. *Crystals*, ISSN 2073-4352, 2017, vol. 7, no. 6, str. 1-11, ilustr. <http://www.mdpi.com/2073-4352/7/6/153>, doi: [10.3390/cryst7060153](https://doi.org/10.3390/cryst7060153). [COBISS.SI-ID [11753556](https://www.cobiss.si/id/11753556)]
2. HARKAI, Saša, AMBROŽIČ, Milan, KRALJ, Samo. Impact of diffusion limited aggregates of impurities on nematic ordering. *Physica. A, Statistical mechanics and its applications*, ISSN 0378-4371. [Print ed.], 2017, vol. 467, str. 249-256, doi: [10.1016/j.physa.2016.10.001](https://doi.org/10.1016/j.physa.2016.10.001). [COBISS.SI-ID [22772744](https://www.cobiss.si/id/22772744)]
3. KRALJ, Samo, MURRAY, Bryce S., ROSENBLATT, Charles. Decomposition of strongly charged topological defects. *Physical review. E*, ISSN 2470-0045, 2017, vol. 95, iss. 4, str. 042702-1-042702-9, doi: [10.1103/PhysRevE.95.042702](https://doi.org/10.1103/PhysRevE.95.042702). [COBISS.SI-ID [23098888](https://www.cobiss.si/id/23098888)]
4. MAKSIMOCHKIN, Gennady I., SHMELIOVA, Dina V., PASECHNIK, Sergey V., DUBTSOV, Alexander, SEMINA, O. A., KRALJ, Samo. Orientational fluctuations and phase transitions in 8CB confined by cylindrical pores of the PET film. *Phase transitions*, ISSN 0141-1594, 2016, vol. 89, no. 7/8, str. 846-855, doi: [10.1080/01411594.2016.1199802](https://doi.org/10.1080/01411594.2016.1199802). [COBISS.SI-ID [22500872](https://www.cobiss.si/id/22500872)]
5. MESAREC, Luka, GÓŹDŹ, Wojciech, IGLIČ, Aleš, KRALJ, Samo. Effective topological charge cancelation mechanism. *Scientific reports*, ISSN 2045-2322, 2016, vol. 6, art. no. 27117, str. 1-9, ilustr. <http://www.nature.com/articles/srep27117>, doi: [10.1038/srep27117](https://doi.org/10.1038/srep27117). [COBISS.SI-ID [22256136](https://www.cobiss.si/id/22256136)]
6. BUČEK, Slavko, KRALJ, Samo, SLUCKIN, T. J. Hysteresis in Two-Dimensional Liquid Crystal Models. *Advances in Condensed Matter Physics*, ISSN 1687-8124. [Spletna izd.], 2015, vol. 2015, str. 1-10. <http://www.hindawi.com/journals/acmp/2015/834867/>. [COBISS.SI-ID [11869235](https://www.cobiss.si/id/11869235)]