Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Trdna snov
Course title:	Solid state

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 1. st.		3	5
Physics 1st degree		3	5

Vrsta predmeta / Course type izbirni/ elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45		30			105	6

Nosilec predmeta / Lecturer: Samo Kralj

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian
	Vaje / Tutorial:	slovenski/Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Pogojev ni. Priporočljiva znanja so: predznanje iz klasične in moderne fizike.	None. Recommended is preknowledge of classical and modern physics.

Vsebina: **Content (Syllabus outline):**

• Osnove kristalografije, Bravaisova in recipročna mreža. • Mrežna nihanja: harmonski približek, specifična toplota trdnih teles, anharmonični pojavi (termično raztezanje, toplotna prevodnost). • Kolektivni pojavi: dielektrične lastnosti dielektrikov, paraelektriki, feroelektriki, antiferoelektriki, paramagnetizem, feromagnetizem.Landauova teorija faznih prehodov, metoda molekularnega polja.	• Basics of crystallography, Bravais lattices. • Lattice oscillations: harmonic approximation, specific heat of solids, anharmonic effects (thermal expansion, heat conductivity) • Collective phenomena: dielectric, paraelectric, ferroelectric, diamagnetic, paramagnetic, ferromagnetic behaviour.Landau theory of phase transitions, mean field approximation.

Temeljni literatura in viri / Readings:

1. N.W. Ashcroft, N.D. Mermin, Solid state physics, (Rinehart and Winston, New York, 1976 in kasnejše izdaje).
2. M. P. Marder, Condensed Matter Physics, John Wiley & Sons, New York 2000.
3. C. Kittel, A. Zettl, Introduction to Solid State Physics, John Wiley & Sons, New York 2004.
4. http://solidstate.physics.sunysb.edu/teach/intlearn/
5. http://www.ruph.cornell.edu/sss/sss.html
6. http://solidstate.physics.sunysb.edu/book/

Cilji in kompetence:	**Objectives and competences:**
Študenti usvojijo temeljna teoretična znanja s področja trdne snovi in jih znajo uporabiti pri reševanju ustreznih problemov z rabo matematičnih orodij.	Students acquire basic theoretical knowledge in solid state physics and are able to use the knowledge to solve problems with the use of mathematical tools.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po uspešno zaključeni učni enoti bodo študenti zmožni: - uporabiti osnovne enačbe v trdni snovi za demonstracijo osnovnih električnih in termodinamskih lastnosti sistemov; - opisati osnovne lastnosti kristalov; - napovedati kvalitativne lastnosti sistema v odvisnosti od simetrije sistema. **Prenesljive/ključne spretnosti in drugi atributi:** Razumevanje procesov v trdni snovi je osnova za razumevanje procesov v fiziki materialov (tehnična aplikacija), mehki snovi in biofiziki.	**Knowledge and Understanding:** On completion of this course students will be able to: - use basic equations of solids state physics to demonstrate basic electrical and thermodynamic properties of crystals; - describe basic properties of crystals; - description of qualitative behaviour of system as a function of symmetry. **Transferable/Key Skills and other attributes:** Understanding of processes in solid state is the basic knowledge necessary to understand processes in physics of materials (technical application), soft matter and biophysics.

Metode poučevanja in učenja:	**Learning and teaching methods:**

predavanja in eksperimentalna predavanja (teoretičen uvod v problematiko z razlago in razgovorom, numerično reševanje posameznih problemov, demonstracijski poskusi pri predavanjih) teoretične vaje (delo s tekstom, metoda pisnih in grafičnih del, uporaba simulacij) elementi obrnjenega poučevanja Poučevanje in učenje potekata z didaktično uporabo informacijsko-komunikacijske tehnologije	lectures and experimental lectures (theoretical introduction by explanation and discussion, numerical solving of specific problems, demonstration experiments during lectures) theoretical excercises (work with text, work with graphic elements, use of simulations) elements of flipped learning Teaching and learning are done through the didactic use of ICT.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit (lahko se nadomesti z dvema pisnima kolokvijema).. Ustni izpit. Za uspešno zaključeno učno enoto mora vsak del posebej biti pozitiven	50 50	Written exam (can be replaced by two written tests). Oral exam. For a successfully finished course, both oral and written exams have to be positive.

Reference nosilca / Lecturer's references:

1) AMBROŽIČ, Milan, KRALJ, Samo. Field percolation-switching in soft ternary anisotropic system. Physica. A, Statistical mechanics and its applications, 2019, vol. 520, str. 11-25, doi: 10.1016/j.physa.2018.12.044 [COBISS.SI-ID 24324104].
2) KLEMENČIČ, Eva, TRČEK, Maja, KUTNJAK, Zdravko, KRALJ, Samo. Giant electrocaloric response in smectic liquid crystals with direct smectic-isotropic transition. Scientific reports, 2019, vol. 9, art. no. 1721, str. 1721-1-1721-10, doi: 10.1038/s41598-019-38604-9 [COBISS.SI-ID 32102951].
3) KURIOZ, Pavlo, KRALJ, Marko, MURRAY, Bryce S., ROSENBLATT, Charles, KRALJ, Samo. Nematic topological defects positionally controlled by geometry and external fields. Beilstein journal of nanotechnology, 2018, vol. 9, str. 109-118, https://www.beilstein-journals.org/bjnano/content/pdf/2190-4286-9-13.pdf, doi: 10.3762/bjnano.9.13 [COBISS.SI-ID 23661832].
4) KRAŠNA, Marjan, KLEMENČIČ, Eva, KUTNJAK, Zdravko, KRALJ, Samo. Phase-changing materials for thermal stabilization and thermal transport. Energy, 2018, vol. 162, str. 554-563 [COBISS.SI-ID 24002824].
5) DUBTSOV, Alexander, PASECHNIK, Sergey V., SHMELIOVA, Dina V., SAIDGAZIEV, Ayvr Sh., GONGADZE, Ekaterina, IGLIČ, Aleš, KRALJ, Samo. Liquid crystalline droplets in aqueous environments: electrostatic effects. Soft matter, 2018, vol. 14, iss. 47, str. 9619-9630, doi: 10.1039/C8SM01529E [COBISS.SI-ID 24177416].
6) MESAREC, Luka, KURIOZ, Pavlo, IGLIČ, Aleš, GÓŹDŹ, Wojciech, KRALJ, Samo. Curvature-controlled topological defects. Crystals, 2017, vol. 7, no. 6, str. 1-11, http://www.mdpi.com/2073-4352/7/6/153, doi: 10.3390/cryst7060153 [COBISS.SI-ID 11753556].