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 cycle		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:	**Prerequisites:**
Priporočljivo je predznanje iz klasične in moderne fizike. Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno.	Recommended is preknowledge of classical and modern physics. Each of the listed obligations in the assessment methods must be completed with a positive grade.

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. C. Kittel, Introduction to Solid State Physics (John Wiley & Sons, New Brisbane, 1996).
3. P. M. Chaikin, T. C. Lubensky, Principles of Condensed Matter Physics (Cambridge University Press, Cambridge, 2003, cop 1995).

Dodatna literatura / Additional Readings:

4. Solid state Physics: Interactive learning: http://solidstate.physics.sunysb.edu/teach/intlearn/
5. L. Mihaly, M. C. Martin, Solid State Physics: Problems and Solutions (Wiley, 2009).
6. M. P. Marder, Condensed Matter Physics (John Wiley & Sons, New York, 2000).

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.	**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.

Prenesljive/ključne spretnosti in drugi atributi:	**Transferable/Key Skills and other attributes:**
Razumevanje procesov v trdni snovi je osnova za razumevanje procesov v fiziki materialov (tehnična aplikacija), mehki snovi in biofiziki.	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 Ustni izpit.	50 50	Written exam Oral exam

Opombe:
Pisni izpit se lahko nadomesti z dvema pisnima kolokvijema.

Comments:
Written exam can be replaced by two written midterm examinations.

Reference nosilca / Lecturer's references:

1) ČREŠNAR, Dejvid, ROŽIČ, Brigita, KUTNJAK, Zdravko, KRALJ, Samo. Theoretical and experimental study of elastocaloric responses in liquid crystalline elastomers. *Journal of molecular liquids*. [Online ed.]. Nov. 2024, vol. 413, [article no.] 126058, str. 1-14, ilustr. ISSN 1873-3166. DOI: 10.1016/j.molliq.2024.126058. [COBISS.SI-ID 208151299],
2) SINGH, Varun, PAL, Kaushik, SINGH WATTS, Sarangat, ASTHANA, Nidhi, ALI KHAN, Azmat, FATIMA, Sabiha, JELEN, Andreja, KRALJ, Samo. Graphene oxide dispersed rose-petals based green chemistry synthesis of hybrid composite for novel spectroscopic applications. *Journal of molecular liquids*. [Print ed.]. 2024, vol. 414, art. 126166, 16 str. ISSN 0167-7322. DOI: 10.1016/j.molliq.2024.126166. [COBISS.SI-ID 211786243]
3) SVETEC, Milan, HARKAI, Saša, PAL, Kaushik, KRALJ, Samo. Twist disclinations mediated transformations in confined nematic liquid crystals. *Journal of molecular liquids*. [Online ed.]. 15 Nov. 2024, part b, [article no.] 126138, 10 str., ilustr. ISSN 1873-3166. DOI: 10.1016/j.molliq.2024.126138. [COBISS.SI-ID 214061315]

4) JELEN, Andreja, ZID, Maha, PAL, Kaushik, RENUKA, Remya Rajan, ČREŠNAR, Dejvid, KRALJ, Samo. Nano and micro-structural complexity of nematic liquid crystal configurations. *Journal of molecular liquids*. [Print ed.]. 2024, vol. 415, part a, [article no.] 126275, 9 str., ilustr. ISSN 0167-7322. DOI: 10.1016/j.molliq.2024.126275, DOI: 20.500.12556/DKUM-91264. [COBISS.SI-ID 217792259]
5) HÖLBL, Arbresha, PAL, Kaushik, AHMAD, Irfan, ASIRI, Hatem Mohammed A, KRALJ, Samo. Colloid and nanoparticle-driven phase behavior in weakly perturbed nematic liquid crystals. *Journal of molecular structure*. [Print ed.]. Jul. 2024, vol. 1307, [article no.] 138002, 8 str. ISSN 0022-2860. DOI: 10.1016/j.molstruc.2024.138002. [COBISS.SI-ID 194451715]