



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Fizikalne lastnosti materialov
Course title:	Physical Properties of Materials

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		1. ali 2.	1., 2. ali 3.
PHYSICS		1. or 2.	1., 2. or 3.

Vrsta predmeta / Course type

Izbirni za modula Biofizika 3 in Fizika
1, 2, 3

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
5					145	5

Nosilec predmeta / Lecturer:

Zdravko Kutnjak

Jeziki /

Languages:

Predavanja / slovenski/Slovenian

Lectures:

Vaje / Tutorial:

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

Predznanje iz moderne fizike

Prerequisites:

Basic knowledge of modern physics

Vsebina:

Content (Syllabus outline):

- 1) struktura materialov in interakcije
- 2) Elektroni v kristalih: fermijeva površina, gostota stanj, energijski pasovi, prevodni pas
- 3) Polprevodniki: homogeni, cisti in dopirani, prevodne lastnosti, nehomogeni, p-n stik, p-n-p tranzistor
- 4) Mrežna nihanja: veriga atomov, optična in akustična veja, fononi, toplotna kapaciteta
- 5) Mrežni defekti in efekti končnih dimenzij
- 6) Dielektriki in Feroelektriki: dielektričnost, spontana polarizacija
- 7) Magnetne lastnosti, diamagneti, paramagneti, feromagneti, magnoni
- 8) Fazni prehodi: Landauova fenomenološka teorija, naivna teorija povprečnega polja, neklasični primeri, univerzalnostni razredi
- 9) superprevodniki, osnovne lastnosti, Londonova fenomenološka teorija, Cooperjevi pari, visokotemperaturni superprevodniki
- 10) Uvod v lastnosti mehke snovi: polimeri, tekoči kristali, koloidi

- 1) Structure of materials: building blocks and interactions,
- 2) Theory of electrons in crystals: free electrons, energy levels/bands, Fermi surface, density of states
- 3) Semiconductors: pure and doped, transport properties, p-n junction, laser diodes, p-n-p transistor,
- 4) Lattice vibrations: chain of atoms, optical and acoustic branch, phonons, specific heat
- 5) Defects of crystal lattice and finite-size effects
- 6) Dielectrics and ferroelectrics: dielectric constant, spontaneous polarization
- 7) Magnetic properties: diamagnets, paramagnets, ferromagnets, magnons
- 8) Phase transitions: Landau phenomenological theory, naive mean-field theory, nonclassical examples, universality classes
- 9) superconductors: basic properties, London theory, Cooper's pairs, high T_c superconductors
- 10) An introduction to soft matter properties: polymers, Liquid crystals, colloids

Temeljni literatura in viri / Readings:

- 1) *Physics of Materials*, Yves Quere, Gordon and Beach Science Publishers (1998);
- 2) *Introduction to Solid State Physics*, C. Kittel, John Wiley, 1986
- 3) *Teorija trdne snovi*, P. Prelovšek, Ljubljana, 1999
- 4) *Solid State Physics*, N.W. Ashcroft, Rinehart & Winston, 1976
- 5) *Molekule, kristali, jedra, delci*, J. Strnad, DZS, 1982 (slovenian)
- 6) M. Kleman, O.D. Lavrentovich, *Soft Matter Physics*, Springer-Verlag, New York, 2003.
- 7) P. M. Chaikin, T. C. Lubensky, *Principles of Condensed Matter Physics*, Cambridge University Press, Cambridge, England, 1995.
- 8) Clanki v Science, Nature, Scientific American.
- 9) *Soft Matter Physics*, M. Daoud, Springer, 1999

Cilji in kompetence:

Objectives and competences:

Izravnalni predmet, ki da določeno predznanje tistim študentom, ki nimajo dovolj predznanja iz fizike kondenzirane materije, tako, da lahko v nadaljnjih semestrih sledijo bolj specializiranim in poglobljenim predmetom.

Introductory course, which purpose is to equalize the knowledge of students. It is suitable for those students who did not acquire enough basic knowledge in condensed matter physics. Acquired knowledge within the course should allow them to be able to follow later more specialized courses.

Predvideni študijski rezultati:

Znanje in razumevanje:

Razumevanje osnovnih fizikalnih lastnosti procesov v izbranih snoveh.

Prenesljive/ključne spretnosti in drugi atributi:

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

Intended learning outcomes:

Knowledge and understanding:

Understanding of basic physical properties in selected materials.

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:

Metodika obsega predavanja in samostojnega dela v obliki seminarjev, ki podajajo uvod v problematiko in trenutno razumevanja fizikalnih lastnosti snovi na uvodni stopnji.

Learning and teaching methods:

Lectures and seminars providing the introduction of current knowledge of physical properties of condensed matter materials

Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekt)

Seminarji
Ustni izpit

60%
40%

Type (examination, oral, coursework, project):

Seminars
Oral exam

Reference nosilca / Lecturer's references:

1. PIRC, Raša, ROŽIČ, Brigita, KORUZA, Jurij, MALIČ, Barbara, KUTNJAK, Zdravko. Negative electrocaloric effect in antiferroelectric PbZrO₃. *Europhysics letters*, ISSN 0295-5075, 2014, vol. 107, no. 1, str. 17002-1-17002-5, doi: [10.1209/0295-5075/107/17002](https://doi.org/10.1209/0295-5075/107/17002). [COBISS.SI-ID 27812647]

2. PIRC, Raša, KUTNJAK, Zdravko. Electric-field dependent freezing in relaxor ferroelectrics = R. Pirc and Z. Kutnjak. *Physical review. B, Condensed matter and materials physics*, ISSN 1098-0121, 2014, vol. 89, no. 18, str. 184110-1-184110-7, doi: [10.1103/PhysRevB.89.184110](https://doi.org/10.1103/PhysRevB.89.184110). [COBISS.SI-ID 27725863]

3. RANJKESH SIAHKAL, Amid, AMBROŽIČ, Milan, CORDOYIANNIS, George, KUTNJAK, Zdravko, KRALJ, Samo. History-dependent patterns in randomly perturbed nematic liquid crystals. *Advances in condensed matter physics*, ISSN 1687-8108, 2013, vol. 2013, str. 505219-1-505219-

10, doi: [10.1155/2013/505219](https://doi.org/10.1155/2013/505219). [COBISS.SI-ID 26806567]

4. LAVRIČ, Marta, CORDOYIANNIS, George, KRALJ, Samo, TZITZIOS, Vassilios, NOUNESIS, George, KUTNJAK, Zdravko. Effect of anisotropic MoS₂ nanoparticles on the blue phase range of a chiral liquid crystal. *Applied optics*, ISSN 1559-128X. Tiskana izd., 2013, vol. 52, no. 22, str. E47-E52, doi: [10.1364/AO.52.000E47](https://doi.org/10.1364/AO.52.000E47). [COBISS.SI-ID 26785319]

5. LAVRIČ, Marta, TZITZIOS, Vassilios, KRALJ, Samo, CORDOYIANNIS, George, LELIDIS, Ioannis, NOUNESIS, George, GEORGAKILAS, V., AMENITSCH, Heinz, ZIDANŠEK, Aleksander, KUTNJAK, Zdravko. The effect of graphene on liquid-crystalline blue phases. *Applied physics letters*, ISSN 0003-6951, 2013, vol. 103, no. 14, str. 143116-1-143116-4, doi: [10.1063/1.4824424](https://doi.org/10.1063/1.4824424). [COBISS.SI-ID 27110951]