Univerza v Mariboru
University of Maribor

Fakulteta za naravoslovje in matematiko
Faculty of Natural Sciences and Mathematics

UČNI NAČRT PREDMETA / SUBJECT SPECIFICATION

Predmet:	Teorija trdne snovi
Subject Title:	Theoretical Solid State Physics

Študijski program Study programme	Študijska smer Study field	Letnik Year	Semester Semester
FIZIKA PHYSICS	-	1 ali 2	**1 ali 2**

Univerzitetna koda predmeta / University subject code:

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Labor work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
30	**20**				**250**	**10**

Nosilec predmeta / Lecturer: Dean Korošak

Jeziki / Languages:
Predavanja / Lecture: slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian
Vaje / Tutorial:

Pogoji za opravljanje študijskih obveznosti:
Ni.

Prerequisites:
None.

Vsebina:
- Uvod: simetrije v kristalih
- Druga kvantizacija: fermioni, bozoni, operatorji v drugi kvantizaciji
- Greenove funkcije: definicije, lastnosti, Dysonova enačba, kvazidelci, enačbe gibanja
- Linearni odziv: korelacijske in odzivne funkcije, Kubova formula, elektronski plin: odzivna funkcija, coulumbska interakcija, plazmoni
- Elektron v periodičnem potencialu: skoraj prosti elektroni, močno vezani elektroni, metode računanja elektronske strukture trdnin
- Interagirajoči elektroni: Hartree-Fockov približek in približek naključnih faz, samousklajeni dielektrični odziv, Fermijeve tekočine
- Izolatorji: dielektrična funkcija, optične lastnosti, ekscitoni, prehod kovina-izolator
- Magnetizem: Hubbardov model, tenzor magnetne susceptibilnosti, magnetne ureditve, feromagnetni in antiferomagnetni spinski valovi
- Fononi: harmonična nihanja kristalne mreže, sklopitev elektron-fonon, polaroni
- Superprevodnost: Cooperjevi pari, BCS osnovno stanje, elektrodinamika superprevodnega stanja, visokotemperaturna superprevodnost

Content (Syllabus outline):
- Introduction: crystal symmetries
- Second quantization: fermions, bosons, operators in second quantization
- Green functions: definitions, properties, Dyson equation, quasiparticles, equations of motion
- Linear response: correlation and response functions, Kubo formula, electron gas: response function, coulumb interaction, plasmons
- Electron in periodic potential: nearly free electron approximation, tight binding approximation, computations of energy band structure in solids
- Interacting electrons: Hartree-Fock approximation, random phase approximation, selfconsistent dielectric response, Fermi liquids
- Insulators: dielectric function, optical properties, excitons, metal-insulator transition
- Magnetism: Hubbard model, tensor of magnetic susceptibility, magnetic ordering, ferromagnetic and antiferromagnetic spin waves
- Phonons: harmonic oscillations in crystal lattice, electron-phonon coupling, polarons
- Superconductivity: Cooper pairs, BCS ground state, electrodynamics of superconducting state, hightemperature superconductivity

Temeljni literatura in viri / Textbooks:

W. Jones, N. H. March, Theoretical Solid State Physics vols. I,II, Wiley-Interscience, 1973.
O. Madelung, Introduction to Solid-State Theory, Springer, 1978.
C. Kittel, Introduction to Solid State Physics 8th ed., Wiley, 2004.
N. W. Ashcroft, N. D. Mermin, Solid State Physics (inter. ed.), Saunders College, 1976.
C. Kittel, Quantum Theory of Solids, Wiley, 1963.

Cilji:	**Objectives:**
Uvajanje in razumevanje modernih teoretičnih in računskih metod teorije trdne snovi kot osnove za samostojno raziskovalno delo in kot podlaga razumevanja principov novih tehnologij in materialov.	Introduction and understanding of modern theoretical and computational methods in solid state physics as a basis for individual research work and understanding of principles of new technologies and materials.
Predvideni študijski rezultati:	**Intended learning outcomes:**
Pregled in razumevanje mikroskopskega opisa pojavov v trdni snovi in uporaba teoretičnih metod v problemih fizike trdne snovi.	Overview and understanding of microscopic description of solid-state phenomena, and application of theoretical methods in solid-state physics problems.
Prenesljive/ključne spretnosti in drugi atributi:. Sposobnost izbire in uporabe ustreznih teoretičnih ter računskih metod pri problemih fizike trdne snovi.	Transferable/Key Skills and other attributes: Skills to choose and implement proper theoretical and computational methods in solid state physics problems
Metode poučevanja in učenja:	**Teaching and learning methods:**
predavanja, seminar, seminarske naloge, reševanje odprtih nalog/problemov	lectures and seminars, student's seminar work, solving of open problems/tasks

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment methods:**
Odprte naloge/problemi	**20**	Opem tasks/problems
seminarji	**20**	seminars
ustni izpit	**30**	oral exam
pisni izpit	**30**	written exam