

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Osnove fizike nanomaterialov
Course title:	Fundamentals of the Physics of Nanomaterials

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Nanoznanosti in nanotehnologije, 2. stopnja	/	1	2
Nanosciences and nanotechnologies, 2 nd cycle	/	1	2

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: NANO2-270

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	30			30	210	10

Nosilec predmeta / Lecturer: Prof. dr. Dragan Mihailović

Jeziki / Languages: **Predavanja / Lectures:** slovenski, angleški
Slovenian, English
Vaje / Tutorial:

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

Zaključen študij prve stopnje s področja naravoslovja ali tehnike ali zaključen študij prve stopnje na drugih področjih z znanjem osnov s področja predmeta.

Prerequisites:

Completed first cycle studies in natural sciences or engineering or completed first cycle studies in other fields with knowledge of fundamentals in the field of this course.

Vsebina:

1. Uvod v nanofiziko
2. Nanomagnetizem
3. Nizkodimenzionalni sistemi in materiali s spinskim redom ali urejanjem naboja
4. Ogljikove nanostrukture
5. Nanožice: osnovne lastnosti in uporaba
6. Fazna separacija in funkcionalne lastnosti fazno separiranih sistemov
7. Bio-nanofizika

Content (Syllabus outline):

1. Introduction to nanophysics
2. Nanomagnetism
3. Low-dimensional charge and spin ordered materials
4. Carbon nanostructures
5. Nanowires: basic properties and applications
6. Phase separation on the nanoscale and Functional properties of phase separated systems
7. Bio-nanophysics

Temeljni literatura in viri / Readings:

Moderni pregledni članki iz nanotehnologije in novejša literatura. / Recent review papers in nanotechnology and recent literature.

Classical text: C.Kittel "Introduction to Solid State Physics", 8th edition (Wiley 2005), particularly chapters on nanotechnology and nanomaterials (18 and 19).

Nanomagnetism: Applications and Perspectives

Claude Fermon (Editor), Marcel Van de Voorde (Editor) ISBN: 978-3-527-33985-3 (2017) or equivalent.

Science of Fullerenes and Carbon Nanotubes by M. S. Dresselhaus (Editor), G. Dresselhaus (Editor), P. C. Eklund (Editor) Academic Press; ISBN: 0122218205; (1996).

Nanoelectronics and information technology, Reiner Waser (Ed.) (Wiley, 2005).

Cilji in kompetence:

Cilj predmeta je spoznavanje aktualnih problemov in najnovejših dosežkov na področju fizike nanomaterialov, pri katerem študenti razvijejo razumevanje različnih pojavov v nizkodimenzionalnih strukturah in njihovi uporabi v nanotehnologiji.

Objectives and competences:

The goal of this course is to give an overview of the major directions of research and the latest achievements in the field of physics of nanomaterials, giving the students an understanding on diverse physical phenomena present in low-dimensional structures and their applications in nanotechnology.

Predvideni študijski rezultati:

Znanje in razumevanje:
Študenti obvladajo najnovejše dosežke v fiziki nanomaterialov in nanosistemov kot temelj za raziskovalno delo na področju fizike nanomaterialov, nanotehnologije in nanoelektronike. Študenti bodo obvladovali:

- fiziko nizkodimenzionalnih sistemov,
- fiziko omejenih sistemov,
- fiziko nanostruktur,
- osnove meritev nizkodimenzionalnih sistemov.

Študenti se bodo seznanili tudi s primeri uporabe fizikalnih pojavov v nanotehnologiji.

Intended learning outcomes:

Knowledge and understanding:
Students will master the latest advances in the rapidly developing field of physics of nanomaterials and nanosystems and nanoelectronics. They will become proficient in:

- physics in low-dimensional systems,
- physics of confined structures,
- physics of nanostructures,
- fundamentals of measurements in low dimensional systems.

Students will also learn about a number of examples of the use of nanophysical phenomena in applications in nanotechnology.

Metode poučevanja in učenja:

Interaktivna predavanja
Seminar
Individualno voden študij

Learning and teaching methods:

Interactive lectures
Seminar
Individual tutorials

Načini ocenjevanja:

Delež (v %) /
Weight (in %)

Assessment:

Seminarska naloga.	50 %	Seminar work.
Ocena zagovora seminarske naloge, pri katerem dokaže osvojitve vseh študijskih izidov z vsaj po enim konkretnim primerom.	50 %	Evaluation of the defense of the seminar work where the student demonstrates the achievement of all learning outcomes with at least one specific case for each outcome.

Reference nosilca / Lecturer's references:

STOJCHEVSKA, Ljupka, VASKIVSKYI, Igor, MERTELJ, Tomaž, KUŠAR, Primož, SVETIN, Damjan, BRAZOVSKII, Serguei, MIHAILOVIĆ, Dragan. Ultrafast switching to a stable hidden quantum state in an electronic crystal. *Science*, ISSN 0036-8075, 2014, vol. 344, no. 6180, str. 177-180, doi: [10.1126/science.1241591](https://doi.org/10.1126/science.1241591).

MADAN, Ivan, KUROSAWA, T., TODA, Y., ODA, Migaku, MERTELJ, Tomaž, KUŠAR, Primož, MIHAILOVIĆ, Dragan. Separating pairing from quantum phase coherence dynamics above the superconducting transition by femtosecond spectroscopy. *Scientific reports*, ISSN 2045-2322, 2014, vol. 4, str. 05656-1-

05656-5. <http://www.nature.com/srep/2014/140711/srep05656/pdf/srep05656.pdf>, doi: [10.1038/srep05656](https://doi.org/10.1038/srep05656).

NARYMBETOV, Bakhyt, OMERZU, Aleš, KABANOV, Viktor V., TOKUMOTO, Madoka, KOBAYASHI, Hayato, MIHAILOVIĆ, Dragan. Origin of ferromagnetic exchange interactions in a fullerene-organic compound. *Nature*, ISSN 0028-0836, 2000, vol. 407, str. 883-885.

YUSUPOV, Roman V., MERTELJ, Tomaž, KABANOV, Viktor V., BRAZOVSKII, Serguei, KUŠAR, Primož, CHU, Jiun-Haw, FISHER, Ian R., MIHAILOVIĆ, Dragan. Coherent dynamics of macroscopic electronic order through a symmetry breaking transition. *Nature physics*, ISSN 1745-2473, 2010, vol. 6, no. 9, str. 681-684.

REMŠKAR, Maja, MRZEL, Aleš, ŠKRABA, Zora, JESIH, Adolf, ČEH, Miran, DEMŠAR, Jure, SADELMANN, Pierre, LÉVY, Francis, MIHAILOVIĆ, Dragan. Self-assembly of subnanometer-diameter single-wall MoS₂ nanotubes. *Science*, ISSN 0036-8075, 2001, vol. 292, str. 479-481.