

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Napredne teme iz nanoznanosti in nanotehnologij
Course title:	Advanced Topics in Nanosciences and Nanotechnologies

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Nanoznanosti in nanotehnologije, 3. stopnja	/	1	1
Nanosciences and nanotechnologies, 3 rd cycle	/	1	1

Vrsta predmeta / Course type

Obvezni / Mandatory

Univerzitetna koda predmeta / University course code:

NANO3-887

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

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer:

Prof. dr. Boštjan Zalar
 Prof. dr. Miran Čeh
 Prof. dr. Goran Dražič
 Prof. dr. Christoph Gadermaier
 Prof. dr. Zdravko Kutnjak
 Prof. dr. Barbara Malič
 Prof. dr. Dragan Mihailović
 Doc. dr. Matjaž Spreitzer

Jeziki /

Predavanja / Lectures: Slovenski, angleški / Slovenian, English

Languages:

Vaje / Tutorial: -

Pogoji za vključitev v delo:

Zaključena izobrazba druge stopnje ali univerzitetna izobrazba s področja naravoslovja ali tehnologije ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).

Prerequisites:

Completed masters level education or equivalent university education from natural sciences or technology or completed second level studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

Vsebina:

Predmet predstavlja napredne teme v nanoznanostih in nanotehnologijah, predvsem na področjih:

Fizika materialov
 - večkomponentni materiali, trdne raztopine, kompoziti, fazna separacija
 - mezoskopske elektronske strukture
 - kolektivni pojavi v končnih sistemih
 - fizika nanomaterialov: nanocevčice, kvantne pike, tanke plasti, nanomagnetne, fulereni

Content (Syllabus outline):

The course presents advanced topics in nanosciences and nanotechnologies, in particular:

Physics of materials
 - multicomponent systems, solid solutions, composites, phase separation
 - mesoscopic electronic structures
 - collective phenomena in finite size systems
 - physics of nanomaterials: nanotubes, quantum dots, thin layers, nanomagnets, fullerenes

<p>Kemija materialov</p> <ul style="list-style-type: none"> - kristalne strukture - kristalne napake - difuzija - mikrostruktura - fazni diagrami <p>Sinteza nanomaterialov</p> <ul style="list-style-type: none"> - 'od zgoraj-navzdol' in 'od spodaj navzgor' - nanodelci, nanocevrke, nanovlakna - tanke plasti, plastne strukture - nanostrukturni materiali <p>Mikroskopske metode</p> <ul style="list-style-type: none"> - uvod in izbrane teme iz mikroskopskih metod: SEM, TEM, STM, SPM, AFM <p>Bioznanosti, proteini in celična biologija</p>	<p>Chemistry of materials</p> <ul style="list-style-type: none"> - crystal structures - crystal defects - diffusion - microstructure - phase diagrams <p>Synthesis of nanomaterials</p> <ul style="list-style-type: none"> -top-down and bottom-up approaches -nanoparticles, nanotubes, nanofibres -thin films, patterned structures -nanostructured materials <p>Microscopic methods</p> <ul style="list-style-type: none"> - introduction to and selected topics from microscopic methods: SEM, TEM, STM, SPM, AFM <p>Biosciences, proteins, and cell biology</p>
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Temeljni literatura in viri / Readings:

Temeljni študijski viri so objavljeni članki v zadnjih letih, predvsem v revijah Science, Nature in Physical Review Letters, Nano Letters, Nature Nanotechnology, Nature Physics ter pregledni članki.

The main sources are review articles as well as chosen articles in Science, Nature in Physical Review Letters, Nano Letters, Nature Nanotechnology, Nature Physics and similar journals.

Introductory texts:

C. Kittel, **"Introduction to Solid State Physics"**, 8th edition (Wiley 2005), particularly chapters on nanotechnology and nanomaterials (18 and 19). ^[1]_[SEP]

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

J. I. Goldstein et al., Scanning Electron Microscopy and X-ray Microanalysis, Springer, 4th edition, 2017

D. B. Williams, C. B. Carter, Transmission Electron Microscopy, Plenum Press, 2009

Ludwig Reimer, Transmission Electrons Microscopy, Springer, 2008

R. Wiesendanger, Scanning probe microscopy and spectroscopy, Methods and applications, Cambridge University Press, Cambridge, 1994

G. Cao, Nanostructures and Nanomaterials, Imperial College Press, London, 2004.

The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C. N. R. Rao, A. Müller (Eds.), Wiley-VCH, 2004.

Cilji in kompetence:

Študenti spoznajo najnovejše dosežke v nanoznanosti in nanotehnologijah in se pripravijo za raziskovalno delo na tem področju.

Splošne kompetence:

- obvladanje raziskovalnih metod za obravnavo nanoznanosti in nanotehnologijah,
- razvoj komunikacijskih sposobnosti in spretnosti, posebej komunikacije v mednarodnem okolju,
- kooperativnost, delo v skupini (in v

Objectives and competences:

Students will become acquainted with the latest advances in nanosciences and nanotechnologies, and prepare themselves for research work in this field.

General Competences:

- The student will master research methods in the physics of nanosciences and nanotechnologies
- The student will develop communications skills to present research achievement in the

mednarodnem okolju)

Predmetnospecifične kompetence:
Predmet pripravlja študente za uporabo znanja s področja nanoznanosti in nanotehnologij pri samostojnem raziskovalnem delu.

international environment

- Work in team (in international environment)

Course Specific Competences:

This course prepares students to apply knowledge of nanosciences and nanotechnologies for research work in this field.

Predvideni študijski rezultati:

Funkcionalno znanje področja skozi poglobljen študij izbranih primerov iz nanoznanosti in nanotehnologij, prirejenih raziskovalnemu programu študenta.

Študenti obvladajo najnovejše dosežke v nanoznanostih in nanotehnologijah.

Študenti se bodo seznanili tudi s primeri uporabe nanoznanosti v različnih nanotehnoloških aplikacijah.

Intended learning outcomes:

A functional knowledge of the field, through in-depth study of selected examples in nanosciences and nanotechnologies specially adapted to the research topic of the student.

Students will master the latest advances in nanosciences and nanotechnologies.

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

Metode poučevanja in učenja:

Interaktivna predavanja
Seminar
Konzultacije
Laboratorijsko delo
Individualno voden študij

Learning and teaching methods:

Interactive lectures
Seminar
Consultations
Laboratory work
Individual guided studies

Načini ocenjevanja:

Seminar
Ustni izpit

Delež (v %) /

Weight (in %)

Assessment:

Seminar
Oral exam

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).
- 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.
- REŠETIČ, Andraž, MILAVEC, Jerneja, ZUPANČIČ, Blaž, DOMENICI, Valentina, ZALAR, Boštjan. Polymer-dispersed liquid crystal elastomers. *Nature Communications*, ISSN 2041-1723, 2016, vol. 7, str. 13140-1-13140-10.