UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Teorija nanomaterialov
Course title:	Theory of Nanomaterials

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 Nanotechnologijes, 3rd cycle	/	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	NANO3-837

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 transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Viktor Kabanov

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključena izobrazba druge stopnje ali univerzitetna izobrazba s področja naravoslovja ali tehnologije.	Completed second level education or university education from natural sciences or technology.

Vsebina:	**Content (Syllabus outline):**
1. Pregled modernih metod statistične fizike, ki so pomembne v teoriji nanomaterialov, s poudarkom na teoriji faznih prehodov v neurejenih snoveh, npr. v spinskih steklih, relaksorjih in nanomagnetih. 2. Teorija nanocevk: Struktura ogljikovih in anorganskih nanocevk. Simetrija, kvantna števila in izbirna pravila. Mrežna dinamika eno- in večslojnih nanocevk: Fononski spektri in sorodne lastnosti: hitrost zvoka, specifična toplota, elastičnost Ramanski in infrardeči spektri Tribologija: (in)komenzurabilne cevke, teleskopski efekt (superdrseče stene), fazoni Elektronske lastnosti: Elektronski pasovi, prevodnost. Optični prehodi in optične lastnosti.	1. Overview of modern methods of statistical physics that are relevant in the theory of nanomaterials, with emphasis on the theory of phase transitions in disordered substances, e.g. in spin glasses, relaxors and nanomagnets. 2. Theory of nanotubes: Structure of carbon and inorganic nanotubes. Symmetry, quantum numbers and selection rules Network dynamic of single- and multi-layer nanotubes: Phonon spectra and related properties: speed of sound, specific heat, elasticity Raman and infrared spectra Tribology: (in) commensurable tubes, telescopic effect (super-slip walls), phasons Electronic properties: Electronic belts, conductivity. Optical transitions and optical properties.

Temeljni literatura in viri / Readings:

Zaradi hitrosti razvijajočega se področja so temeljni študijski viri objavljeni članki v zadnjih letih predvsem v revijah Science, Nature in Physical Review Letters. / Latest articles from following scientific journals: Science, Nature and Physical Review Letters.

Kot dodatni viri so predvideni:
P. G. de Gennes, Simple views on condensed matter physics, World Scientific, 1992

P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter Physics, Cambridge University Press, 2000

J. M. Ziman, Models of Disorder, Cambridge University Press, 1979

K. H. Fischer and J. A. Hertz, Spin Glasses, Cambridge University Press, 1991

M. Dresselhaus, G. Dresselhaus, and P. C. Eklund: Science of Fullerenes and Carbon Nanotubes, Academic, San Diego, 1998.

R. Saito, G. Dresselhaus, and M. Dresselhaus, Physical Prpoperties of Carbon Nanotubes, Imperial College Press, London, 1998.

Cilji in kompetence:

Študenti spoznajo najnovejše dosežke v teoriji nanomaterialov in se pripravijo za raziskovalno delo na področju nanomaterialov.

Splošne kompetence:

- obvladanje raziskovalnih metod, postopkov in procesov, razvoj kritične in samokritične presoje,
- sposobnost uporabe znanja v praksi,
- razvoj komunikacijskih sposobnosti in spretnosti, posebej komunikacije v mednarodnem okolju,
- kooperativnost, delo v skupini (in v mednarodnem okolju).

Predmetnospecifične kompetence:

- Predmet pripravlja študente za uporabo znanja s področja teorije nanomaterialov.

Objectives and competences:

Students become acquainted with the latest advancements in the theory of nanomaterials, and prepare themselves for research work in the field of nanomaterials.

General Competences:

- The student will master research methods, procedures and processes.
- The student will develop critical thinking.
- The student will develop communications skills to present research achievement in the international environment.
- Work in team (in international environment*).*

Course Specific Competences:

- This course prepares students to apply knowledge of the theory of nanomaterials.

Predvideni študijski rezultati:

Znanje in razumevanje:

- Razumevanje teorije nanomaterialov.

Vrednotenje in sinteza:

- Sposobnost izbire primernega modela za izbrane primere nanomaterialov.
- Sposobnost komuniciranja v angleškem jeziku na področju teorije nanomaterialov.

Intended learning outcomes:

Knowledge and understanding:

- The student will understand the theory of nanomaterials.

Evaluation and synthesis:

- Ability to select a proper model for selected cases of nanomaterials.
- Ability to communicate in English in the field of

	theory of nanomaterials.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja • Seminarji • Konzultacije • Laboratorijsko delo	• Lectures • Seminar work • Consultations • Laboratory work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminar	50 %	Seminar
Ustni izpit	50 %	Oral exam

Reference nosilca / Lecturer's references:

SHUMILIN, A. V., KABANOV, Viktor V., DEDIU, V. I. Magnetoresistance in organic semiconductors : including pair correlations in the kinetic equations for hopping transport. *Physical review. B*, ISSN 2469-9950, 2018, vol. 97, no. 9, str. 094201-1-094201-9, doi: 10.1103/PhysRevB.97.094201

BUH, Jože, MRZEL, Aleš, KOVIČ, Andrej, KABANOV, Viktor V., JAGLIČIĆ, Zvonko, VRTNIK, Stanislav, KOŽELJ, Primož, MIHAILOVIĆ, Dragan. Phase slip and telegraph noise in δ−MoNδ−MoN nanowires. *Physica. C, Superconductivity and its applications*, ISSN 0921-4534. [Print ed.], 2017, vol. 535, str. 24-29, doi: 10.1016/j.physc.2017.03.003

BECK, M., KABANOV, Viktor V., DEMŠAR, Jure, et al. Energy dependence of the electron-boson coupling strength in the electron-doped cuprate superconductor Pr[sub](1.85)Ce[sub](0.15)CuO[sub](4-[delta]). *Physical review. B*, ISSN 2469-9950, 2017, vol. 95, no. 8, str. 085106-1-085106-8, doi: 10.1103/PhysRevB.95.085106

MADAN, Ivan, BARANOV, Vladimir V., TODA, Y., ODA, Migaku, KUROSAWA, T., KABANOV, Viktor V., MERTELJ, Tomaž, MIHAILOVIĆ, Dragan. Dynamics of superconducting order parameter through ultrafast normal-to-superconducting phase transition in Bi2Sr2CaCu2O8+δBi2Sr2CaCu2O8+δ from multipulse polarization-resolved transient optical reflectivity. *Physical review. B*, ISSN 2469-9950, 2017, vol. 96, no. 18, str. 184522-1- 184522-9, doi: 10.1103/PhysRevB.96.184522

BUH, Jože, KABANOV, Viktor V., BARANOV, Vladimir V., MRZEL, Aleš, KOVIČ, Andrej, MIHAILOVIĆ, Dragan. Control of switching between metastable superconducting states in δδ-MoN nanowires. *Nature communications*, ISSN 2041-1723, 2015, vol. 6, str. 10250-1-10250-6, doi: 10.1038/ncomms10250