Univerza v Novi Gorici
Fakulteta za aplikativno naravoslovje

University of Nova Gorica
School of Applied Sciences

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Fizika faznih prehodov
Course name:	Physics of phase transitions

Študijski program in stopnja **Study program and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Fizika in Astrofizika II. stopnja	Fizika trdne snovi	1	/
Physics and Astrophysics II. level	Solid state physics	1	/

Vrsta predmeta / Course type	obvezni / mandatory
Univerzitetna koda predmeta / University course code:	2FTS04

Predavanja **Lectures**	**Seminar** **Seminar**	**Sem. vaje** **Tutorial**	**Lab. vaje** **Lab. work**	**Teren. vaje** **Field work**	**Samost. delo** **Indiv. work**	**ECTS**
45	/	45	/	/	180	9

Nosilec predmeta / Lecturer:	Izr. prof. dr. Artem Badasyan	
Jeziki / **Languages:**	**Predavanja / Lectures:**	slovenščina / English
	Vaje / Tutorial:	slovenščina / English

Pogoji za opravljanje študijskih obveznosti:	**Prerequisits:**
Mat. Analiza I, II Linearna Algebra Statistična Mehanika	Mat. Analysis I, II Linear Algebra Statistical Mechanics

Vsebina:	**Syllabus outline:**
I. REALNI PLIN Odstopanja plina od idealne enačbe stanja; Enačba razširjanja kot fukcija gostote; Van der Waalsova enačba. II. FAZNO RAVNOVESJE IN FAZNI PREHOD 1. STOPNJE Pogoji faznega ravnovesja; Clausis-Clapeyron-ova enačba; Kritična točka; Definicija faznega prehoda in klasifikacija po Ehrenfest-u.	I. NON-IDEAL GASES Deviation of gases from the ideal state; Expansion in powers of the density; Van der Waals' formula. 5hrs II. PHASE EQUILIBRIUM AND PHASE TRANSITIONS OF Ist ORDER Conditions of phase equilibrium; The Clapeyron-Clausius formula; The critical point; The law of corresponding states; Definition of phase transition and its classification by

III. RAZTOPINE Sistemi različnih delcev; Fazno pravilo; Šibke raztopine; Ozmotski tlak; Stik med fazami topil; Mešanica idealnih plinov; Parni tlak nasičene raztopine. IV. ISINGOV MODEL Definicija Isingovega modela; Povezava z ostalimi modeli; Spontana magnetizacija; Bragg-Williamsova aproksimacija; Bethe-Pierlsova aproksimacija; 1D Isingov model in Landau-Pierlsov teorem. V. KRITIČNI POJAVI Faktor urejenosti; Korelacijska funkcija in fluktuacijsko-disipacijski teorem; Kritični eksponenti; Hipoteza skaliranja; Invariantnost skaliranja; Goldstoneovo vzbujanje; Vpliv dimenzionalnosti. VI. LANDAUOV PRISTOP Landauova prosta energija; Matematična zaokrožitev; Izpeljave enostavnih modelov; Teorija povprečnega polja; Van der Waalsova enačba stanja; Trojna točka; Gausov model; Ginzburgov kriterij; Anomalne dimenzije.	Ehrenfest. III. SOLUTIONS Systems, containing different particles; The phase rule; Weak solutions; Osmotic pressure; Solvent phases in contact; Mixture of ideal gases; Vapor pressure over concentrated solution. IV. THE ISING MODEL Definition of the Ising model; Equivalence to other models; Spontaneous magnetization; The Bragg-Williams approximation; The Bethe-Pierls approximation; 1D Ising model and Landau-Pierls theorem. V. CRITICAL PHENOMENA The order parameter; The correlation function and the Fluctuation-Dissipation theorem; Critical exponents; The scaling hypothesis; Scale invariance; Goldstone excitations; The importance of dimensionality. VI. THE LANDAU APPROACH Landau free energy; Mathematical digression; Derivation in simple models; Mean-field theory; The Van der Waals equation of state; Tricritical point; Gaussian model; Ginzburg criterion; Anomalous dimensions.

Temeljni literatura in viri / Basic readings:
1. K. Huang, *Statistical mechanics*. New York: Wiley (1987). 2. L. D. Landau, E. M. Lifshitz: 'Statistical Physics (Third Edition, Part 1: Volume 5 (Course of Theoretical Physics, Volume 5, first printed 1980, reprinted 1982,1985, 1986, 1988, 1993, 1994, 1996, 2000, 2001, 2003, 2005).

Cilji in kompetence:	**Objectives and competences:**
Seznaniti študenta s sodobnimi znanji iz področja statistične fizike. Seznaniti študenta z idejami, modeli, metodami in pristopi statistične	Objectives of the course are to provide the student with the contemporary state of the art in the field of statistical physics and to introduce

fizike. Študenti bodo poznali fiziko faznih prehodov in kritičnih pojavov.	him to the statistical physics ideas, models, approaches and methods. Students will understand methods, ideas and approaches to phase transitions and critical phenomena.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študenti bodo pridobili znanje in znali prepoznati fazne prehode, ustrezno terminologijo in koncepte, ki se uporabljajo na tem področju znanosti.	Students will gain understanding of what phase transitions are and the relevant terminology and concepts used in the field.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• predavanja • računske vaje	• lectures • tutorial

Načini ocenjevanja:	**Utež / Weight (%)**	**Assessment:**
• kolokviji, pisni izpit • ustni izpit	50 50	• written tests, writen exam • oral exam

Reference nosilca / references of the course principal:

Dr. Artem Badasyan je izredni profesor za področje fizike na Univerzi v Novi Gorici.

Dr. Artem Badasyan is associate professor of Physics at University of Nova Gorica.

1. BADASYAN, Artem, TONOYAN, Sh. A., GIACOMETTI, Achille, PODGORNIK, Rudolf, PARSEGIAN, Vozken Adrian, MAMASAKHLISOV, Yevgeni S., MOROZOV, Vladimir. Unified description of solvent effects in the helix-coil transition. Physical review. E, Statistical, nonlinear, and soft matter physics, ISSN 1539-3755, 2014, vol. 89, iss. 2, str. 022723-1-022723-10, graf. prikazi. http://journals.aps.org/pre/abstract/10.1103/PhysRevE.89.022723. [COBISS.SI-ID 2645348].

2. BADASYAN, Artem, TONOYAN, Sh. A., GIACOMETTI, Achille, PODGORNIK, Rudolf, PARSEGIAN, Vozken Adrian, MAMASAKHLISOV, Yevgeni S., MOROZOV, Vladimir. Osmotic pressure induced coupling between cooperativity and stability of a helix-coil transition. Physical review letters, ISSN 0031-9007. [Print ed.], 2012, vol. 109, iss. 6, str. 068101-1-068101-5. http://link.aps.org/doi/10.1103/PhysRevLett.109.068101. [COBISS.SI-ID 2453860].

3. BADASYAN, Artem, TONOYAN, Sh. A., MAMASAKHLISOV, Yevgeni S., GIACOMETTI, Achille, BENIGHT, A. S., MOROZOV, Vladimir. Competition for hydrogen-bond formation in the helix-coil transition and protein folding. Physical review. E, Statistical, nonlinear, and soft matter physics, ISSN 1539-3755, 2011, vol. 83, no. 5, str. 051903-1-051903-9, doi: 10.1103/PhysRevE.83.051903. [COBISS.SI-ID 25488423].

4. BADASYAN, Artem, GIACOMETTI, Achille, MAMASAKHLISOV, Yevgeni S., MOROZOV, Vladimir, BENIGHT, A. S. Microscopic formulation of the Zimm-Bragg model for the helix-coil transition. Physical review. E, Statistical, nonlinear, and soft matter physics, ISSN 1539-3755,

2010, vol. 81, no. 2, str. 021921-1-021921-8, doi: 10.1103/PhysRevE.81.021921. [COBISS.SI-ID 26172455].

5. MAMASAKHLISOV, Yevgeni S., TODD, Brian A., BADASYAN, Artem, MKRTCHYAN, Anna V., MOZOROV, Vladimir F., PARSEGIAN, Vozken Adrian. DNA stretching and multivalent-cation-induced condensation. Physical review. E, Statistical, nonlinear, and soft matter physics, ISSN 1539-3755, 2009, vol. 80, no. 3, str. 031915-1-031915-9, doi: 10.1103/PhysRevE.80.031915. [COBISS.SI-ID 26173991].