Univerza v Novi Gorici
Fakulteta za naravoslovje

University of Nova Gorica
School of Science

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Statistična mehanika
Course name:	Statistical mechanics

Študijski program in stopnja **Study program and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Fizika in Astrofizika I. stopnja	/	3	1
Physics and Astrophysics I. level	/	3	1

Vrsta predmeta / Course type	obvezni / mandatory
Univerzitetna koda predmeta / University course code:	1FTS15

Predavanja **Lectures**	**Seminar** **Seminar**	**Sem. vaje** **Tutorial**	**Lab. vaje** **Lab. work**	**Teren. vaje** **Field work**	**Samost. delo** **Indiv. work**	**ECTS**
45	/	15	/	/	120	6

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

Pogoji za opravljanje študijskih obveznosti:	**Prerequisits:**
Vpis v tekoče študijsko leto. Za študente v okviru študentskih izmenjav bo izpolnjevanje pogojev preverila Študijska komisija FN.	Enrollment into the current study year. For the exchange students, meeting of the course prerequisites will be checked by the Study committee of the School of Science.

Vsebina:	**Syllabus outline:**
1. TEMELJNA NAČELA STATISTIČNE FIZIKE Statistične porazdelitve; Statistična neodvisnost; Liouvilleov izrek; Pomen energije; Entropija; Zakon večanja entropije. 4 ure 2. TERMODINAMIČNE KOLIČINE Temperatura; Adiabatski procesi; Tlak; Delo in količina toplote; Toplotna funkcija; Prosta energija in termodinamski potencial; Termodinamska temperaturna skala; Nernstov izrek; Odvisnost termodinamskih količin od števila delcev; Ravnovesje telesa v zunanjem polju. 6 ur 3. GIBBSOVA PORAZDELITEV IN IDEALNI PLINI	1. THE FUNDAMENTAL PRINCIPLES OF STATISTICAL PHYSICS Statistical distributions; Statistical independence; Liouville's theorem; Significance of energy; Entropy; The law of increase of entropy. 4hrs 2. THERMODYNAMIC QUANTITIES Temperature; Adiabatic processes; Pressure; Work and quantity of heat; The heat function; The free energy and the thermodynamic potential; The thermodynamic scale of temperature; Nernst's theorem; The dependence of the thermodynamic quantities on the number of particles; Equilibrium of a body in an external field. 6hrs

Gibbsova porazdelitev; Maxwellova porazdelitev; Prosta energija v Gibbsovi porazdelitvi; Gibbsova porazdelitev za spremenljivo število delcev. Boltzmannova porazdelitev; Boltzmannova porazdelitev v klasični statistiki; Prosta energija idealnega Boltzmannovega plina; Enačba stanja idealnega plina; Idealni plini s konstantno specifično toploto; Ekviparticijski zakon; Monatomni idealni plini.8 ur 4. PORAZDELITVE FERMI IN BOSE Fermijeva porazdelitev; Bosejeva porazdelitev; Fermijev in Bosejev plin osnovnih delcev; Degeneriran plin elektronov ; Specifična toplota degeneriranega plina elektronov; Degeneriran Bosejev plin; Sevanje črnega telesa.6 ur 5. FAZNO RAVNOTEŽJE IN FAZNI PREHODI Pogoji faznega ravnotežja. Clapeyron-Clausiusova formula. Kritična točka in zakon ustreznega stanja (na primeru van der Waalsove formule). Klasifikacija faznih prehodov. Kritični pojavi in teorija Landau. 6 ur 6. RAZTOPINE Sistemi, ki vsebujejo različne delce. Fazno pravilo. Razredčene raztopine. Osmotski tlak. Fazna meja na stiku tekočina-tekočina. Ravnotežje topljenca. Sprememba toplote in prostornine pri raztapljanju. Mešanice idealnih plinov. Parni tlak koncentriranih raztopin. 6 ur 7. KEMIJSKE REAKCIJE Pogoj za kemijsko ravnotežje. Zakon vpliva mas. Reakcijska toplota. 4 ure	3. THE GIBBS DISTRIBUTION AND IDEAL GASES The Gibbs distribution; The Maxwellian distribution; The free energy in the Gibbs distribution; The Gibbs distribution for a variable number of particles. The Boltzmann distribution; The Boltzmann distribution in classical statistics; The free energy of an ideal Boltzmann gas; The equation of state of an ideal gas; Ideal gases with constant specific heat; The law of equipartition; Monatomic ideal gases.8hrs 4. THE FERMI AND BOSE DISTRIBUTIONS The Fermi distribution; The Bose distribution; Fermi and Bose gases of elementary particles; A degenerate electron gas; The specific heat of a degenerate electron gas; A degenerate Bose gas; Black-body radiation.6hrs 5. PHASE EQUILIBRIUM AND PHASE TRANSITIONS Conditions of phase equilibrium. The Clapeyron-Clausius formula. The critical point and the law of corresponding state (on the example of van der Waals formula). Classification of phase transitions. Critical phenomena and Landau theory. 6hrs 6. SOLUTIONS Systems containing different particles. The phase rule. Weak solutions. Osmotic pressure. Solvent phases in contact. Equilibrium with respect to the solute. Heat and volume changes at dissolution. Mixtures of ideal gases. Vapour pressure over concentrated solutions. 6 hrs 7. CHEMICAL REACTIONS The condition for chemical equilibrium. The law of mass action. Heat of reaction. 4 hrs

Temeljni literatura in viri / Basic readings:
1. 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). 2. K. Huang, *Statistical mechanics*. New York: Wiley (1987). 3. R. Kubo, N. Saito and M. Toda: *Statistical Physics I: Equilibrium Statistical Mechanics.* Springer Series of Solid-State Sciences (1998).

Cilji in kompetence:	**Objectives and competences:**
Osnovno poznavanje konceptov statistične	Basic knowledge of concepts, approaches and

fizike, njenih modelov, pristopov in metod, pri čemer so poudarjene teme iz področja fizike trdne snovi.	methods of Statistical Mechanics with the special attention to Solid State Physics topics.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Sposobnost opisovanja in analiziranja obnašanja statističnih sistemov z uporabo splošnih načel statistične mehanike in termodinamike.	Ability to describe and analyze the behavior of statistical systems, using general principles of statistical mechanics and thermodynamics.

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

Načini ocenjevanja:	**Utež / Weight (%)**	**Assessment:**
- ustni izpit	100	- 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 the University of Nova Gorica.

Izbrane publikacije / selected publications:

1. BADASYAN, Artem, TONOYAN, Sh. A., VALANT, Matjaž, GRDADOLNIK, Jože. Implicit water model within the Zimm-Bragg approach to analyze experimental data for heat and cold denaturation of proteins. *Communications chemistry*. 2021, vol. 4, str. 1-8, ilustr. ISSN 2399-3669. https://doi.org/10.1038/s42004-021-00499-x

2. BADASYAN, Artem, VALANT, Matjaž, GRDADOLNIK, Jože, UVERSKY, Vladimir N. The finite size effects and two-state paradigm of protein folding. *International journal of molecular sciences*. Feb. 2021, vol. 22, iss. 4, str. 1-7, ilustr. ISSN 1422-0067. https://www.mdpi.com/1422-0067/22/4/2184

3. BADASYAN, Artem. System size dependence in the Zimm-Bragg model : partition function limits, transition temperature and interval. *Polymers*. 2021, vol. 13, iss. 12, str. 1-11, ilustr. ISSN 2073-4360. https://www.mdpi.com/2073-4360/13/12/1985

4. TONOYAN, Sh. A., KHECHOYAN, Davit, MAMASAKHLISOV, Yevgeni S., BADASYAN, Artem. Statistical mechanics of DNA-nanotube adsorption. *Physical review. E*. Jun. 2020, vol. 101, iss. 6, str. 062422-1-062422-5, ilustr. ISSN 2470-0045. DOI: 10.1103/PhysRevE.101.062422.

5. PEZHUMKATTIL PALAKKAL, Jasnamol, VALANT, Matjaž, BADASYAN, Artem, et al. Unusual magnetodielectric effects in La2CuMnO6 induced by a dynamic crossover in dielectric relaxation at TC. *Materials research bulletin*. [Print ed.]. Apr. 2018, vol. 100, str. 226-233, ilustr. ISSN 0025-5408. DOI: 10.1016/j.materresbull.2017.12.027.