UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Statistična termodinamika
Course title:	Statistical Thermodynamics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 2. st.		1	1
Physics 2nd degree		1	1

Vrsta predmeta / Course type obvezni/compulsory

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
30	0	45	0	0	165	**8**

Nosilec predmeta / Lecturer: Milan Brumen, Jure Dobnikar

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski/Slovenian in/and angleški/English
	Vaje / Tutorial:	slovenski/Slovenian in/and angleški/English

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

Formalno oziroma neformalno osvojeno znanje iz vsebin predmetov Mehanika, Termodinamika, Elektromagnetizem, Nihanje in valovanje, Moderna fizika.

Prerequisits:

Formal or informal knowledge from subjects Mechanics, Thermodynamics, Electromagnetism, Vibrational and Wave motion, Modern Physics.

Vsebina:

1. Termodinamika. Makroskopska stanja in termodinamične spremenljivke. Enačbe stanja. Zakoni termodinamike. Termodinamični potenciali. Fazne spremembe. Osnove neravnovesne termodinamike.
2. Osnovni pojmi teorije verjetnosti. Diskretne in zvezne porazdelitve verjetnosti.
3. Statistična mehanika. Mikroskopska stanja in princip maksimalne entropije. Teorija ansamblov: mikrokanoničen, kanoničen in velekanoničen ansambel ter porazdelitvene funkcije. Boltzmannova statistika. Primeri: idealni plin, idealna raztopina, kristal; toplotna kapaciteta idealnega plina in trdne snovi, paramagnetizem, enačba stanja realnega plina, kemijske reakcije.
4. Osnove kvantne statistične mehanike. Idealni Bosejevi in Fermijevi sistemi. Primeri: harmonski oscilator, idealni plin, sevanje črnega telesa, elektroni v kovini.
5. Kinetična teorija transportnih procesov. Difuzija snovi, prevajanje toplote, viskoznost.
6. Izbrani primeri iz biologije in kemije. Struktura vode in voda kot topilo. Ionske in polimerne raztopine. Elektrokemijski potencial, osmozni tlak,

Content (Syllabus outline):

1. Thermodynamics. Macro states and state variables. Equations of state. The laws of thermodynamics. Thermodynamic potentials. Phase transitions. Introduction to non-equilibrium thermodynamics.
2. Principles of probability. Probability distribution functions.
3. Statistical mechanics. Microstates and the principle of maximum entropy. The ensemble theory: microcanonical, canonical and grand canonical ensemble and partition functions. Boltzmann statistics. Examples and applications: ideal gas and ideal solution, solids; heat capacity; paramagnetism, equation of state of real gases, chemical reactions.
4. Introduction to quantum statistics. Ideal Bose and Fermi systems. Examples and applications: ideal gas, harmonic oscillator, black-body radiation, the electron gas in metals.
5. Kinetic theory of transport processes. Diffusion, heat conduction, viscosity.
6. Selected examples from biology and chemistry. Structure of water and water as a solvent. Ionic and polymer solutions. Electrochemical potential, transmembrane potential, osmotic pressure,

prekomembranski potencial, transport vode in ionov preko celične membrane. Električno nabite površine v ionski raztopini. Adsorpcija. Kooperativna vezava ligandov. Encimske reakcije. Kinetika kemijskih reakcij.	transmembrane transport of water and ions. Charged surfaces in ionic solutions. Adsorption. Cooperative ligand binding. Enzymatic reactions. Chemical kinetics.

Temeljni literatura in viri / Readings:

1. W. Greiner, L. Neise, H. Stöcker: Thermodynamics and Statistical Mechanics, Springer, New York 1997.
2. F. Reif: Statistische Physik und Theorie der Wärme, Walter de Gruyter, Berlin 1987.
3. I. Kuščer, S. Žumer: Toplota, DMFA, Ljubljana 1987
4. K.A. Dill, S. Bromberg: Molecular Driving Forces, Statistical Thermodynamics in Chemistry and Biology, Garland Science, New York 2003

Cilji in kompetence:	**Objectives and competences:**
Podati metode in koncepte fizikalnega opisa sistemov na mikroskopski in makroskopski ravni s poudarkom na njuni medsebojni povezanosti.	Students gain methods and concepts of description of systems on the micro and macroscopic scales with the interrelationship between the two levels emphasized.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje procesov v naravi (primeri iz fizike, kemije in biologije) na makroskopski in mikroskopski ravni. Pri tem študentje osvojijo kvantitativne matematično fizikalne pristope in metode opisa teh pojavov. Prenesljive/ključne spretnosti in drugi atributi: Celosten pristop k reševanju problemov in izdelavi matematičnih modelov. Osvojiti znanja uporabne matematike. Sposobnost prepoznati problem in ga teoretično obravnavati v okviru koceptov in metod statistične termodinamike.	Knowledge and Understanding: Understanding of processes in nature (examples from physics, chemistry and biology) on the macroscopic as well as microscopic scales. The students acquire to use quantitative mathematical and physical methods in comprehensive description of these phenomena. Transferable/Key Skills and other attributes: An integral approach to solving problems and elaborating the corresponding mathematical models. To gain advanced mathematical tools. Ability to identify problems and describe them theoretically within the scope of methods of statistical thermodynamics.

Metode poučevanja in učenja:	**Learning and teaching methods:**
- Predavanja - Seminar - Računske vaje	- Lectures - Seminar - Tutorials

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
pisni in ustni izpit	70	written and oral exam
seminarska naloga	30	course work

Reference nosilca / Lecturer's references:

Milan Brumen:

DOBOVIŠEK, Andrej, ŽUPANOVIĆ, Paško, BRUMEN, Milan, BONAČIĆ LOŠIĆ, Željana, KUIĆ, Domagoj, JURETIĆ, Davor. Enzyme kinetics and the maximum entropy production principle. *Biophysical chemistry*. [Print ed.], 2011, vol. 154, iss. 2/3, str. 49-55, doi: 10.1016/j.bpc.2010.12.009. [COBISS.SI-ID 18206984]

MBIKOU, Prisca, FAJMUT, Aleš, BRUMEN, Milan, ROUX, Etienne. Contribution of Rho kinase to the early phase of the calcium-contraction coupling in airway smooth muscle. *Exp. physiol. (Print)*, 2011, vol. 96, issue 2, str. 240-258, ilustr., doi: 10.1113/expphysiol.2010.054635. [COBISS.SI-ID 18009864]

DOBOVIŠEK, Andrej, FAJMUT, Aleš, BRUMEN, Milan. Role of expression of prostaglandin synthases 1 and 2 and leukotriene C [sub] 4 synthase in aspirin-intolerant asthma: a theoretical study. *Journal of pharmacokinetics and pharmacodynamics*, 2011, vol. 38, no. 2, str. 261-278, doi: 10.1007/s10928-011-9192-6. [COBISS.SI-ID 18203144]

DOBOVIŠEK, Andrej, FAJMUT, Aleš, BRUMEN, Milan. Strategy for NSAID administration to aspirin-intolerant asthmatics in combination with PGE [sub] 2 analogue: a theoretical approach. *Med. biol. eng. comput.*. [Print ed.], 2012, vol. 50, no. 1, str. 33-42, doi: 10.1007/s11517-011-0844-x. [COBISS.SI-ID 18845192]

BOHINC, Klemen, SHRESTHA, Ahis, BRUMEN, Milan, MAY, Sylvio. Poisson-Helmholtz-Boltzmann model of the electric double layer : analysis of monovalent ionic mixtures. *Phys. rev., E Stat. nonlinear soft matter phys. (Print)*, 2012, vol. 85, no. 3, str. 031130-1-031130-12, doi: 10.1103/PhysRevE.85.031130. [COBISS.SI-ID 4353131]

Jure Dobnikar:

KANDUČ, Matej, DOBNIKAR, Jure, PODGORNIK, Rudolf. Counterion-mediated electrostatic interactions between helical molecules. *Soft matter*, 2009, issue 5, vol. 5, str. 868-877, doi: 10.1039/b811795k. [COBISS.SI-ID 2149988]

TRIZAC, Emmanuel, EL SHAWISH, Samir, DOBNIKAR, Jure. Dimeric and dipolar ground state orders in colloidal molecular crystals. *An. Acad. Bras. Cienc.*, 2010, vol. 82, no. 1, str. 87-94. [COBISS.SI-ID23483687]

EL SHAWISH, Samir, DOBNIKAR, Jure, TRIZAC, Emmanuel. Colloidal ionic complexes on periodic substrates : ground-state configurations and pattern switching. *Phys. rev., E Stat. nonlinear soft matter phys. (Print)*, 2011, vol. 83, no. 4, str. 041403-1-041403-10. [COBISS.SI-ID 24653095]

MATTHÄUS, Franziska, MOMMER, Mario S., CURK, Tine, DOBNIKAR, Jure. On the origin and characteristics of noise-induced Lévy Walks of E. Coli. *PLoS one*, 2011, vol. 6, no. 4, str. e18623-1-e18623-8.http://www.plosone.org/article/info:doi/10.1371/journal.pone.0018623. [COBISS.SI-ID 25045031]

CURK, Tine, HOOGH, Anouk de, MARTINEZ-VERACOECHEA, Francisco J., EISER, Erika, FRENKEL, Daan, DOBNIKAR, Jure, LEUNISSEN, Mirjam E. Layering, freezing, and re-entrant melting of hard spheres in soft confinement. *Phys. rev., E Stat. nonlinear soft matter phys. (Online)*. [Online ed.], 2012, vol. 85, iss. 2, str. 021502-1-021502-5. http://link.aps.org/doi/10.1103/PhysRevE.85.021502, doi:10.1103/PhysRevE.85.021502. [COBISS.SI-ID 518221081]