Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Moderna fizika**
Course title:	**Modern Physics**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika, 1. stopnja		**2**	**4**
Physics, 1st cycle		**2**	**4**

Vrsta predmeta / Course type	Obvezni/Compulsory
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
60		**30**			**150**	**8**

Nosilec predmeta / Lecturer:	Samo Kralj

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian
	Vaje / Tutorial:	slovenski/Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Priporočljivo je predznanje klasične fizike. Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno.	Preknowledge of classical physics is recommended. Each of the listed obligations in the assessment methods must be completed with a positive grade.

Vsebina:	**Content (Syllabus outline):**

Posebna teorija relativnosti. Osnovni načeli, Lorentzova transformacija, skrčenje dolžine in podaljšanje časa, Dopplerjev pojav, lastna polna in kinetična energija; poskusi, ki potrjujejo enačbe posebne teorije relativnosti. Uvod v kvantno fiziko. Fotoefekt, Comptonov pojav, zavorno sevanje, interferenčni poskusi s curki delcev; nedoločenost lege in gibalne količine, Rutherfordov in Bohrov model atoma; laser. Osnove kvantne fizike. Valovna funkcija, pričakovane vrednosti; osnovni zakon za stacionarni primer, delec v potencialni jami, tunelski pojav, harmonski oscilator. Vodikov atom. Lastne energije in lastne funkcije stanja, degeneriranost stanj, ionizacijska energija; magnetni moment in Stern-Gerlachov poskus, spin elektrona, polna vrtilna količina in polni magnetni moment; vodikov spekter, širina spektralnih črt. Atomi z več elektroni. Izključitveno načelo, periodni sistem elementov. Molekule. Ionska, kovalentna vez in Van der Wallsova vez. Vezi v kristalih. Energijski nivoji elektronov v kristalih, ionski in kovalentni kristali, kovine, polprevodniki, polprevodniški elementi. Lastnosti jedra in nukleonov. Modeli, radioaktivni razpad; jedrske reakcije, verižni razcep, zlitje; delci, antidelci, ohranitveni zakoni, merilniki delcev; standardni model delcev, elementarne sile in delci; Kozmologija. Big Bang; moderne kozmološke teorije.	Special theory of relativity. Postulates, Lorentz transformation, length contraction and time dilatation, Doppler effect; energy; experimental verifications Semi-quantum mechanics. Fotoeffect, Compton effect, x-ray spectrum, interference of particles; exclusion principle; Rutherford and Bohr atom; laser. Fundamentals of quantum mechanics. Wave function, expected values; Schroedinger equation, particle in a potential well, tunnelling, harmonic oscillator. Hydrogen atom. Eigen states&spectrum, degeneracy, ionisation energy; magnetic moment and Stern-Gerlach experiment, spin, total momentum; hydrogen spectrum, line width. Atoms with more electrons. Pauli exclusion principle, periodic system of elements. Molecules. Ionic, covalent and Van der Walls bonds. Bonds in crystals. Energy levels; ionic, covalent and metal bonds; semiconductors. Atomic Nucleus. Models, radioactivity; nuclear reactions; particles&antiparticles; conservation laws; measuring cells; standard model, forces and elementary particles. Cosmology. Big Bang; modern cosmological theories.

Temeljni literatura in viri / Readings:

1. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, 5. izdaja, (John Wiley & Sons, Inc., New York, 1997).
2. J. Strnad, Fizika, 3. del, (DMFA, Ljubljana, 2002).
3. J. Strnad, Fizika, 4. del, (DMFA, Ljubljana, 2005).
4. I.V. Savelcev, Physics : a general course. 3, (Mir Publishers, Moscow, 1985)
5. Z. Bradač, Naloge iz fizike, (Pedagoška fakulteta Maribor, 1991).
6. M. Gros, M. Hribar, A. Kodre, J. Strnad, Naloge iz fizike, (DMFA, Ljubljana, 1991).
7. B. V. Stanić, M. I. Marković, Zbirka rešenih zadataka iz atomske fizike, (Nauka, Beograd, 1991).

Dodatna literatura / Additional Readings
1. L. Črepinšek, Uvod v moderno fiziko : učbenik za strojnike (Visoka tehniška, šola, Maribor, (1977).
2. A. Zorko, Zbirka rešenih nalog iz moderne fizike (DMFA, Ljubljana 2018).

Cilji in kompetence:

Študenti usvojijo temeljna teoretična znanja s področja modern fizike in jih znajo uporabiti pri reševanju ustreznih problemov z rabo matematičnih orodij.

Objectives and competences:

Students acquire basic theoretical knowledge in modern physics and are able to use the knowledge to solve problems with the use of mathematical tools.

Predvideni študijski rezultati:

Znanje in razumevanje:
Po uspešno zaključeni učni enoti bodo študenti zmožni:
- uporabiti osnovne enačbe kvantne mehanike za demonstracijo ključnih kvantnih pojavov v naravi;
- opisati osnovne lastnosti atomov, molekul in kristalov;
- napovedati kvalitativne lastnosti sistema v odvisnosti od sestavnih gradnikov sistema.

Prenesljive/ključne spretnosti in drugi atributi:
Razumevanje osnovnih procesov v naravi in celosten pristop k reševanju problemov.

Intended learning outcomes:

Knowledge and understanding:
On completion of this course students will be able to:
- use basic equations of quantum mechanics to demonstrate key quantum phenomena;
- describe basic properties of atoms, molecules and crystals;
- description of qualitative behaviour of system as a function of its basic ingredients.

Transferable/Key Skills and other attributes:
Understanding of basic processes in the nature and gained global approach to solving problems.

Metode poučevanja in učenja:

Learning and teaching methods:

predavanja in eksperimentalna predavanja (teoretičen uvod v problematiko z razlago in razgovorom, numerično reševanje posameznih problemov, demonstracijski poskusi pri predavanjih), teoretične vaje (delo s tekstom, metoda pisnih in grafičnih del, uporaba simulacij) elementi obrnjenega poučevanja Poučevanje in učenje potekata z didaktično uporabo informacijsko-komunikacijske tehnologije	Lectures and experimental lectures (theoretical introduction by explanation and discussion, numerical solving of specific problems, demonstration experiments during lectures) theoretical excercises (work with text, work with graphic elements, use of simulations) elements of flipped learning Teaching and learning are done through the didactic use of ICT.

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

Opombe:
Pisni izpit se lahko nadomesti z dvema pisnima kolokvijema.

Comments:
Written exam can be replaced by two written midterm examinations.

Reference nosilca / Lecturer's references:

1) ČREŠNAR, Dejvid, ROŽIČ, Brigita, KUTNJAK, Zdravko, KRALJ, Samo. Theoretical and experimental study of elastocaloric responses in liquid crystalline elastomers. *Journal of molecular liquids*. [Online ed.]. Nov. 2024, vol. 413, [article no.] 126058, str. 1-14, ilustr. ISSN 1873-3166. DOI: 10.1016/j.molliq.2024.126058. [COBISS.SI-ID 208151299],
2) SINGH, Varun, PAL, Kaushik, SINGH WATTS, Sarangat, ASTHANA, Nidhi, ALI KHAN, Azmat, FATIMA, Sabiha, JELEN, Andreja, KRALJ, Samo. Graphene oxide dispersed rose-petals based green chemistry synthesis of hybrid composite for novel spectroscopic applications. *Journal of molecular liquids*. [Print ed.]. 2024, vol. 414, art. 126166, 16 str. ISSN 0167-7322. DOI: 10.1016/j.molliq.2024.126166. [COBISS.SI-ID 211786243]
3) SVETEC, Milan, HARKAI, Saša, PAL, Kaushik, KRALJ, Samo. Twist disclinations mediated transformations in confined nematic liquid crystals. *Journal of molecular liquids*. [Online ed.]. 15 Nov. 2024, part b, [article no.] 126138, 10 str., ilustr. ISSN 1873-3166. DOI: 10.1016/j.molliq.2024.126138. [COBISS.SI-ID 214061315]
4) JELEN, Andreja, ZID, Maha, PAL, Kaushik, RENUKA, Remya Rajan, ČREŠNAR, Dejvid, KRALJ, Samo. Nano and micro-structural complexity of nematic liquid crystal configurations. *Journal of molecular liquids*. [Print ed.]. 2024, vol. 415, part a, [article no.] 126275, 9 str., ilustr. ISSN 0167-7322. DOI: 10.1016/j.molliq.2024.126275, DOI: 20.500.12556/DKUM-91264. [COBISS.SI-ID 217792259]
5) HÖLBL, Arbresha, PAL, Kaushik, AHMAD, Irfan, ASIRI, Hatem Mohammed A, KRALJ, Samo. Colloid and nanoparticle-driven phase behavior in weakly perturbed nematic liquid crystals. *Journal of molecular structure*. [Print ed.]. Jul. 2024, vol. 1307, [article no.] 138002, 8 str. ISSN 0022-2860. DOI: 10.1016/j.molstruc.2024.138002. [COBISS.SI-ID 194451715]