UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Teoretična fizika
Course title:	Theoretical physics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Enoviti magistrski študijski program Pedagoška matematika	ni smeri	3	prvi ali drugi
Integrated Master's study programme Pedagogical Mathematics	none	3	first or second

Vrsta predmeta / Course type	izbirni

Univerzitetna koda predmeta / University course code:	M0544

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
60		30			120	7

Nosilec predmeta / Lecturer:	prof. Anton Ramšak

Jeziki / Languages:	Predavanja / Lectures:	slovenski/Slovene
	Vaje / Tutorial:	slovenski/Slovene

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

Vsebina:	Content (Syllabus outline):

Kratek pregled fizike: Zgodovinski pregled vseh fizikalnih področjih od fizike osnovnih delcev do kozmologije.

Osnovne konstante v fiziki: Fizikalne količine. Simetrije fizikalnih zakonov. Področja veljavnosti klasične nerelativistične in relativistične mehanike ter kvantne relativistične in nerelativistične mehanike.

Osnove klasične mehanike: Princip najmanjše akcije, Lagrangeove enačbe gibanja in ohranitveni zakoni. Sipanje delcev na centralno simetričnih potencialih. Sipalni preseki in doseg potencialov. Majhne oscilacije in harmonski oscilatorji. Gibanje togega telesa.

Posebna teorija relativnosti: Princip relativnosti in metrika Minkowskega. Lorentzove transformacije. Ohranitveni zakoni v relativistični mehaniki. Skalarji, vektorji, tenzorji. Relativistične enačbe gibanja v eni dimenziji.

Elektrodinamika: Delec v elektromagnetnem polju, vektor četverec elektromagnetnega polja. Prosto elektromagnetno polje, tenzor elektromagnetnega polja in Lagrangeova gostota. Maxwellove enačbe za prosto polje in za polje z izviri. Primeri.

Splošna teorija relativnosti: Gravitacijska sila. Newtonova mehanika in homogeni model vesolja. Ekvivalenčni princip. Kvalitativni pregled Einsteinovih enačb gibanja. Primeri.

Short overview of physics: Historic overview of all physics fields, from particle physics to cosmology.

Basics constants in physics: Physics quantities. Symmetries of laws of physics. Validity of classical non-relativistic and relativistic mechanics. Validity of relativistic and non-relativistic quantum mechanics.

Basics classical mehanics: Principle of least action, Lagrange equations of motion and conservation laws. Scattering of particles on spherically symmetric potentials. Scattering cross cection. Small oscillations of harmonic oscillators. Rigid body.

Special theory of relativity: Principle of relativity and Minkowski metric. Lorentz transformations. Conservation laws in relativistic mechanics. Scalars, vectors, tensors. Relativistic equations in one dimension. Examples.

Electrodynamics: Particles in electromagnetic field, four-vector of electromagnetic field. Free field, tensor of field, Lagrange density. Maxwells equations for fields with sources. Examples.

General theory of relativity: Gravitational force. Newton mechanics and homogeneous model of Universe. Equivalence principle. Qualitative overview of Einstein equations of motion. Examples.

Temeljni literatura in viri / Readings:

M. Mizushima: Theoretical physics, Wiley, New York, 1972.

A. S. Kompaneec: Teoretičeskaja fizika, Moskva, 1961.

L.D.Landau, E.M.Lifshitz: Mechanics and electrodynamics, Butterworth Heineman, 1996

The Feynman lectures on physics, Addison - Wesley,Massachusetts, 1966.

Cilji in kompetence:

Cilji: Razumevanje osnovnih fizikalnih teorij. Uporaba matematičnega opisa za razumevanje fizikalnih pojavov ter samostojnega reševanja preprostih fizikalnih problemov. Analiza problema, iskanja enačb gibanja in robnih pogojev za dani problem, razpoznavanja simetrij, reševanje enačb ter interpretacije rešitev.

Kompetence:

Teoretično razumevanje.

Sposobnost modeliranja in reševanja fizikalnih problemov.

Globlje poznavanje teorije kvantne mehanike.

Sposobnost iskanja po strokovni literaturi.

Objectives and competences:

Objectives: Understanding of basical physical theories. Application of mathematical description to understand physical phenomena. The analysis of problems, search for equations of motion, boundary conditions, symmetries, solving and critical interpretation of solutions. Acquired competence:

Theoretical understanding.

Modeling and solving the models of physical systems.

In depth knowledge of the quantum mechanics.

Acquired capacity to do independent literature search.

Predvideni študijski rezultati:

Znanje in razumevanje: Sposobnost analize preprostih fizikalnih problemov, jih opisati z matematičnimi modeli in interpretirati rezultate.
Uporaba: Vsaj nekaj pri tem predmetu pridobljenega znanja bo kot učitelj lahko prenesel na dijake. Širše poznavanje problemov pa mu bo pomagalo, da bo dijakom predstavil realne probleme.

Refleksija: Uporaba že osvojenih matematičnih znanj v fiziki pomaga študentu poglobiti razumevanje osnovnih matematičnih metod.

Prenosljive spretnosti – niso vezane le na en predmet: Sposobnost opaziti problem, ga analizirati, poiskati način reševanja problema in razpoznati, ali je rešitev, ki jo je našel, smiselna.

Intended learning outcomes:

Knowledge and understanding: Analysis of physical problems, description with mathematical models and interpretation of results.
Application: A broader understanding of problems will help to motivate students to connect mathematical formalism to practical problems.

Reflection: Application of mathematical methods in physics will help to get a deeper understanding of mathematical background.

Transferable skills: Ability to spot a problem, to analyse it, to find a method to solve it and finally, critically to discuss the solution.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, individualne konzultacije, računske vaje, domače naloge.	Lectures, numerical exercices, homeworks and consultations.

Načini ocenjevanja:	**Delež (v %) / Weight (in %)**	**Assessment:**
2 pisna kolokvija iz vaj, ustni izpit. Ocene 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL).	50%	2 tests on numerical exercises or a written examination, oral examination. Grading: 1-5 (negative), 6-10 (positive).
	50%	

Reference nosilca / Lecturer's references:

Anton Ramšak:

– RAMŠAK, Anton, SEGA, Igor, JEFFERSON, J. H. Entanglement of two delocalized electrons. Physical review. A, Atomic, molecular, and optical physics, ISSN 1050-2947, 2006, 74, str. 010304-1-010304-4 [COBISS.SI-ID 1923428]

– RAMŠAK, Anton, MRAVLJE, Jernej, ŽITKO, Rok, BONČA, Janez. Spin qubits in double quantum dots : entanglement versus Kondo effect. Physical review. B, Condensed matter and materials physics, ISSN 1098-0121, 2006, 74, str. 241305-1-1241305-4 [COBISS.SI-ID 1962340]

– RAMŠAK, Anton. Geometrical view of quantum entanglement. Europhysics letters, ISSN 0295-5075, 2011, issue 4, article number 40004, str. 40004-p1-40004-p6 [COBISS.SI-ID 2373220]

– RAMŠAK, Anton. Geometric analysis of entangled qubit pairs. New journal of physics, ISSN 1367-2630. [Online ed.], 2011, vol. 13, no. 10, str. 103037-1-103037-7 [COBISS.SI-ID 2373476]

– ČADEŽ, Tilen, JEFFERSON, J. H., RAMŠAK, Anton. A non-adiabatically driven electron in a quantum wire with spin-orbit interaction. New journal of physics, ISSN 1367-2630. [Online ed.], 2013, vol. 15, art. no. 013029, 11 str [COBISS.SI-ID 2526308]