Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Matematična fizika 2**
Course title:	**Mathematical Physics 2**

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
45		**30**			**165**	**8**

Nosilec predmeta / Lecturer: Mitja Slavinec

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Priporočljiva predznanja so: formalno in neformalno predznanje na področjih matematične analize, algebre, mehanike, elektromagnetizma, termodinamike. Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Opravljena seminarska naloga je pogoj za pristop k pisnemu izpitu. Pozitiven pisni izpit je pogoj za pristop k ustnemu izpitu.	Recommended preknowledge: formal or non-formal knowledge in the field of mathematical analysis, algebra, mechanics, electromagnetism, thermodynamics. Each of the listed obligations in the assessment methods must be completed with a positive grade. Completed seminar paper is a prerequisite for taking the written exam. A positive grade of the written exam is a prerequisite for taking the oral exam.

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

1) Vektorji Skalarna in vektorska polja, gradient (tokovi in potenciali), divergenca, rotor, drugi odvodi, Gaussov teorem, Stokesov teorem. 2) Analitične aproksimacije Linearna interpolacija, Diracova delta funkcija, Taylorjeva vrsta funkcije več spremenljivk, limite, variacijski račun, Euler-Lagrangeeve enačbe. 3) Funkcijska analiza Fourierova transformacija, Laplaceova transformacija, korelacijske funkcije, avtokorelacijska funkcija. 4) Navadne diferencialne enačbe Hitrostna polja, analitične metode reševanja, primeri enačb prvega reda, enodimenzionalna stacionarna polja, reševanje s pomočjo Laplaceove transformacije. 5) Parcialne diferencialne enačbe Valovna, difuzijska in Schrödingerjeva enačba, metoda separacije, robni pogoji, reševanje s pomočjo Fourierove transformacije, Greenove funkcije. 6) Verjetnostni račun Splošni pojmi, porazdelitve (zvezna, Gaussova, Maxwellova, Poissonova), spektri, povprečja, fluktuacije, stohastični procesi, simulacije Monte Carlo.	1) Vectors Scalar and vector fields, gradient (flows and potentials), divergence, curl, second derivatives, Gauss theorem, Stokes theorem. 2) Analytical approximations Linear interpolation, Dirac delta function, Taylor series of function of multiple variables, limits, variational calculus, Euler–Lagrange equations. 3) Functional analysis Fourier transformation, Laplace transformation, correlation functions, autocorrelation function. 4) Ordinary differential equations Velocity fields, analytical methods, few examples of ordinary differential equations, used in physics, one dimensional stationary fields, Laplace transformation method. 5) Partial differential equations Wave, diffusion equation and Schrödinger equation, method of separation of variables, boundary conditions, Fourier transformation method, Green functions. 6) Probability calculus General introduction, distributions (continuous, Gauss, Maxwell, Poisson), spectra, averages, fluctuations, stochastic processes, Monte Carlo simulations.

Temeljni literatura in viri / Readings:

- M. Ambrožič, R. Repnik, M. Slavinec, Višja matematika v fiziki (Fakulteta za naravoslovje in matematiko, Univerza v Mariboru, 2018).
- M. Slavinec, M. Ambrožič, R. Repnik: Matematična fizika 1 (Fakulteta za naravoslovje in matematiko, Univerza v Mariboru, 2016).
- Kuščer, A. Kodre: Matematika v fiziki in tehniki (DMFA, Ljubljana 2016)..
- G. B. Arfken, H. J. Weber: Mathematical Methods for Physicists (Academic Press, San Diego, 1995).
- V. S. Vladimirov (urednik): A Collection of problems on the Equations of Mathematical Physics (Mir Publishers, Moscow, 1986).

Dodatna literatura / Additional Readings:

- K.F. Riley, M.P. Hobson, S.J. Bence: Mathematical Methods for Physics and Engineering (Cambridge University Press, Cambridge, 2005).
- B. M. Budak, A. A. Samarskii, A. N. Tikhonov: A collection of problems on Mathematical Physics (Pergamon Press, New York, 1980).
- I. Rubinstein, L. Rubinstein, Partial diferencial equations in classical mathematical physics (Cambridge University Press, Cambridge, 1998).
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Cilji in kompetence:

Cilj predmeta je kompleksno razumevanje fizikalnih zakonitosti in pridobitev sposobnosti za kvantitativni opis fizikalnih zakonitosti in napovedati ter izračunati rezultate

Objectives and competences:

The goal of this subject is complex understanding of physical laws and ability to qualitatively describe them, predict and calculate results.

Predvideni študijski rezultati:

Znanje in razumevanje:

Po uspešno zaključeni učni enoti je študent zmožen:

- razlikovati skalarna in vektorska polja ter uporabiti vektorske operatorje (gradient, divergenca, rotor),
- uporabiti analitične aproksimacije za poenostavitev fizikalnih problemov in analitično kvantitativno obravnavo,
- uporabiti operacije za funkcijsko analizo,
- izraziti dani fizikalni problem v obliki diferencialne enačbe oziroma sistema diferencialnih enačb in ga analizirati,
- razumeti verjetnostni račun za vse vrste naključnih spremenljivk in ga uporabiti v pomembnih naravoslovnih in družboslovnih aplikacijah,
- uporabiti zahtevna matematična orodja na konkretnih primerih,
- tvoriti ustrezne matematične modele za fizikalne probleme, oblikovati robne pogoje in vrednotiti ter interpretirati dobljene rezultate.

Intended learning outcomes:

Knowledge and understanding:

On completion of this course student is able to:

- distinguish between scalar field and vector field and use vector operators (gradient, divergence, curl),
- use analytical approximations to simplify physics problems and quantitative analysis,
- use operations for functional analysis,
- express a given physical problem in the form of differential equation or system of differential equations and analyse it,
- understand in detail the probability calculus for all types of random variables and is capable of using it in important nature and social science applications,
- use the demanding mathematical tools in specific examples,
- create suitable mathematical model for describing physics phenomena, formulate boundary conditions and evaluate and interpret results.

Prenesljive/ključne spretnosti in drugi atributi:	**Transferable/Key Skills and other attributes:**
Rešitev fizikalnih in tehničnih problemov z matematičnimi orodji in postopki.	Solution of physical and technical problems using the mathematical tools and methods.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja (razlaga, razgovor, demonstracija) in eksperimentalna predavanja Problemski pouk (postavitev problema, izbira potrebnih matematičnih orodij za reševanje, postavitev matematičnega modela, analitično in numerično reševanje, interpretacija dobljenih rešitev) Seminarske vaje (metoda dela s tekstom, metoda pisnih in grafičnih del, uporaba programskih orodij) Poučevanje in učenje potekata z didaktično uporabo informacijsko-komunikacijske tehnologije..	Lectures (explanation, discussion, demonstration) and experimental lectures Problem based learning (setting up physical problem, selection of appropriate mathematical tools, setting up a mathematical model, finding of an analytical or numerical solution, interpretation of obtained solutions) Seminar work (work with text, work with graphic elements, use of computer tools) Teaching and learning are done through the didactic use of ICT.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
pisni izpit	**40**	written exam
ustni izpit	**40**	oral exam
seminarska naloga	**20**	seminar paper

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:

HÖLBL, Arbresha, PAL, Kaushik, SLAVINEC, Mitja, KRALJ, Samo. Slave-master mechanism of thermotropic liquid crystal phase transitional behavior. *Physica. B, Condensed matter*. [Print ed.]. Oct. 2022, vol. 642, str. 1-8. ISSN 0921-4526. DOI: 10.1016/j.physb.2022.414142. [COBISS.SI-ID 117878531]

KLEMENČIČ, Eva, ZAVEC PAVLINIČ, Daniela, SLAVINEC, Mitja. Modelling the impact of moisture on the thermal conductivity of cotton jersey. *Fibres & textiles in Eastern Europe : an international magazine devoted to current problems of the textile industries in Central and Eastern Europe*. 2021, vol. 29, iss. 2 (146), str. 61-65. ISSN 1230-3666. http://www.fibtex.lodz.pl/article2286.html, DOI: 10.5604/01.3001.0014.6083. [COBISS.SI-ID 60647427]

LI, Wen-Jing, JIANG, Luo-Luo, CHEN, Zhi, PERC, Matjaž, SLAVINEC, Mitja. Optimization of mobile individuals promotes cooperation in social dilemmas. *Chaos, solitons and fractals*. [Print ed.]. Dec. 2020, vol. 141, str. 1-7. DOI: 10.1016/j.chaos.2020.110425. [COBISS.SI-ID 37159939]

HÂNCEAN, Marian-Gabriel, SLAVINEC, Mitja, PERC, Matjaž. The impact of human mobility networks on the global spread of COVID-19. *Journal of complex networks*. [Online ed.]. Dec. 2020, vol. 8, iss. 6, 14 str. ISSN 2051-1329. DOI: 10.1093/comnet/cnaa041. [COBISS.SI-ID 55149571]