Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Matematična fizika 1**
Course title:	**Mathematical Physics 1**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika, 1. stopnja		**2**	**3**
Physics, 1st cycle			

Vrsta predmeta / Course type obvezni/Compulsory

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
45		**30**			**135**	**7**

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:

Priporočljivo je predznanje na področjih matematične analize, algebre, mehanike, elektromagnetizma.

Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Pozitiven pisni izpit je pogoj za pristop k ustnemu izpitu.

Prerequisites:

Recommended is preknowledge in the fields of mathematical analysis, algebra, mechanics, electromagnetism.

Each of the listed obligations in the assessment methods must be completed with a positive grade. A positive grade of the written exam is a prerequisite for taking the oral exam.

Vsebina:

Content (Syllabus outline):

1.) Funkcije ene in več spremenljivk. Posebne funkcije (trigonometrična, eksponentna, logaritemska, hiperbolična), polinomi, grafi funkcij, funkcije kompleksne spremenljivke 2.) Odvod in integral. Hitrost, pospešek, moč, iskanje ekstremov, integriranje in določeni integral (delo, pot, energija), parcialni odvodi, klasifikacija ekstremov funkcij dveh spremenljivk, dvojni in trojni integral (masa, težišče, vztrajnostni moment) računanje z diferenciali, Taylorjeva vrsta.. 3.) Matrike in tenzorji Vektorska in tenzorska algebra, determinanta, inverzne matrike, kompleksne in hermitsko konjugirane matrike, lastni vektorji in lastne vrednosti, linearne transformacije in operatorji, sistemi linearnih enačb, fizikalna uporaba tenzorjev (vztrajnostni moment, dielektrična konstanta, toplotna prevodnost), Jonesove matrike. 4.) Fourierova analiza Opis sinusnih nihanj, Fourierove vrste, Fourierova transformacija. 5.) Navadne diferencialne enačbe Enačbe prvega reda, Mehanska nihanja (harmonsko nihanje, dušeno nihanje, vsiljeno nihanje, sklopljeno nihanje, majhna nihanja, aharmonska nihanja).	1) Functions of one and multiple variables Special functions (trigonometric, exponential, logarithmical, hyperbolic), polynomial, function Graph, function properties, functions of complex variable, vectors. 2) Derivative and integration Derivation velocity, acceleration, power), extreme finding, integration (work, length, energy), partial derivative (use in thermodynamics), lassification of two variable extremes, double triple integration (mass, centre of gravity, moment of inertia), Jacoby determinant. 3) Matrices and tensors Vectorial and tensorial algebra, determinants, reciprocal matrices, complex and Hermitian conjugated matrices, eigenvectors, eigenvalues, Linear transformations and operators, linear systems of equations, use of tensors in physics (moment of inertia, dielectric constants, heat conductivity), Jones matrices. 4.) Fourier Analysis Description of harmonic oscillations, Fourier Series, Fourier's Transformation 5.) Ordinary differential equations First order equations, mechanic oscillations, (harmonic oscillations, damped oscillations, forced oscillations, coupled oscillations, small oscillations, nonharmonic fluctuations).

Temeljni literatura in viri / Readings:

- 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).

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je kompleksno razumevanje fizikalnih zakonitosti in pridobitev sposobnosti za kvantitativni opis fizikalnih zakonitosti in napovedati ter izračunati rezultate.	The goal of this subject is complex understanding of physical laws and ability to qualitatively describe them, predict and calculate results.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po uspešno zaključeni učni enoti je študent zmožen: • razlikovati med funkcijami ene in več spremenljivk, jih narisati in analizirati, • uporabiti odvode za računanje ekstremnih vrednosti in računanje z diferenciali, • uporabiti razvoj v Taylorjevo vrsto pri obravnavi fizikalnih problemov, • razumeti pomen Fouriereve transformacije za analizo fizikalnih pojavov in razviti periodične funkcije v Fourierevo vrsto, • uporabiti znanje vektorske in tenzorske algebre za reševanje problemov, v katerih nastopajo tenzorske fizikalne količine, • opisati fizikalni sistem (dušeno, vsiljeno, sklopljeno nihanje) z uporabo navadnih diferencialnih enačb in kvantitativno napovedati rešitev navadne diferencialne enačbe. • tvoriti ustrezne matematične modele za opis fizikalnih pojavov, oblikovati ustrezne robne pogoje in vrednotiti ter interpretirati dobljene rezultate.	**Knowledge and understanding:** On completion of this course student will be able to: • distinguish between one variable and multivariable functions, draw and analyze them, • use derivatives to calculate extreme values and differential calculus, • apply Taylor's expansion to study physics problems, • understand the importance of Fourier transformation for analysis of physics phenomena and expand periodic functions to Fourier series, • apply knowledge of vector and tensor algebra to solve problems involving tensor physics quantities, • describe the system (damped, forced, couple oscillations) using ordinary differential equations and quantitatively estimate the solution of the ordinary differential equation, • create suitable mathematical model for describing physics phenomena, formulate boundary conditions and evaluate and interpret results.
Prenesljive/ključne spretnosti in drugi atributi: Reševanje fizikalnih in tehničnih problemov z matematičnimi orodji in postopki.	**Transferable/Key Skills and other attributes:** Problem solving in the field of physics and technics 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 Ustni izpit	**50** **50**	Written exam 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:

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]