



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:

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:

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

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

Pogojev ni.
Priporočljivo predznanje na področjih matematične analize, algebre, mehanike, elektromagnetizma.

Prerequisites:

None.
Recommended preknowledge in the field of mathematical analysis, algebra, mechanics, electromagnetism.

Vsebina:

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

Content (Syllabus outline):

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), classification

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).

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:

- Kuščer, A. Kodre: Matematika v fiziki in tehniki; DMFA; Ljubljana 1994.
- S. Pahor: Uvod v analitično mehaniko. DMFA, Ljubljana 1989.
- Vidav: Variacijski račun. DMFA, Ljubljana 1991.
- K.F. Riley, M.P. Hobson, S.J. Bence: Mathematical Methods for Physics and Engineering; Cambridge University Press; Cambridge 2000.
- Brešar: Matematika III; Fakulteta za elektrotehniko, računalništvo in informatiko Maribor, Maribor 1995.
- C. Harper: Introduction to Mathematical Physics. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1976.
- Arfken: Mathematical Methods for Physicists. New York, S. Francisco, London: Academic Press, 1970.
- B. M. Budak, A. A. Samarskii, A. N. Tikhonov: A collection of problems on Mathematical Physics. New York: Pergamon Press, 1980.
- V. Bitsadze, D. F. Kalinichenko: A Collection of problems on the Equations of Mathemammtical Physics. Moscow: Mir Publishers, 1980.
- Slavinec M., Ambrožič M., Repnik R. Matematična fizika 1, Fakulteta za naravoslovje in matematiko, Univerza v Mariboru, 2016.

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:

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 Fourierjeve transformacije za analizo fizikalnih pojavov in razviti periodične funkcije v Fourierjevo 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.

Prenesljive/ključne spretnosti in drugi atributi:

Reševanje fizikalnih in tehničnih problemov z matematičnimi orodji in postopki.

Intended learning outcomes:

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.

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:

<p>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)</p> <p>Poučevanje in učenje potekata z didaktično uporabo informacijsko-komunikacijske tehnologije.</p>	<p>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)</p> <p>Teaching and learning are done through the didactic use of ICT.</p>
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Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

<p>Pisni izpit (lahko se nadomesti z dvema pisnima kolokvijema) Ustni izpit</p> <p>Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno.</p> <p>Pozitivna ocena iz pisnega izpita je pogoj za pristop k ustnemu izpitu.</p>	<p>50 50</p>	<p>Type (examination, oral, coursework, project): Written exam (can be replaced by two written tests) Oral exam</p> <p>Each of the mentioned commitments must be assessed with a passing grade.</p> <p>Positive grade of written exam is a prerequisite for access to the oral exam.</p>
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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](https://doi.org/10.1016/j.physb.2022.414142). [COBISS.SI-ID [117878531](https://www.cobiss.si/id/117878531)]

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](https://doi.org/10.1016/j.chaos.2020.110425). [COBISS.SI-ID [37159939](https://www.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](https://doi.org/10.1093/comnet/cnaa041). [COBISS.SI-ID [55149571](https://www.cobiss.si/id/55149571)]