Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Napredne numerične metode v fiziki
Course title:	Advanced numerical methods in Physics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 2. st.		2	3
Physics 2nd degree		2	3

Vrsta predmeta / Course type izbirni/ optional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	**15**	**45**			**210**	**10**

Nosilec predmeta / Lecturer: Marko Gosak

Jeziki / Languages:	
Predavanja / Lectures:	slovenski/Slovenian in/and angleški/English
Vaje / Tutorial:	slovenski/Slovenian in/and angleški/English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Priporočljivo je predznanje osnov programiranja.	Basic programming skills are recommended.

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

Programski jeziki in orodja (C++, Python, Mathematica). Linearna in nelinearna analiza časovnih vrst, filtriranje podatkov, statistične analize, vizualizacija podatkov. Podatkovno rudarjenje. Monte Carlo, molekularna dinamika in stohastične metode simulacije. Numerična kvantna mehanika. Numerično reševanje navadnih in parcialnih diferencialnih enačb. Osnove procesiranja slik. Analize kompleksnih mrež.	Programming languages and tools (C++, Python, Mathematica). Linear and non-linear time series analysis, data filtration, statistical analyses, data visualization. Data mining. Monte Carlo, molecular dynamics and stochastic simulation methods. Numerical quantum mechanics. Numerical methods for ordinary and partial differential equations. Basics of image processing. Complex network analysis.

Temeljni literatura in viri / Readings:

1. D. Frenkel, B.J.Smit, Understanding Molecular Simulation,Elsevier, 2002
2. W.H. Press indr.: Numerical Recipes in C, Cambridge University Press, 1994
3. F.J. Vesely: Computational Physics, An Introduction, Plenum Press, 1994
4. R.H. Shumway, D.S. Stoffer: Time Series Analysis and Its Applications, Springer, 2011
5. R. H. Landau indr.: Computational Physics: Problem Solving with Python, Wiley-VCH, 2015

Cilji in kompetence:	**Objectives and competences:**
Študentje pridobijo poglobljeno znanje s področja obdelave podatkov in sodobnih numeričnih metod pri preučevanju realnih kompleksnih sistemov, s katerim se bodo sposobni samostojno lotiti novih fizikalnih problemov.	Students acquire advanced knowledge on data processing and advanced computational methods for investigating real complex systems, which will enable them to deal with new physical problems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent je sposoben: Izdelave lastnih algoritmov za napredne analize signalov, slik in drugih vrst podatkov.	Knowledge and Understanding: Student is able to: Create its own algorithms for advanced signal and image analysis, and data processing.

Uporabiti različne numerične metode za reševanje diferencialnih enačb za naslavljanje konkretnih problem iz različnih podroji. Samostojno se zna opredeliti za najboljšo metodo za dani problem. Uporabljati različne programske jezike in pozna prednosti in slabosti posameznih jezikov. Pri reševanju konkretnih problemov zna programske jezike tudi ustrezno kombinirati. Prenesljive/ključne spretnosti in drugi atributi: Spretnosti komuniciranja: ustni zagovor laboratorijskih vaj, pisno izražanje pri pisnem izpitu, predstavitev seminarja. Uporaba informacijske tehnologije: uporaba različnih programskih orodij za izračune in vizualizacijo. Reševanje problemov: reševanje problemov z uporabo računalnika in numeričnih metod.	Implement different numerical methods for solving differential equations for addressing concrete problems from various fields. He is able to decide for the best method for a given problem. Use different programming languages and knows the advantages and disadvantages of given languages. When dealing with concrete problems, he is able to combine different programming languages. Transferable/Key Skills and other attributes: Communication skills: oral lab work defence, manner of expression at written examination, presentation of seminars. Use of information technology: use of different programming tools for computation and visualization. Problem solving: problem solving with computers and numerical methods.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja Naloge Seminarji Vaje Problemsko učenje in metoda praktičnih del	Lectures Coursework Seminars Excersises Problem based learing and practical work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni izpit Seminar Rešene naloge	**25** **25** **50**	Oral exam Seminar Solved projects

Reference nosilca / Lecturer's references:

1. ŠTERK, Marko, DOLENŠEK, Jurij, SKELIN, Maša, KRIŽANČIĆ BOMBEK, Lidija, PARADIŽ, Eva, KERČMAR, Jasmina, PERC, Matjaž, RUPNIK, Marjan, STOŽER, Andraž (avtor, korespondenčni avtor), GOSAK, Marko (avtor, korespondenčni avtor). Functional characteristics of hub and wave-

initiator cells in β cell networks. Biophysical journal. 2023, vol. 122, iss. 5, str. 784-801, ilustr. ISSN 0006-3495. DOI: 10.1016/j.bpj.2023.01.039. [COBISS.SI-ID 141760003]

2. GOSAK, Marko, YAN-DO, Richard, LIN, Haopeng, MACDONALD, Patrick E., STOŽER, Andraž. Ca2+ oscillations, waves, and networks in islets from human donors with and without type 2 diabetes. Diabetes. Dec. 2022, vol. 71, iss. 12, str. 2584-2596. ISSN 1939-327X. DOI: 10.2337/db22-0004. [COBISS.SI-ID 130567683]

3. RISTIČ, David, GOSAK, Marko. Interlayer connectivity affects the coherence resonance and population activity patterns in two-layered networks of excitatory and inhibitory neurons. Frontiers in computational neuroscience. 2022, vol. 16, str. 1-16, ilustr. ISSN 1662-5188. DOI: 10.3389/fncom.2022.885720. [COBISS.SI-ID 105323267]