



Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Dinamični sistemi v okolju
Course title:	Dynamical Systems in the Environment

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

Vrsta predmeta / Course type

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
15	0	15	15	0	105	5

Nosilec predmeta / Lecturer:

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

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

Prerequisites:

Vsebina:

- 1. Okoljski sistemi kot dinamični sistemi**
Osnove dinamičnih sistemov (linearna in nelinearna dinamika, stacionarna stanja sistema, stabilnostna analiza, bifurkacije,)
- 2. Kompleksnost modelov**
Oscilirajoči in neoscilirajoči sistemi. Kaotično obnašanje kompleksnih sistemov. Pri kaotičnih sistemih poudarimo občutljivost na začetne pogoje in pomen za okoljske sisteme.
- 3. Modeliranje kompleksnih okoljskih sistemov**
Modeliranje kroženja vode v naravi, padavine, površinske vode in regulacija nivoja podtalnice, modeliranje propagiranja polutantov v zraku in v vodi. Antropogeni dejavniki v okoljskih sistemih. Modeliranje globalnega segrevanja, nalezljivih bolezni in potresov.
- 4. Računalniška simulacija in modelno napovedovanje**

Content (Syllabus outline):

- 1. Environmental systems – dynamical systems**
Basics about dynamical systems (linear and non-linear dynamics, steady states, stability analysis, bifurcations,)
- 2. Model complexity**
Oscillatory and non-oscillatory systems. Chaotic behaviour of complex systems. The extreme sensitivity of chaotic systems to initial conditions is pointed out for environmental systems.
- 3. Modelling of complex environmental systems**
Modelling of water-cycle, precipitations, surface water and regulation of the groundwater level, modelling of pollutants propagation in the air and water. Antropogen factors in environmental systems. Modelling of global warming, infectious diseases and earthquakes.
- 4. Computer simulation and model predictions**
Implementations of models in: Madonna, C++, ...

Implementacija modelov v različnih okoljih:
Madonna, C++,

Temeljni literatura in viri / Readings:

1. Steven H. Strogatz, Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry, and Engineering. Perseus Pub., Cambridge, 1994.
2. Natali Hritonenko, Yuri Yatsenko, Mathematical Modeling in Economics, Ecology and the Environment, Springer, New York, 1999.
3. Gongbing Peng, Lance Leslie, Yaping Shao, Environmental Modeling and Prediction, Springer, New York, 2002.
4. Strokovni in znanstveni članki v revijah / Articles published in professional and scientific journals.

Cilji:

Cilj predmeta je, da bodo študentje razumeli osnove matematičnega modeliranja kompleksnih okoljskih sistemov.

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Objectives:

The objective of the course is that the students will be able to understand the fundamental mathematical modelling of complex environmental systems.

- 1.

Predvideni študijski rezultati:

Znanje in razumevanje:

Po zaključku tega predmeta bo študent sposoben:

- kvalitativno in kvantitativno analizirati obravnavane dinamične okoljske sisteme,
- pridobiti in vrednotiti podatke o parametrih modelov iz različnih strokovnih virov, uporabiti računalniške programe za modeliranje sistemske dinamike,
- iz rezultatov matematičnega modeliranja oblikovati hipoteze okoljskih problemov.

Prenesljive/ključne spretnosti in drugi atributi:

- sposobnost uporabe računalniških orodij za modeliranje, numerično računanje ter analizo podatkov,
- sposobnost prenosa znanja na druge sisteme (povezava okoljskih in bioloških sistemov).

Intended learning outcomes:

Knowledge and Understanding:

On completion of this course the student will be able to:

- perform quantitative and qualitative analyses on environmental dynamical systems,
- acquire and evaluate data from different relevant sources to define model parameter values,
- use computer programs for modelling system dynamics,

based on results generated by mathematical modeling, define hypotheses regarding environmental problems.

Transferable/Key Skills and other attributes:

- Ability to use different computer-based tools for modelling, numerical computation and data analysis,
- a knowledge transfer is emphasised to other fields (interconnections between environmental and biological systems).

Metode poučevanja in učenja:

- Predavanja
- Vaje na računalniku
- Seminarske vaje

Learning and teaching methods:

- Lectures
- Computer exercises
- Seminar

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
izpit iz teoretičnega znanja	50	exam of theoretical knowledge project work
projektna naloga	50	

Reference nosilca / Lecturer's references:

- GRUBELNIK, Vladimir, GRUBELNIK, Lidija, MARKOVIČ, Rene, MARHL, Marko. Awareness of water on earth and in space from educational perspective. V: CELEC, Robert (ur.). *Sustainability as a way of life - from education to economy*. Hamburg: Verlag Dr. Kovač, 2022. Str. 57-74, graf. prikazi. Erziehung - Unterricht - Bildung, Bd. 201. ISBN 978-3-339-12438-8. ISSN 0945-487X. [COBISS.SI-ID [93647107](#)]
- GRUBELNIK, Vladimir, MARKOVIČ, Rene. Gibanje objektov v bližini Zemlje. V: SLAVINEC, Mitja (ur.). *Astronomi v Kmici : štiriindvajsetič*. Murska Sobota: AD Kmica: ZOTKS, 2021. Str. 10-14, ilustr. ISBN 978-961-95235-1-3. [COBISS.SI-ID [103917571](#)]
- MARKOVIČ, Rene, GOSAK, Marko, GRUBELNIK, Vladimir, MARHL, Marko, VIRTič, Peter. Data-driven classification of residential energy consumption patterns by means of functional connectivity networks. *Applied energy*, ISSN 0306-2619, 2019, vol. 242, str. 506-515, graf. prikazi, doi: [10.1016/j.apenergy.2019.03.134](https://doi.org/10.1016/j.apenergy.2019.03.134). [COBISS.SI-ID [1024346460](#)]
- GRUBELNIK, Vladimir, MARHL, Marko. Influence of the atmosphere on the average temperature of planets. V: CELEC, Robert (ur.). *Transfer of studies regarding environmental problems to the field of economy through education*, (Schriftenreihe Erziehung - Unterricht - Bildung, ISSN 0945-487X, Band 188). Hamburg: Dr. Kovač. 2018, str. 27-42. [COBISS.SI-ID [24301576](#)]
- GRUBELNIK, Vladimir, MARHL, Marko, REPNIK, Robert. Determination of the size and depth of craters on the moon. *CEPS journal : Center for Educational Policy Studies Journal*, ISSN 1855-9719, 2018, vol. 8, no. 1, str. 35-53, ilustr., graf. prikazi. <https://ojs.cepsj.si/index.php/cepsj/article/view/322/267>, doi: [10.26529/cepsj.322](https://doi.org/10.26529/cepsj.322). [COBISS.SI-ID [11968585](#)]