Univerza v Mariboru

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 2nd degree		2	3

Vrsta predmeta / Course type   izbirni/ optional

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		15	15		105	5

Nosilec predmeta / Lecturer: Vladimir Grubelnik

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Pogojev ni	None

Vsebina:

1. **Okoljski sistemi kot dinamični sistemi**
   Osnove dinamičnih sistemov (linearna in nelinearnadinamika, 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,

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,

nalezljivih bolezni in potresov.	infectious diseases and earthquakes.
4. Računalniška simulacija in modelno napovedovanje Implementacija modelov v različnih okoljih: Madonna, C++, ….	**4. Computer simulation and model predictions** Implementations of models in: 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:	**Objectives:**
Cilj predmeta je, da bodo študentje razumeli osnove matematičnega modeliranja kompleksnih okoljskih sistemov.	The objective of the course is that the students will be able to undestand the fundamental mathematical modelling of complex environmental systems.

Predvideni študijski rezultati: / **Intended learning outcomes:**

Znanje in razumevanje:	Knowledge and Understanding:
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.	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.
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).	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:	**Learning and teaching methods:**

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

Reference nosilca / Lecturer's references:

- 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. [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. [COBISS.SI-ID 11968585]
- GRUBELNIK, Vladimir. Povprečna letna osvetljenost vodoravne površine zemeljskega površja. V: SLAVINEC, Mitja (ur.). *Astronomi v Kmici : devetnajstič*. Murska Sobota: AD Kmica: ZOTKS. 2016, str. 12-14, graf. prikazi. [COBISS.SI-ID 24525832]
- FORJAN, Matej, GRUBELNIK, Vladimir. How well do students in secondary school understand temporal development of dynamical systems?. *European journal of science and mathematics education*, ISSN 2301-251X, 2015, vol. 3, 2, str. 185-204, ilustr. http://scimath.net/articles/32/327.pdf. [COBISS.SI-ID 808438]

- Predavanja
- Vaje na računalniku
- Seminarske vaje

- Lectures
- Computer exercises
- Seminar