



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Modeliranje pri pouku fizike
Course title:	Modelling in Physics Education

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		1. ali 2.	1., 2. ali 4.
PHYSICS		1. ali 2.	1., 2. or 4.

Vrsta predmeta / Course type

Izbirni za vse module

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje	Samost. delo Individ. work	ECTS
15					165	6

Nosilec predmeta / Lecturer:

Marko Marhl

Jeziki /

Languages:

Predavanja /

Lectures:

slovenski/Slovenian

Vaje / Tutorial:

slovenski/Slovenian

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

Ni posebnih pogojev.

Prerequisites:

No special prerequisites

Vsebina:

1. Pomen kvalitativne analize kompleksnih sistemov pri pouku fizike.
2. Uporaba kvantitativne analize dinamike kompleksnih sistemov: določanje spremenljivk v sistemu, ki opisujejo stanja in tokove. Medsebojni vplivi in zunanji vplivi na posamezne spremenljivke.

Content (Syllabus outline):

1. Importance of qualitative analysis of complex systems in physics education.
2. Application of quantitative analysis of complex systems dynamics: determination of system variables – the so-called stock and flow variables. Interrelated influences and external influences on the variables.

4. Konstruiranje matematičnih modelov pri pouku fizike; prikaz prednosti modelnega pristopa; primeri, ki so analitično težko rešljivi: npr. upoštevanje zračnega upora v primerih iz kinematike, ...; primeri, ki nakazujejo univerzalnost pristopov: npr. modeliranje radioaktivnih razpadov, ...

5. Aplikacije v fiziki in na drugih področjih: biološki sistemi, ekonomija, ...

6. Uporaba računalniških programov za modeliranje systemske dinamike: grafično orientirani programi DynaSys, Stella, Madonna, ...; primerjava z Excel, C++.

4. Construction of mathematical models in physics education; pointing out the advantages of the modelling approach; examples of analytically difficult-solvable problems: kinematics with air resistance, ...; examples of generalisation of approaches: e.g. modelling of radioactive decay, ...

5. Applications in physics and other fields: biology, economy, etc.

6. Using computer programs for modelling of system dynamics: graphic-oriented computer programmes: DynaSys, Stella, Madonna, ...; comparison with Excel, C++.

Temeljni literatura in viri / Readings:

- 1) J. W. Forrester, World Dynamics, Wright-Allen Press, Cambridge 1971.
- 2) H. P. Schecker, Physik-Modellieren, Grafikorientierte Modellbildungssysteme im Physikunterricht, Ernst Klett Verlag, Stuttgart (1998).
- 3) J. B. Snape, I. J. Dunn, J. Ingham, J. E. Prenosil, Dynamics of Environmental Bioprocesses, Modelling and Simulation, VCH Verlagsgesellschaft, Weinheim 1995.
- 4) Strokovni in znanstveni članki v revijah / Articles published in professional and scientific journals.

Cilji in kompetence:

- Usvojiti metode za kvalitativno analizo kompleksnih sistemov, ki so primerni za pouk fizike.
- Razvijati sposobnosti za opravljanje kvantitativne analize kompleksnih sistemov.
- Matematično modeliranje.
- Poudariti univerzalnost metod in prenos znanja na druga področja.
- Uporaba računalniških programov za modeliranje systemske dinamike.

Objectives and competences:

- Using of methods for qualitative analysis of complex systems in physics education.
- Developing skills for quantitative analysis of complex systems.
- Mathematical modelling.
- Universality of the methods and transfer of knowledge to other fields.
- Using computer programs for system dynamics modelling.

Predvideni študijski rezultati:

Intended learning outcomes:

<p>Znanje in razumevanje:</p> <ul style="list-style-type: none"> • Usvojiti metode za kvalitativno analizo kompleksnih sistemov. • Sposobnost opravljanja kvantitativne analize kompleksnih sistemov. • Usvojiti osnove matematičnega modeliranja. • Znati uporabljati računalniške programe za modeliranje sistemske dinamike. <p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> • Metode kvalitativne in kvantitativne analize dinamike sistemov so univerzalne in jih je mogoče uporabiti na najrazličnejših področjih. • Poudarek je na prenosu znanja s primerov iz fizike na področja populacijske dinamike, okoljskih problemov, bioloških sistemov, ...

<p>Knowledge and understanding:</p> <ul style="list-style-type: none"> • Developing skills for qualitative analysis of complex systems. • Developing skills for quantitative analysis of complex systems. • Be able to construct basic mathematical models. • Be able to use computer programs for modelling system dynamics. <p>Transferable/Key Skills and other attributes:</p> <ul style="list-style-type: none"> • Methods for qualitative and quantitative analysis of system dynamics are universal and can be implemented in different fields of research. • In particular, a knowledge transfer from examples in Physics to examples in population dynamics, environment and biological systems will be emphasised.
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<p>Metode poučevanja in učenja:</p> <ul style="list-style-type: none"> • Predavanja • Teoretične vaje • Vaje na računalniku • Eksperimentalne vaje

<p>Learning and teaching methods:</p> <ul style="list-style-type: none"> • Lectures • Theoretical exercises • Computer exercises • Experiments

Delež (v %) /

Načini ocenjevanja: Weight (in %)

Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
• ustni izpit	40%	• oral
• pisni izpit	40%	• written
• praktično - seminar	20%	• practical - seminar

Reference nosilca / Lecturer's references:

<p>1. FORJAN, Matej, MARHL, Marko, GRUBELNIK, Vladimir. Mathematical modelling of the electrostatic pendulum in school and undergraduate education. <i>European journal of physics</i>, ISSN 0143-0807, 2014, vol. 35, no. 1, str. 015022-1-015022-13, doi: 10.1088/0143-0807/35/1/015022. [COBISS.SI-ID 20357128]</p> <p>2. FORJAN, Matej, SLIŠKO, Josip, MARHL, Marko, GRUBELNIK, Vladimir. Do solved problems in Slovenian secondary school physics textbooks emphasize modeling process?. <i>Latin American</i></p>

journal of physics education, ISSN 1870-9095, 2014, vol. 8, no. 3, str. 383-389. http://www.lajpe.org/sep14/01_LAJPE_Matej_Forjan.pdf. [COBISS.SI-ID 775158]

3. GOSAK, Marko, MARKOVIČ, Rene, MARHL, Marko. The role of neural architecture and the speed of signal propagation in the process of synchronization of bursting neurons. *Physica. A, Statistical mechanics and its applications*, ISSN 0378-4371. [Print ed.], 2012, vol. 391, no. 8, str. 2764-2770, ilustr., doi: [10.1016/j.physa.2011.12.027](https://doi.org/10.1016/j.physa.2011.12.027). [COBISS.SI-ID 18948872]

4. BODENSTEIN, Christian, GOSAK, Marko, SCHUSTER, Stefan, MARHL, Marko, PERC, Matjaž. Modeling the seasonal adaptation of circadian clocks by changes in the network structure of the suprachiasmatic nucleus. *PLoS computational biology*, ISSN 1553-734X. [Print ed.], Sep. 2012, vol. 8, iss. 9, e1002697-1-e1002697-12, doi: [10.1371/journal.pcbi.1002697](https://doi.org/10.1371/journal.pcbi.1002697). [COBISS.SI-ID 19375368]

5. MARKOVIČ, Rene, GOSAK, Marko, REPNIK, Robert, KRALJ, Samo, MARHL, Marko. Defects in planar cell polarity of epithelium: what can we learn from liquid crystals?. V: IGLIČ, Aleš (ur.), KULKARNI, Chandrashekhhar (ur.). *Advances in planar lipid bilayers and liposomes*, (Advances in planar lipid bilayers and liposomes, ISSN 1554-4516, vol. 20). Amsterdam [etc.]: Elsevier: Academic Press, cop. 2014, str. 197-217, ilustr., doi: [10.1016/B978-0-12-418698-9.00008-3](https://doi.org/10.1016/B978-0-12-418698-9.00008-3). [COBISS.SI-ID 20825864]