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, 3. stopnja		**1. ali 2.**	**1., 2. ali 4.**
PHYSICS, 3rd cycle		**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:	**Prerequisits:**
Ni posebnih pogojev.	No special prerequisites

Vsebina:	**Content (Syllabus outline):**
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.	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 sistemske 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:	**Objectives and competences:**
Cilj tega predmeta je, da se študenti usposobijo uporabiti kvalitativni in kvantitativni opis dinamike sistemov pri svojem raziskovalnem delu. Operativni cilji so: • predstaviti metode metode za kvalitativno analizo kompleksnih sistemov, ki so primerni za pouk fizike; • razviti sposobnosti za opravljanje kvantitativne analize kompleksnih sistemov; • naučiti študente matematičnega modeliranja; • poudariti univerzalnost metod in prenos znanja na druga področja; • naučiti študente uporabljati računalniške programe za modeliranje sistemske dinamike.	The objective of this course is for students to be able to apply qualitative and quantitative description of systems dynamics in their research work. The operative objectives are: • presenting methods for qualitative analysis of complex systems in physics education; • developing skills for quantitative analysis of complex systems; • practicing mathematical modelling; • emphasizing universality of the methods and transfer of knowledge to other fields; • developing skills for using computer programs for system dynamics modelling.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku tega predmeta bo študent sposoben: • razumeti in uporabiti metode za kvalitativno analizo kompleksnih sistemov; • opravljati kvantitativne analize kompleksnih sistemov; • implementirati matematično modeliranje na praktičnih primerih v fiziki; • uporabljati računalniške programe za modeliranje sistemske dinamike. **Prenesljive/ključne spretnosti in drugi atributi:** • *Spretnosti komuniciranja:* ustni zagovor vaj, pisno izražanje pri pisnem izpitu. • *Uporaba informacijske tehnologije:* uporaba računalniških programov za modeliranje sistemov. • *Reševanje problemov:* reševanje problemov z uporabo matematičnega modeliranja dinamike sistemov. • *Prenos znanja na druga področja:* prenos znanja s primerov iz fizike na področja populacijske dinamike, okoljskih problemov, bioloških sistemov, …	**Knowledge and understanding:** On completion of this course the student will be able to: • understand and implement methods for qualitative analysis of complex systems; • carry out quantitative analysis of complex systems; • implement mathematical modelling on practical physical systems; • use computer programs for modelling system dynamics. **Transferable/Key Skills and other attributes:** • *Communication skills:* oral defense of practical work, manner of expression at written examination. • *Use of information technology:* use of computer programs for systems modelling. • *Problem solving:* problem solving with implementing mathematical modelling of systems dynamics. • *Transfer of knowledge to other fields:* knowledge transfer from examples in physics to examples in population dynamics, environment and biological systems, …

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja • Teoretične vaje • Vaje na računalniku • Eksperimentalne vaje	• Lectures • Theoretical exercises • Computer exercises • Experiments

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
• ustni izpit	**40%**	• oral
• pisni izpit	**40%**	• written
• izdelana seminarska naloga	**20%**	• written seminar work

Reference nosilca / Lecturer's references:

1. ROUX, Etienne, **MARHL, Marko**. Theoretical analysis of the vascular system and its relation to Adrian Bejan's constructal theory. *Journal of Theoretical and Applied Vascular Research*, ISSN 2532-0831, Feb. 2017, vol. 2, iss. 1, str. 1-6, doi: 10.24019/jtavr.20. [COBISS.SI-ID 24300552]

2. GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, PERC, Matjaž, RUPNIK, Marjan, **MARHL, Marko**. Critical and supercritical spatiotemporal calcium dynamics in beta cells. *Frontiers in physiology*, ISSN 1664-042X, 2017, vol. 8, str. 1-17, ilustr., doi: 10.3389/fphys.2017.01106. [COBISS.SI-ID 512760376]

3. MARKOVIČ, Rene, PELTAN, Julien, GOSAK, Marko, HORVAT, Denis, ŽALIK, Borut, SEGUY, Benjamin, CHAUVEL, Remi, MALANDAIN, Gregoire, COUFFINHAL, Thierry, DUPLÁA, Cécile, **MARHL, Marko,** ROUX, Etienne. Planar cell polarity genes frizzled4 and frizzled6 exert patterning influence on arterial vessel morphogenesis. *PloS one*, ISSN 1932-6203, 2017, vol. 12, iss. 3, str. 1-19, doi: 10.1371/journal.pone.0171033. [COBISS.SI-ID 22990856]

4. GOSAK, Marko, MARKOVIČ, Rene, DOLENŠEK, Jurij, RUPNIK, Marjan, **MARHL, Marko**, STOŽER, Andraž, PERC, Matjaž. Network science of biological systems at different scales : a review. *Physics of life reviews*, ISSN 1873-1457, 2018, vol. 24, str. 118-135, doi: 10.1016/j.plrev.2017.11.003. [COBISS.SI-ID 512746040]

5. MARKOVIČ, Rene, GOSAK, Marko, PERC, Matjaž, **MARHL, Marko**, GRUBELNIK, Vladimir. Applying network theory to fables : complexity in Slovene belles-lettres for different age groups. *Journal of complex networks*, ISSN 2051-1329. [Online ed.], 2019, vol. 7, issue 1, str. 114-127, doi: 10.1093/comnet/cny018. [COBISS.SI-ID 24086536]