Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Modeliranje sistemov v okolju
Course title:	Modelling of Environmental Systems

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Biologija in ekologija z naravovarstvom, 2. stopnja	/	1/2	Poletni/ Zimski
Biology and Ecology with Nature Conservation, 2nd cycle	/	1/2	Summer/ Winter

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code:

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
15	**15**	**15**			**135**	**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:

Pogojev ni.

Prerequisites:

None.

Vsebina:

- Okoljski sistemi: struktura, dinamika in razvoj sistemov
- Analiza sistemov
- Kvalitativna analiza sistemov
  - Določitev sistema in njegove okolice, ki pomembno vpliva na dinamiko sistema. Razgradnja sistema; prepoznavanje komponent sistema, določitev povezav med deli sistema, medsebojnih vplivov in zunanjih vplivov na sistem.

Content (Syllabus outline):

- Environmental systems: structure, dynamics and system's development
- Systems analysis
- Qualitative system analysis:
  - Determination of a system and its surrounding that considerably influences the systems dynamics. Decomposition of a system into components, determining the interrelations between the components, influences between the components and external influences on

○ Kvantitativna analiza dinamike sistemov Določanje spremenljivk v sistemu, ki opisujejo stanja in tokove. Medsebojni vplivi in zunanji vplivi na posamezne spremenljivke. • Opis dinamike sistemov ○ Kvalitativni opis dinamike sistemov: diagrami stanj in tokov, kavzalni diagrami. ○ Kvantitativni opis sistemske dinamike: prehod s kavzalnih diagramov in diagramov stanj in tokov na matematičen opis vpliva tokov količin na njihovo dinamiko; diferenčne enačbe; matematični model. • Modeliranje, simulacija, napovedi modelov • Konstruiranje preprostih modelov: populacijski modeli, modeli ekosistemov, kroženje snovi v naravi, modeli na celični ravni, ... Reševanje diferenčnih enačb v urejevalnikih tabel (Excel) – simulacija s poudarkom na napovedni moči modelov. • Uporaba računalniških programov: grafično orientirani računalniški programi za modeliranje sistemske dinamike: DynaSys, Stella, Vensim, Powersim, Madonna, ...	the system. ○ Quantitative analysis of system dynamics: Determination of system variables – the so- called stock and flow variables. Interrelated influences and external influences on the variables. • Description of system dynamics ○ Qualitative approaches in system dynamics: causal-loop diagrams, stock-flow diagrams. ○ Quantitative approaches in system dynamics: quantification of causal-loop diagrams and stock-flow diagrams; mathematical description of influences of fluxes on system variables; mathematical model. • Modelling, simulation, model prediction • Construction of simple models: models of population dynamics, ecosystems, models on cellular level, ... Solving of equations in spread-sheet programmes (Excel) – simulations with emphasis on predictive power of models. • Using computer programs: graphic-oriented computer programmes for modelling of system dynamics: DynaSys, Stella, Vensim, Powersim, Madonna, ...

Temeljni literatura in viri / Readings:

Obvezna:

S. P. Otto, S.A. & T. Day, A Biologist's Guide to Mathematical Modeling in Ecology and Evolution, Princeton University Press, 2007.

D. H. Meadows, D.H. Thinking in Systems, Chelsa Green Publishing, 2008.

Priporočena:

S. H. Strogatz, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, Westview Press, 2000.

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 naučijo uporabljati metode modeliranja okoljskih sistemov. Operativni cilji so: • predstaviti zvezo med strukturo, dinamiko in razvojem okoljskih sistemov;	The objective of this course is for students to use methods for modelling environmental systems. The operative objectives are: • presenting the relationship between structure, dynamics, and development of environmental

• predstaviti odnos med sistemskim mišljenjem in modeliranjem sistemske dinamike; • razviti sposobnosti za kvalitativno in kvantitativno analizo dinamike okoljskih sistemov; • poudariti uporabnost univerzalnih metod analize dinamike sistemov; • izpostaviti prenos znanja na druga področja	systems; • establishing the relationship between the system thinking and system dynamics modelling; • developing skills for qualitative and quantitative analysis of system dynamics; • emphasizing the universality of methods for system dynamics analysis; • knowledge transfer to other fields.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Po zaključku tega predmeta bo študent sposoben: • razumeti zvezo med strukturo, dinamiko in razvojem okoljskih sistemov; • uporabiti pristop sistemskega mišljenja za modeliranje sistemske dinamike; • uporbiti metode kvalitativne in kvantitativne analize dinamike okoljskih sistemov na enostavnih primerih; • uporabljati grafično orientirane računalniške programe za modeliranje in simulacijo dinamike sistemov.	On completion of this course the student will be able to: • understand the relationship between the structure, dynamics, and development of environmental systems; • use system thinking approach for modelling of system dynamics; • carry out a qualitative and quantitative analysis of system dynamics for simple systems; • use graphic-oriented computer programmes for modelling and simulation of dynamical systems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja • Seminar • Vaje na računalniku	• Lectures • Seminar • Computer exercises

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): • Seminarska naloga • Pisni izpit	**50** **50**	Type (examination, oral, coursework, project): • Seminar essay • Written exam

Reference nosilca / Lecturer's references:

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], [JCR, SNIP, WoS do 9. 6. 2019: št. citatov (TC): 42, čistih citatov (CI): 39, Scopus do 29. 5. 2019: št. citatov (TC): 57, čistih citatov (CI): 52]

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], [JCR, SNIP, Scopus do 29. 4. 2019: št. citatov (TC): 1, čistih citatov (CI): 1]

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], [JCR, SNIP, WoS do 12. 5. 2019: št. citatov (TC): 3, čistih citatov (CI): 2, Scopus do 29. 5. 2019: št. citatov (TC): 3, čistih citatov (CI): 2]

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]

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], [JCR, SNIP, WoS do 12. 5. 2019: št. citatov (TC): 5, čistih citatov (CI): 4, Scopus do 29. 5. 2019: št. citatov (TC): 6, čistih citatov (CI): 5]