UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Uvod v modeliranje in simulacijo dogodkovnih in zveznih sistemov
Course title:	Introduction to Modelling and Simulation of Discrete and Continuous Systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Informatika v sodobni družbi, visokošolski strokovni študijski program prve stopnje	-	Drugi	Četrti
Informatics in Contemporary Society, first cycle Professional Study Programme and Academic Study programme	-	Second	Fourth

Vrsta predmeta / Course type

Izbirni / Elective

Univerzitetna koda predmeta / University course code:

1-ISD-VS-IP-UMSDZS-2020-05-14

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	45	-	-	105	6

Nosilec predmeta / Lecturer:

izr. prof. dr. Blaž Rodič

Jeziki / **Languages:**	**Predavanja /** **Lectures:**	Slovenski / Slovenian, Angleški / English
	Vaje / Tutorial:	Slovenski / Slovenian, Angleški / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Študent/študentka mora pred pristopom k izpitu pripraviti in zagovarjati empirično seminarsko nalogo.	The student is obliged to prepare and defend their seminar paper before the admission to the examination.

Vsebina:	**Content (Syllabus outline):**
Uvod v predmet. Namen študija predmeta, povezanost predmeta z drugimi predmeti, vsebina študija predmeta, študijska literatura. Simulacija sistemov in reševanje poslovnih in organizacijskih problemov. *Diskretna dogodkovno orientirana simulacija.* Stohastične spremenljivke in verjetnostna funkcija. Verjetnostne porazdelitve in generiranje	*Introduction to the course* The purpose of the study object, integration with other subjects, study the course content, textbooks. Simulation systems and solving business and organizational problems. *Discrete event- oriented simulation* Stochastic variables and probability function. Probability distribution and generatig random variables.

slučajne spremenljivke. Modeli strežbe. • *Zvezna simulacija in sistemska dinamika.* Diferenčne in diferencialne enačbe v simulaciji. Vzročno posledični diagrami in referenčni odziv sistema. Razvoj modelov sistemske dinamike. Zbiranje podatkov, izračun statistike in analiza rezultatov. • *Agentna simulacija.* Vrste agentov. Primeri agentnih modelov. • *Uvod v projekt, Izbira teme projekta.* • *Testiranje in validacija modelov.* • *Načrtovanje eksperimentov.* • *Simulacijski primeri:* Kreativno Jedro: Simulacije in drugi projekti. • *Modeliranje kompleksnih sistemov.* • Metode iz projekta Kreativno Jedro: Simulacije.	Service models. • *Continuous simulation and system dynamics.* Difference and differential equations in simulation. Cause and effect diagram and reference system response. Development of system dynamics models. Data collection, calculation and statistical analysis results. • *Agent based simulation.* Agent types. Agent based model examples. • *Introduction to the project, choice of theme for the project.* • *Testing and validation of models.* • *Design of Experiments.* • *Simulation examples:* Creative Core: Simulations and other projects. • *Modelling complex systems.* • Automated model building (methods developed in Creative Core: Simulations).

Temeljni literatura in viri / Readings:

- Banks, J., Carson, J. S., Nelson, B. L. & Nicol, D. M. (2009). *Discrete-Event System Simulation* (5th ed.). Prentice Hall.
- Borschchev A. (2013). *The Big Book of Simulation Modeling. Multimethod Modeling with AnyLogic 6*. AnyLogic North America.
- Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin/McGraw-Hill.
- Law, A. (2014). *Simulation Modeling and Analysis* (5th ed.). McGraw-Hill.
- Kljajić, M. (1994). *Teorija sistemov*. Kranj: Moderna organizacija.
- Atanasijević-Kunc, M., Karba, R. & Zupančič, B. (2016). *Modeliranje in simulacija*. Založba FE.

Cilji in kompetence:

Cilji:
- seznaniti slušatelje s področjem uporabe dogodkovne simulacije in sistemske dinamike pri reševanju organizacijskih problemov
- spoznati metode in tehnike modeliranja po principih dogodkovne simulacije in sistemske dinamike
- obvladati kvantitativni pristop k izgradnji dogodkovnih modelov in modelov sistemske dinamike.
- obravnavati osnove simulacijskih jezikov
- osvojiti postopke priprave eksperimenta in interpretacijo rezultatov

Objectives and competences:

Objectives:
- the main objective of the course is to introduce the application of discrete simulation and system dynamics at solving of the organizational problems
- understand the methods and techniques of modeling by the principles of discrete event simulation and system dynamics
- learn the quantitative approach to the discrete event models building and system dynamics models
- learn the basics of simulation languages

- izvedba celovitega projekta s področja dogodkovne simulacije in sistemske dinamike na akademskem primeru.

Učna enota prispeva k razvoju naslednjih splošnih in predmetno-specifičnih kompetenc:

- sposobnost fleksibilne in aplikativne uporabe teoretičnega znanja
- razvoj in uporaba informacijsko komunikacijske tehnologije, sposobnosti in spretnosti v lokalnem in mednarodnem okolju
- sposobnost etične refleksije in zavezanost profesionalni etiki v družbenem okolju
- zmožnost vzpostavljanja in vzdrževanja odnosov za delo v skupini in z drugimi uporabniki ter skupinami (lokalna skupnost, organizacije javne uprave, gospodarstvo, nevladne organizacije)
- prizadevanje za kakovost strokovnega dela skozi avtonomnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje v strokovnem delu
- poznavanje in razumevanje interakcij med informacijsko komunikacijsko tehnologijo in sodobno družbo
- uporaba metodologij informatizacije poslovnih procesov v praksi
- sposobnost zapisati problem v obliki algoritma in pretvorba algoritma v računalniški program z uporabo sodobnih programskih orodij
- razumevanje in uporaba računalniških sistemov in arhitektur

- study the experimental design approaches and interpretation of the results
- conduct of the complete project in the field of discrete event simulation and system dynamics in an academic case

The instructional unit contributes to the development of the following general and subject-specific competences:

- ability to flexibly apply knowledge in practice
- development and the use of ICT, ability and skills in local and international environment
- competence to ethical reflexion and commitment to professional ethics in the social environment
- ability to establish and maintain relationships for group-work as well as with other users and groups (local communities, public administration organizations, industry, non-governmental organizations)
- striving to achieve quality of professional work through autonomy, (self) criticism, (self) reflexivity and (self) evaluation in professional work
- knowledge and understanding of interactions between ICT and the modern society
- the use of methodologies of business processes informatisation in practice
- the ability to write the problem in the form of an algorithm and converting the algorithm into a computer program using modern programming tools
- understanding and use of computer systems and architectures

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: *Študent/študentka pridobi znanja za:* - kvantitativno modeliranje organizacijskih problemov na področju proizvodnje, logistike in sistemov strežbe - analizo vhodnih podatkov, priprava in statistična obdelava - definicijo kriterijev in dinamično testiranje hipoteze pri izboru rešitve - optimizacija procesov z uporabo simulacijskih orodij	Knowledge and understanding: *The student has the knowledge of:* - quantitative modeling of organizational problems in manufacturing, logistics, and service systems - input data analysis, preparation and statistical processing - definition of criterions and dynamical hypothesis testing at the solution selection - process optimization using simulation tools

Metode poučevanja in učenja:	Learning and teaching methods:
- *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov) - *laboratorijske vaje* (uporaba simulacijskih orodij) - individualne in skupinske *konzultacije* (diskusija, dodatna razlaga, obravnava specifičnih vprašanj)	- *lectures* with active students' involvement (explanation, discussion, questions, examples, problem solving) - *laboratory work (usage of simulation tools)* - individual and group consultations (discussions, supplementary explanations, treatment of specific questions)

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
- pisni izpit - empirična seminarska naloga s poročili eksperimentalnih vaj ter predstavitev naloge	50 50	- written examination - empirical student assignment with the reports from experimental exercises together with the presentation of the assignment

Reference nosilca / Lecturer's references:

- RODIČ, Blaž. Industry 4.0 and the new simulation modelling paradigm. Organizacija : revija za management, informatiko in kadre, ISSN 1318-5454. [Tiskana izd.], aug. 2017, vol. 50, no. 3, str. 193-207, ilustr., doi: 10.1515/orga-2017-0017
- BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, 2018, vol. , iss. , str. https://link.springer.com/content/pdf/10.1007%2Fs10100-018-0600-5.pdf, doi: 10.1007/s10100-018-0600-5.
- KANDUČ, Tadej, RODIČ, Blaž. Optimisation of machine layout using a force generated graph algorithm and simulated annealing. International journal of simulation modelling, ISSN 1726-4529, 2016, vol. 15, no. 2, str. 275-287.

- RODIČ, Blaž, BAGGIA, Alenka. Dynamic airport ground crew scheduling using a heuristic scheduling algorithm. International journal of applied mathematics and informatics, ISSN 2074-1278, 2013, vol. 7, iss. 4, str. 153-163.
- RODIČ, Blaž. Mobile agents for distributed decision support systems. The International Scientific Journal of Management Information Systems, ISSN 1452-774X, 2011, vol. 6, no. 1, str. 20-27.
- RODIČ, Blaž, KLJAJIĆ, Miroljub. Accessing distributed data sources with mobile agents and XML. V: JAŠKOVÁ, Mária (ur.). ECON '05 : [selected research papers], (Research works proceedings, ISSN 0862-7908, Vol. 12, 2005). Ostrava: Technical University of Ostrava, Faculty of Economics. 2005, str. 280-287.
- RODIČ, Blaž, KLJAJIĆ, Miroljub. Integracija simulacijskih orodij v e-poslovni informacijski sistem. V: GRIČAR, Jože (ur.). Izboljšanje konkurenčnosti regije z e-poslovanjem, (Organizacija, ISSN 1318-5454, Letn. 37, 2004, št. 3). Kranj: Moderna organizacija. 2004, str. 162-167.
- ŠKRABA, Andrej, BAGGIA, Alenka, RODIČ, Blaž. Application of a group decision support system in the reform of study programmes. V: DONDON, Philippe (ur.). Recent advances in education and modern educational technologies, (Educational technologies series, 9). [S. l.: s. n.]. 2013, str. 128-134.
  RODIČ, Blaž. Issues of e-collaboration and knowledge management in media industries. V: LUGMAYR, Artur (ur.), et al. Information systems and management in media and entertainment industries, (International series on computer entertainment and media technology (Online), ISSN 2364-9488). Cham: Springer. cop. 2016.