

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

<b>Predmet:</b>	Uvod v modeliranje in simulacijo dogodkovnih in zveznih sistemov
<b>Course title:</b>	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 ali tretji	Četrta ali šesta
Informatics in Contemporary Society, first cycle Professional Study Programme	-	Second or third	Fourth or sixth

**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:**

Študent/študentka mora pred pristopom k izpitu pripraviti in zagovarjati empirično seminarsko nalogo.

**Prerequisites:**

The student is obliged to prepare and defend their seminar paper before the admission to the examination.

**Vsebina:**

- *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 slučajne spremenljivke.

**Content (Syllabus outline):**

- *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 generating random variables.  
Service models.

<p>Modeli strežbe.</p> <ul style="list-style-type: none"> <li>• <i>Zvezna simulacija in sistemska dinamika.</i> Diferenčne in diferencialne enačbe v simulaciji. Vzročno posledični diagrami in referenčni odziv sistema. Razvoj modelov sistemske dinamike. Zbiranje podatkov, izračun statistike in analiza rezultatov.</li> <li>• <i>Agentna simulacija.</i> Vrste agentov. Primeri agentnih modelov.</li> <li>• <i>Uvod v projekt, Izbira teme projekta.</i></li> <li>• <i>Testiranje in validacija modelov.</i></li> <li>• <i>Načrtovanje eksperimentov.</i></li> <li>• <i>Simulacijski primeri:</i> Kreativno Jedro: Simulacije in drugi projekti.</li> <li>• <i>Modeliranje kompleksnih sistemov.</i></li> <li>• <i>Metode iz projekta Kreativno Jedro: Simulacije.</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Continuous simulation and system dynamics.</i> 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.</li> <li>• <i>Agent based simulation.</i> Agent types. Agent based model examples.</li> <li>• <i>Introduction to the project, choice of theme for the project.</i></li> <li>• <i>Testing and validation of models.</i></li> <li>• <i>Design of Experiments.</i></li> <li>• <i>Simulation examples:</i> Creative Core: Simulations and other projects.</li> <li>• <i>Modelling complex systems.</i></li> <li>• <i>Automated model building (methods developed in Creative Core: Simulations).</i></li> </ul>
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### Temeljni literatura in viri / Readings:

<ul style="list-style-type: none"> <li>• Banks, J., Carson, J. S., Nelson, B. L. &amp; Nicol, D. M. (2009). <i>Discrete-Event System Simulation</i> (5<sup>th</sup> ed.). Prentice Hall.</li> <li>• Borschchev A. (2013). <i>The Big Book of Simulation Modeling. Multimethod Modeling with AnyLogic 6.</i> AnyLogic North America.</li> <li>• Sterman, J. D. (2000). <i>Business Dynamics: Systems Thinking and Modeling for a Complex World.</i> Irwin/McGraw-Hill.</li> <li>• Law, A. (2014). <i>Simulation Modeling and Analysis</i> (5th ed.). McGraw-Hill.</li> <li>• Kljajić, M. (1994). <i>Teorija sistemov.</i> Kranj: Moderna organizacija.</li> <li>• Atanasijević-Kunc, M., Karba, R. &amp; Zupančič, B. (2016). <i>Modeliranje in simulacija.</i> Založba FE.</li> </ul>
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### Cilji in kompetence:

<p>Cilji:</p> <ul style="list-style-type: none"> <li>• seznaniti slušatelje s področjem uporabe dogodkovne simulacije in sistemske dinamike pri reševanju organizacijskih problemov</li> <li>• spoznati metode in tehnike modeliranja po principih dogodkovne simulacije in sistemske dinamike</li> <li>• obvladati kvantitativni pristop k izgradnji dogodkovnih modelov in modelov sistemske dinamike.</li> <li>• obravnavati osnove simulacijskih jezikov</li> <li>• osvojiti postopke priprave eksperimenta in interpretacijo rezultatov</li> </ul>
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### Objectives and competences:

<p>Objectives:</p> <ul style="list-style-type: none"> <li>• the main objective of the course is to introduce the application of discrete simulation and system dynamics at solving of the organizational problems</li> <li>• understand the methods and techniques of modeling by the principles of discrete event simulation and system dynamics</li> <li>• learn the quantitative approach to the discrete event models building and system dynamics models</li> <li>• learn the basics of simulation languages</li> </ul>
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- izvedba celovitega projekta s področja dogodkovne simulacije in systemske 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:**

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

**Intended learning outcomes:**

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:**

- *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)*

**Learning and teaching methods:**

- *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:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):

- pisni izpit
- empirična seminarska naloga s poročili eksperimentalnih vaj ter predstavitev naloge

Delež (v %) /

Weight (in %) /

**Assessment:**

Type (examination, oral, coursework, project):

- 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, Mirosljub. 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, Mirosljub. 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.