

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
<b>Predmet:</b>	Osnove modeliranja in simulacije dogodkovnih in zveznih sistemov
<b>Course title:</b>	Fundamentals of 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, magistrski študijski program druge stopnje	-	Prvi ali drugi	Drugi ali četrti
Informatics in Contemporary Society, second cycle Masters Study Programme	-	First or second	Second or fourth

<b>Vrsta predmeta / Course type</b>	Izbirni / Elective
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<b>Univerzitetna koda predmeta / University course code:</b>	1-ISD-MAG-IP-OMSDZS-2016-06-21
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Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	15	-	30	75	5

<b>Nosilec predmeta / Lecturer:</b>	
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<b>Jeziki / Languages:</b>	<b>Predavanja / Lectures:</b> Slovenski, angleški / Slovene, English
	<b>Vaje / Tutorial:</b> Slovenski, angleški / Slovene, English

<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b> Študent/študentka mora pred pristopom k izpitu pripraviti in zagovarjati empirično seminarsko naložbo.	<b>Prerequisites:</b> The student is obliged to prepare and defend his/her assignments before the admission to the examination.
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<b>Vsebina:</b>	<b>Content (Syllabus outline):</b>
<ul style="list-style-type: none"> <li><i>Uvod v predmet.</i> Namen študija predmeta, povezanost predmeta z drugimi predmeti, vsebina študija predmeta, študijska literatura. Simulacija sistemov in reševanje poslovnih in organizacijskih problemov.</li> <li><i>Diskretna dogodkovno orientirana simulacija.</i> Stohastične spremenljivke in verjetnostna funkcija. Verjetnostne porazdelitve in generiranje</li> </ul>	<ul style="list-style-type: none"> <li><i>Introduction to the course.</i> The purpose of the study object, integration with other subjects, study the course content, textbooks. Simulation systems and solving business and organizational problems.</li> <li><i>Discrete event- oriented simulation</i> Stochastic variables and probability function. Probability distribution and generating random variables.</li> </ul>

<p>slučajne spremenljivke. Enakomerna, eksponentna in empirična porazdelitev. Modeli strežbe.</p> <p>Porazdelitve časov med prihodi in časov strežbe</p> <p>Disciplina vrste.</p> <p>Generiranje časov med prihodi in časov strežbe.</p> <ul style="list-style-type: none"> <li>• Zvezna simulacija in sistemski dinamika. Diferenčne in diferencialne enačbe v simulaciji.</li> </ul> <p>Vzročno posledični diagrami in referenčni odziv sistema.</p> <p>Oblikovanje dinamične hipoteze.</p> <p>Razvoj modelov sistemski dinamike.</p> <p>Zbiranje podatkov, izračun statistike in analiza rezultatov.</p> <ul style="list-style-type: none"> <li>• Testiranje in validacija modelov.</li> <li>• Načrtovanje eksperimentov.</li> <li>• Pregled simulacijskih jezikov: GPSS, AnyLogic.</li> <li>• Simulacijski primeri:</li> <p>Kreativno Jedro: Simulacije in drugi projekti.</p> <li>• Modeliranje kompleksnih sistemov:</li> <li>• Metode iz projekta Kreativno Jedro: Simulacije.</li> </ul>	<p>Uniform, exponential and empirical distribution.</p> <p>Service models.</p> <p>Distribution of time between arrivals and times of comfort and convenience.</p> <p>Queue discipline .</p> <p>Generating times between arrivals and times of comfort and convenience.</p> <ul style="list-style-type: none"> <li>• Continuous simulation and system dynamics.</li> </ul> <p>Difference and differential equations in simulation.</p> <p>Cause and effect diagram and reference system response.</p> <p>Creating a dynamic hypothesis.</p> <p>Development of system dynamics models.</p> <p>Data collection , calculation and statistical analysis results.</p> <ul style="list-style-type: none"> <li>• Testing and validation of models.</li> <li>• Design of Experiments.</li> <li>• Review of simulation languages: GPSS, AnyLogic.</li> <li>• Simulation examples: Creative Core: Simulations and other projects.</li> <li>• Modelling complex systems.</li> <li>• Automated model building (methods developed in Creative Core: Simulations).</li> </ul>
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#### **Temeljni literatura in viri / Readings:**

- Banks, J., Carson, J. S., Nelson, B. L., Nicol, D. M. (2009) Discrete-Event System Simulation, Prentice Hall.
- Borschchev A. (2013) The Big Book of Simulation Modeling. Multimethod Modeling with AnyLogic 6, AnyLogic North America.
- Grigoryev, I., Borschchev A. (2012) AnyLogic 6 in Three Days: A Quick Course in Simulation Modeling.
- Sterman, J. D. (2000) Business Dynamics: Systems Thinking and Modeling for a Complex World, Irwin/McGraw-Hill.
- Law, A., Kelton, W. D. (1999) Simulation Modeling and Analysis. McGraw-Hill.
- Severance, F. L. (2001) System Modeling and Simulation: An Introduction, John Wiley & Sons, Chichester.
- Kljajić M. (1994) Teorija sistemov, Fakulteta za organizacijske vede.
- Prašnikar J., Debeljak, Ž. (1998) Ekonomski modeli za poslovno odločanje, Gospodarski vestnik.

**Cilji in kompetence:****Cilji:**

- seznaniti slušatelje s področjem uporabe dogodkovne simulacije in sistemski dinamike pri reševanju organizacijskih problemov
- spoznati metode in tehnike modeliranja po principih dogodkovne simulacije in sistemski dinamike
- obvladati kvantitativni pristop k izgradnji dogodkovnih modelov in modelov sistemski dinamike
- obravnavati osnove simulacijskih jezikov
- osvojiti postopke priprave eksperimenta in interpretacijo rezultatov
- izvedba celovitega projekta s področja dogodkovne simulacije in sistemski dinamike na akademskem primeru

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

- poznavanje pomena kakovosti in prizadevanje za kakovost strokovnega dela skozi avtonomnost, samoiniciativnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje v strokovnem delu
- zmožnost za prepoznavanje in izkorisčanje priložnosti, ki se ponujajo v delovnem in družbenem okolju (ki se izkazujejo kot podjetniški duh in aktivno državljanstvo)
- usposobljenost za samostojno in avtonomno uporabo, nadzor in vzdrževanje informacijsko komunikacijske tehnologije v organizaciji
- poznavanje varnostnih vidikov elektronskega poslovanja
- poglobljeno razumevanje in kritično razmišljanje o zmožnostih in omejitvah informacijsko komunikacijskih tehnologij
- poznavanje programskih orodij in metodologij za analizo podatkov ter simulacije diskretnih oziroma zveznih modelov
- sposobnost analize stanja na področju informatizacije organizacije in izdelave

**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
- 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:*

- familiarity with the importance of quality, striving to maintain the quality of professional work through practicing autonomous behaviour, showing initiative, as well as through (self-) criticism, (self-)reflection and (self-) evaluation
- the ability to recognise and take advantage of the opportunities, arising in work and social environment (and shown as the entrepreneurial spirit and active citizenship);
- competence for independent and autonomous use, monitoring and maintenance of information communication technology in an institution
- knowledge of the security aspects of e - business
- in-depth understanding and critical thinking regarding the possibilities and limitations of information and communication technologies
- knowledge of programming tools and methodologies for data analysis and

predlogov za izboljšanje stanja	simulation of discrete and continuous models • competence to analyse the state in the field of informatisation of an organisation and generate suggestions for the improvement of said state
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#### **Predvideni študijski rezultati:**

Znanje in razumevanje:

Študent/študentka pridobi znanja za:

- kvantitativno modeliranje organizacijskih problemov na področju proizvodnje, logistike in sistemov storitve
- 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, obravnavanje 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)

Delež (v %) /

Weight (in %)

#### **Assessment:**

Način ocenjevanja:	Delenje	Delež (v %) / Weight (in %)	Type (examination, oral, coursework, project):
Način (pisni izpit, ustno izpraševanje, naloge, projekt): <ul style="list-style-type: none"> <li>• pisni/ustni izpit</li> <li>• empirična seminarska naloga s poročili eksperimentalnih vaj ter predstavitev naloge</li> </ul>	50 50		Type (examination, oral, coursework, project): <ul style="list-style-type: none"> <li>• written/oral examination</li> <li>• empirical student assignment with the reports from experimental exercises together with the presentation of the assignment</li> </ul>