

UČNI NAČRT PREDMETA / COURSE SYLLABUS						
<b>Predmet:</b>	Tehnologija CUDA v okoljih razširjene resničnosti					
<b>Course title:</b>	CUDA technology in Extended Reality Environments					
<b>Študijski program in stopnja</b> Study programme and level	<b>Študijska smer</b> Study field			<b>Letnik</b> Academic year	<b>Semester</b> Semester	
Razvoj videoiger in razširjenih resničnosti, visokošolski strokovni študijski program prve stopnje	-			Tretji	Peti	
Game and Extended Reality Development, first cycle Professional Study Programme	-			Third	Fifth	
<b>Vrsta predmeta / Course type</b>			Obvezni / Obligatory			
<b>Univerzitetna koda predmeta / University course code:</b>			4-RVRR-VS-TCUDAORR-2025-09-19			
<b>Predavanja</b> Lectures	<b>Seminar</b> Seminar	<b>Vaje</b> Tutorials	<b>Klinične vaje</b> work	<b>Druge oblike študija</b>	<b>Samost. delo</b> Individ. work	<b>ECTS</b>
30	-	45	-	-	105	6
<b>Nosilec predmeta / Lecturer:</b>			izr. prof. dr. Pavle Boškosi			
<b>Jeziki / Languages:</b>		<b>Predavanja / Lectures:</b>	Slovenski, angleški / Slovene, English			
		<b>Vaje / Tutorials:</b>	Slovenski, angleški / Slovene, English			
<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>			<b>Prerequisites:</b>			
Študenti predhodno osvojijo vsebine predmetov 3D modeliranje in 3D animacija likov.			Students first study the content of the courses in 3D modeling and 3D Character Animation.			
<b>Vsebina:</b>			<b>Content (syllabus outline):</b>			
<ul style="list-style-type: none"> <li>Osnovno razumevanje računalniške grafike.</li> <li>Osnovni koncepti programiranja CUDA: <ul style="list-style-type: none"> <li>Jedra: Funkcije, ki se izvajajo na GPE.</li> <li>Niti, bloki in mreže: Organiziranje vzporednega izvajanja.</li> </ul> </li> </ul>			<ul style="list-style-type: none"> <li>Fundamental understanding of computer graphics.</li> <li>Basic CUDA programming concepts <ul style="list-style-type: none"> <li>Kernels: Functions executed on the GPU.</li> <li>Threads, blocks, and grids: Organizing parallel execution.</li> <li>Memory management: Device and host memory, memory transfers.</li> </ul> </li> </ul>			

<ul style="list-style-type: none"> <li>○ Upravljanje pomnilnika: pomnilnik naprave in gostitelja, prenos pomnilnika.</li> <li>○ Vzporedna računalniška platforma in model API-ja, ki ga je ustvarila NVIDIA.</li> <li>○ Izkoriščanje moči grafičnih procesorjev za sprotno in kompleksno upodabljanje.</li> <li>• Uporaba OpenGL in DirectX.</li> <li>• Napredne tehnike renderiranja.</li> <li>• Uporaba NVIDIA orodij v okoljih razširjene resničnosti.</li> </ul>	<ul style="list-style-type: none"> <li>○ A parallel computing platform and API model created by NVIDIA.</li> <li>○ Leveraging the power of GPUs for real-time and complex rendering.</li> <li>• Use of OpenGL and DirectX.</li> <li>• Advanced rendering techniques</li> <li>• Use of NVIDIA tools in extended reality environments.</li> </ul>
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### Temeljni literatura in viri / Readings:

Literatura in viri se zaradi nenehnega razvoja posodablja v vsakem študijskem letu. / Readings will be updated annually.

- Lanaro, G., Nguyen, Q., Kasampalis, S. (2019). Advanced Python programming : build high performance, concurrent, and multi-threaded apps with Python using proven design patterns
- Ghor, A. (2020). RHCSA Red Hat Enterprise Linux 8 : training and exam preparation guide
- Needham, Timothy C. (2017). Python for beginners : a crash course guide to learn python in 1 week
- Linowes, J. (2020). Unity 2020 virtual reality projects : learn VR development by building immersive applications and games with Unity 2019.4 and later versions
- Venter, H., Ogterop, W. (2022). Unreal Engine 5 character creation, animation, and cinematics : create custom 3D assets and bring them to life with Unreal Engine 5 using MetaHuman, Lumen, and Nanite

### Cilji in kompetence:

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

#### Splošne kompetence:

- Usposobljenost za izvajanje vseh faz razvoja programskih rešitev: načrtovanje, razvoj, testiranje, implementacija in vzdrževanje.
- Prepoznavanje in ocenitev aktualnih in nastajajočih tehnologij in sodobnih metod, veščin in tehnik s področij videoiger in razširjenih resničnosti ter ocenitev njihove

### Objectives and competences:

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

#### General competences:

- Ability to perform all phases of software development: design, development, testing, implementation and maintenance.
- Identify and evaluate current and emerging technologies and contemporary methods, skills and techniques in the fields of video games and extended reality, and

<p>uporabnosti za reševanje potreb uporabnikov.</p> <ul style="list-style-type: none"> <li>• Sposobnost interdisciplinarnega povezovanja in nadgradnje znanj iz drugih sorodnih kreativnih področij.</li> <li>• Sposobnost samostojnega sledenja najnovejšim tehnološkim dosežkom in pridobivanja novih znanj, ki so uporabna v produkciji videoiger in razširjenih resničnosti.</li> <li>• Obvladovanje sodobnih orodij in specializirane programske opreme za obdelavo podatkov.</li> </ul> <p><i>Predmetno-specifične kompetence:</i></p> <ul style="list-style-type: none"> <li>• Razvijanje in optimiziranje programov za paralelno procesiranje na grafičnih procesorskih enotah s pomočjo CUDA tehnologije.</li> <li>• Strokovna uporaba CUDA zbirke orodij in drugih NVIDIA orodij za izboljšanje zmogljivosti in učinkovitosti pri renderiranju grafičnih modelov za okolja razširjene resničnosti.</li> </ul>	<p>assess their applicability to address user needs.</p> <ul style="list-style-type: none"> <li>• Ability to interdisciplinarily integrate and build on knowledge from other related creative fields.</li> <li>• Ability to independently keep up to date with the latest technological developments and gain new skills useful in video game and extended reality production.</li> </ul> <p>Expertise in modern data processing tools and specialised software.</p> <p><i>Subject-specific competences:</i></p> <ul style="list-style-type: none"> <li>• Develop and optimize programs for parallel processing on graphics processing units (GPUs) using CUDA technology.</li> <li>• Proficient use of CUDA Toolkit and other NVIDIA tools to improve performance and efficiency in rendering graphical models for Extended Reality environments.</li> </ul>
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### **Predvideni študijski rezultati:**

<p>Znanje in razumevanje:</p> <ul style="list-style-type: none"> <li>• Pridobijo znanje v osnovnih konceptih razvoja CUDA tehnologije.</li> <li>• Sposobnost razvijanja in prilagajanja programov, ki izkoriščajo paralelne zmogljivosti NVIDIA grafičnih kartic s pomočjo CUDA tehnologije.</li> <li>• Razumevanje uporabe OpenGL in DirectX za razširjena okolja.</li> <li>• Sposobnost uporabe različnih metodologij, ter uporabljati NVIDIA orodja.</li> <li>• Razumevanje in spretnost v uporabi NVIDIA orodij, kot sta CUDA zbirka orodij in OptiX, za optimizacijo in izboljšanje procesiranja slike.</li> <li>• Sposobnost medpredmetnega povezovanja NVIDIA orodji in virtualnih vsebin.</li> </ul>
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### **Intended learning outcomes:**

<p>Knowledge and understanding:</p> <ul style="list-style-type: none"> <li>• Gain knowledge in the basic concepts of CUDA technology development.</li> <li>• Ability to develop and adapt programs that exploit the parallel capabilities of NVIDIA graphics cards using CUDA technology.</li> <li>• Understanding of the use of OpenGL and DirectX for extended reality environments.</li> <li>• Ability to use various methodologies, and use NVIDIA tools.</li> <li>• Understanding and proficiency in using NVIDIA tools such as CUDA Toolkit and OptiX to optimize and improve image processing.</li> <li>• Ability to interoperate with NVIDIA tools and virtual content.</li> </ul>
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<p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> <li>• pridobljeno znanje se lahko uporabi pri vseh fazah razvoja videoiger in projektov v razširjeni resničnosti.</li> </ul> <p>OPOMBA: Nekatere vaje v okviru predmeta se izvajajo z uporabo naprav za virtualno realnost (VR) in razširjeno realnost (AR) ter spremljajoče opreme, prilagojene posebnim zahtevam vsake vaje.</p>
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<p>Transferable/key skills and other attributes:</p> <ul style="list-style-type: none"> <li>• acquired knowledge can be applied in all phases of video game and extended reality development projects.</li> </ul> <p>NOTE: Some exercises for the course are conducted using virtual reality (VR) and augmented reality (AR) devices and accompanying equipment tailored to the specific requirements of each exercise.</p>
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**Metode poučevanja in učenja:**

<p>Predmet je organiziran kot kombinacija teoretičnih predavanj, katerim bodo sledile praktične vaje in rezultirale v projektnih nalogah (projektno učenje). Študentje individualno delajo na projektni nalogi (v razredu in nato doma) s kreativno uporabo pridobljenega znanja. Dodatna raziskava je naloga s poudarkom na določenem delu splošne tematike predmeta. Raziskovanje, medpredmetno povezovanje vsebin, skupinsko in samostojno reševanje problemov, podprto s personaliziranim pristopom predavatelja, so temeljne metode poučevanja in učenja pri predmetu.</p>
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**Learning and teaching methods:**

<p>The course is organized as a combination of theoretical lectures, followed by practical exercises and resulting in project assignments (project-based learning). Students work individually on a project assignment (in class and then at home) with creative use of the acquired knowledge. Additional research is an assignment with an emphasis on a specific part of the general subject matter of the course. Research, interdisciplinary connection of content, group and independent problem solving, supported by a personalized approach of the lecturer, are the fundamental methods of teaching and learning in the course.</p>
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**Načini ocenjevanja:**

Delež (v %) /

Weight (in %) **Assessment:**

<ul style="list-style-type: none"> <li>• vaje</li> <li>• timski projekti</li> <li>• končni interaktivni prototip</li> </ul>	<p>25 %</p> <p>10 %</p> <p>65 %</p>	<ul style="list-style-type: none"> <li>• exercises</li> <li>• collaborative projects</li> <li>• final interactive prototype</li> </ul>
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**Reference nosilca / Lecturer's references:**

<ul style="list-style-type: none"> <li>• BOŠKOSKI, Pavle, PERNE, Matija, RAMEŠA, Martina, MILEVA BOSHKOSKA, Biljana. Variational Bayes survival analysis for unemployment modelling. Knowledge-based systems, ISSN 0950-7051. [Print ed.], 11 Oct. 2021, vol. 229, [article no.] 107335, str. 1-11, doi: 10.1016/j.knosys.2021.107335.</li> <li>• P. Boskoski. Towards digital transformation : implementation experience. International Conference on Information Society and Information Technologies - ITIS 2017, Novo mesto: Faculty of Information Studies 2017.</li> <li>• B. Mileva-Boshkoska, M. Bohanec, P. Boskoski, Đ. Juricic. Copula-based decision support system for quality ranking in the manufacturing of electronically commutated motors. Journal of intelligent manufacturing, 26 (2), 281-293, 2015.</li> </ul>
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- A. Debenjak, P. Boskoski, B. Musizza, M. Kern, A. Bicek. Informacijska arhitektura za proizvodno analitiko. Ventil : revija za fluidno tehniko in avtomatizacijo, ISSN 1318-7279, 23 (4), 284-288, 2017.
- DAMIJ, Nadja, BOŠKOSKI, Pavle, BOHANEC, Marko, MILEVA BOSHKOSKA, Biljana. Ranking of business process simulation software tools with DEX/QQ hierarchical decision model. PloS one, ISSN 1932-6203, 2016, vol. 11, no. 2, str. 1-16, doi: 10.1371/journal.pone.0148391.