UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Računalniške strukture in sistemi
Course title:	Computer Structures and Systems

Študijski program in stopnja Study programme and level	Modul Module	Letnik Academic year	Semester Semester
Informacijske in komunikacijske tehnologije, 2. stopnja	Računalniške strukture in sistemi	1	1
Information and Communication Technologies, 2nd cycle	Computer Structures and Systems	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	IKT2-698

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
60	30			60	450	20

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Gregor Papa Prof. dr. Peter Korošec

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina, angleščina / Slovenian, English
	Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Zaključen študijski program prve stopnje s področja naravoslovja, tehnike ali računalništva.	Student must complete first-cycle study programmes in natural sciences, technical disciplines or computer science.

Vsebina:	**Content (Syllabus outline):**
Uvod: Pregled razvoja računalništva, abstraktni nivoji računalniškega sistema. Osnovna računalniška arhitektura: Predstavitev podatkov v računalniških sistemih, enostaven računalniški sistem (CPE, vodilo, urini signali, vhodno/izhodni podsistem, prekinitve). CPE: Struktura, nabor ukazov, računska aritmetika. Vodilo: Vrste povezav, arhitekture, krmilni mehanizmi. Pomnilnik: Vrste pomnilnika, pomnilniška hierarhija, predpomnilnik, interni pomnilnik, zunanji pomnilnik, virtualni pomnilnik.	Introduction: Overview of development of computer systems, abstract levels of computing systems. Basic computer structure: Data representation in computer systems, a simple computer system (CPU, bus, clocks, input/output subsystem, interrupts). CPU: Structure, instruction set, computer arithmetic. Bus: Connection types, architectures, control mechanisms. Memory: Types of memory, memory hierarchy, cache memory, internal memory, external memory, virtual memory.

Periferija: Vrste vhodno/izhodnih enot, arhitekture, krmilni mehanizmi. Procesorske arhitekture: Procesorji z reduciranim naborom ukazov, procesorji s kompleksnim naborom ukazov, superskalarni procesorji, GPE. Vzporedne računalniške arhitekture: Topologije, deljen in porazdeljen način procesiranja, večjedrni procesorji, gruče, gridi. Metodologije snovanje računalniških sistemov: Osnovne polprevodniške tehnologije, glavni koraki sinteze sistema, jeziki za opis strojne opreme. Metodologije snovanja vgrajenih sistemov: Načrtovalske metodologije, arhitekture vgrajenih mikroprocesorjev. Metodologije sočasnega načrtovanja strojne in programske opreme: Koncepti sočasnega načrtovanja, delitev sistema na komponente strojne in programske opreme ter njihova sinteza. Meritve in analize zmogljivosti: Osnovni izračuni zmogljivosti računalniških sistemov, zgledovalno primerjanje, metrike, optimizacija delovanja procesorske enote.	Peripherals: Input/output unit types, architectures, control mechanisms. Processor architectures: Processors with reduced instruction set, processors with complex instruction set, superscalar processors, GPUs. Parallel computer architectures: Topologies, shared and distributed processing, multi-core processors, clusters, grids. Computer systems design methodologies: Basic semiconductor technologies, essential system synthesis steps, hardware description languages. Embedded system design methodologies: Design methodologies, architecture of embedded microprocessors. Methodologies for hardware/software codesign: Modeling concepts, system partitioning to hardware and software components, hardware/software codesign platforms, synthesis. Performance measurement and analysis: Basic approaches to computer performance evaluation, benchmarking, metrics, CPU performance optimization.

Temeljna literatura in viri / Readings:

Izbrana poglavja iz naslednjih knjig: / Selected chapters from the following books:

- P.R. Schaumont, *A Practical Introduction to Hardware/Software Codesign*. Springer, 2013, ISBN: 978-1-4614-3736-9
- W. Stallings, *Computer Organization and Architecture: Designing for Performance, 9 edition*. Prentice Hall, 2012. ISBN: 978-0132936330
- M. Wolf, *Computers as Components*. Academic Press, 2012. ISBN 978-0123884367
- P. Marwedel, *Embedded System Design*. Springer, 2011. ISBN: 978-94-007-0257-8
- L. Null, and J. Lobur, *The Essentials of Computer Organization and Architecture*. Jones & Bartlett Learning. 2010. ISBN: 978-1449600068

Cilji in kompetence:	**Objectives and competences:**
Cilj tega predmeta je posredovati splošno znanje o računalniški arhitekturi. Predstavljene so osnovne računalniške strukture (procesorji, pomnilnik, vhodno/izhodni podsistemi in sistemi za shranjevanje podatkov), ki imajo neposreden vpliv na izvajanje programov. Študij računalniške arhitekture se osredotoča na povezavo med strojno in programsko opremo. Izvedbeni primeri so opisani do mere, kolikor je potrebno za razumevanje struktur in delovanja računalniškega sistema. Slušatelji pridobijo osnovno teoretično razumevanje in praktične izkušnje s področja	The goal of this course is to provide an overview of computer architecture. The course introduces the major structures (processors, memory, input/output subsystems and storage systems) that have direct influence on the execution of programs. The study of computer architecture focuses on the interface between hardware and software. Implementation issues are covered to the extend necessary to understand the structure and operation of a computer system. Students gain basic theoretical understanding and practical knowledge of computer architecture (including advanced processor architectures, parallel

računalniških arhitektur (vključno z naprednimi procesorskimi arhitekturami, vzporednim procesiranjem in metodologijo snovanja vgrajenih sistemov), kar je predpogoj za dobro programiranje in učinkovite aplikacije v praksi.	processing, and principles of embedded system design), which is a prerequisite for good programming practice and efficient applications in practice.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili: • poznavanje razvoja računalništva in razumevanje konceptov računalniške arhitekture • poznavanje zgradbe in delovanja glavnih funkcijskih delov računalniških sistemov • zmožnost optimiziranja programske opreme ob upoštevanju značilnosti dane računalniške arhitekture • poznavanje naprednih računalniških arhitektur, njihovih lastnosti in omejitev z vidika možne uporabe v praksi • sposobnost integriranja znanja in obvladovanja zahtevnosti pri reševanju specifičnih problemov v računalniških aplikacijah • poznavanje konceptov zgledovalnega primerjanja in zmožnost interpretiranja in predstavitev rezultatov primerjanja	Students successfully completing this course will acquire: • Knowledge of development of computer systems and understanding of concepts of computer architecture • Knowledge of structure and operation of the main functional parts of computer systems • Ability to optimize programs by considering specifics of given computer architecture • Knowledge of the advanced computer architectures and awareness of their features and limits for possible applications in practice • Ability to integrate knowledge and handle complexity when solving specific problems in computer applications, • Knowledge with the concepts of benchmarking and be able to interpret and present the results of benchmarking.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar, konzultacije, individualno delo	Lectures, seminar, consultancy, individual work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga	50 %	Seminar work
Ustni zagovor seminarske naloge	50 %	Oral defense of seminar work

Reference nosilca / Lecturer's references:

- **G. Papa**, “Parameter-less algorithm for evolutionary-based optimization: for continuous and combinatorial problems,” *Computational Optimization and Applications,* vol. 56, no. 1, pp. 209-229, 2013.
- A. Biasizzo, F. Novak, and **P. Korošec**, “A multi-alphabet arithmetic coding hardware implementation for small FPGA devices,” *Journal of Electrical Engineering*, vol. 64, no. 1, pp. 44-49, 2013.
- **P. Korošec**, M. Vajteršic, J. Šilc, and R. Kutil, “Multi-core implementation of the differential ant-stigmergy algorithm for numerical optimization,” *Journal of Supercomputing*, vol. 63, no. 3, pp. 757–772, 2013.
- K. Tashkova, **P. Korošec**, and J. Šilc, “A Distributed Multilevel Ant-Colony Algorithm for the Multi-Way Graph Partitioning,” *International Journal of Bio-Inspired Computation*, vol. 3, no. 5, pp. 286-296, 2011.
- T. Garbolino, and **G. Papa**, “Genetic algorithm for test pattern generator design, Automatic evolution of circuits,” *Applied Intelligence*, vol. 32, no. 2, pp. 193-204, 2010.