Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	RAČUNALNIŠKE ARHITEKTURE
Course title:	COMPUTER ARCHITECTURE

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
PREDMETNI UČITELJ Enovit magistrski študijski program druge stopnje	PREDMETNI UČITELJ	3.	5.
SUBJECT TEACHER Five-year master's degree program Subject Teacher	SUBJECT TEACHER		

Vrsta predmeta / Course type	Obvezni / Compulsory
Univerzitetna koda predmeta / University course code	UR09

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30	0	45	0	0	105	6

Nosilec predmeta / Lecturer:	JANEZ BREST

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenščina / Slovene
	Vaje / Tutorial:	Slovenščina / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
• Ni pogojev	• None

Vsebina:	**Content (Syllabus outline):**
• Uvod: zgodovinski pregled računalniških arhitektur, strojne komponente, zmogljivost, predstavitev podatkov. • Instrukcijska množica: karakteristike, načini naslavljanj, instrukcijski formati, semantični prepad, zbirni jezik. • Arhitektura 80x86: zgodovinski pregled, zgradba, načini delovanja, instrukcijska množica CISC. • Komponente računalnika: centralno procesna enota, instrukcijski cikel, pomnilnik, naprave, prekinitve. • Pomnilnik: hierarhija, zgodovinski pregled, zunanji pomnilnik, analitični modeli zmogljivosti. • Predpomnilnik: vloga, struktura, funkcije preslikave, politika pisanja. • Operacijski sistem: arhitekturni vidik, večopravilnost, upravljanje s pomnilnikom, razvrščanje procesov. • Navidezni pomnilnik: razdeljevanje in ostranjevanje, izmenjevanje, tabela strani, TLB, segmentacija. • Centralno procesna enota: struktura, registri, notranja vodila, mikroprogram, izvršitev instrukcije. • Cevenje: pohitritve, podroben instrukcijski cikel, stopnje cevenja, hazardi, predvidevanje vejitev. • Paralelne arhitekture: superskalarnost, procesorji SMP, NUMA, grozdne arhitekture.	• Introduction: historic overview of computer architectures, hardware components, performance, data representation. • Instruction set: characteristics, addressing modes, instruction formats, semantic gap, assembly language. • Architecture 80x86: historic overview, structure, modes of operation, CISC instruction set. • Computer components: central processing unit, instruction cycle, memory, devices, interrupts. • Memory: hierarchy, historic overview, external memory, analytical performance models. • Cache: role, structure, mapping functions, writing policy. • Operating system: architectural view, multitasking, memory management, scheduling. • Virtual memory: partitioning, paging, swapping, page table, TLB, segmentation. • Central processing unit: structure, registers, datapath, microprogram, instruction execution. • Pipelining: speedup, detailed instruction cycle, pipelining levels, hazards, branch prediction. • Parallel architectures: superscalar, SMP, NUMA, cluster architectures.

Temeljna literatura in viri / Readings:

• Stallings, W. (2013). Computer organization and architecture: designing for performance (9th ed., International ed., p. 786). Pearson Education.
• Hennessy, J. L., & Patterson, D. A. (2012). Computer architecture: a quantitative approach (5th ed., p. 1 zv. (loč. pag.)). Morgan Kaufmann.
• Patterson, D. A., & Hennessy, J. L. (2014). Computer organization and design: the hardware/software interface (5th ed., p. 1 zv. (loč. pag.)). Morgan Kaufman; Elsevier.
• Kodek, D. (2008). Arhitektura in organizacija računalniških sistemov (p. VIII, 496). Bi-tim.
• Shiva, S. G. (2006). Advanced computer architectures (p. XIV, 335). CRC/Taylor & Francis.

Cilji:	**Objectives:**
Cilj predmeta je vpeljati študente, da bodo sposobni razumeti organizacijo in arhitekturo računalnika od von Neumannovega modela do novejših arhitektur	The objective of this course is to acquaint students that they will be able to understand organization and architecture of a computer dating from von Neumann model to modern architectures

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • razumeti in podrobno razložiti delovanje posameznih računalniških komponent, njihovo vlogo in parametre zmogljivosti • razumevanje inštrukcijskega cikla in delovanja računalnika • z uporabo zbirnega jezika programirati posamezne komponente računalnika Prenosljive/ključne spretnosti in drugi atributi: • Spretnosti komuniciranja: ustni zagovor laboratorijskih vaj, pisno izražanje pri pisnem izpitu. • Uporaba informacijske tehnologije: uporaba zbirnega jezika za programiranje in orodij za simulacijo procesorja. • Reševanje nalog: načrtovanje arhitektur, programiranje strojnih komponent, izračun parametrov zmogljivosti.	Knowledge and understanding: • understand and explain in detail the operation of specific computer components, their role and performance parameters • understand the instruction cycle and how a computer works • program specific computer components with assembly language Transferable/Key skills and other attributes: • Communication skills: oral lab work defence, manner of expression at written examination. • Use of information technology: use of assembly for programming and tools for processor simulation. • Problem solving: designing architecture, programming of hardware components, performance evaluation

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja: pri predavanjih študentje spoznajo teoretične vsebine predmeta. Predavanja se izvajajo kot klasična predavanja v frontalni obliki z diskusijo ob primerih uporabe. • Seminarske vaje: pri seminarskih vajah se študentje seznanijo s potekom računalniških vaj. • Računalniške vaje: pri računalniških vajah študentje uporabljajo usvojeno znanje na konkretnih problemih.	• Lectures: in lectures students get to know the theoretical contents of the course. Lectures are conducted as classical lectures in frontal form interleaved with discussions on practical examples. • Tutorials: in tutorial exercises students are informed about lab work. • Lab work: in laboratory exercises students work on individual programming tasks.

Načini ocenjevanja:	**Assessment:**
Računalniško delo - 50% Pisni izpit - 50%	Computer skills - 50% Written exam - 50%

Opombe: Pisni izpit se lahko nadomesti s kolokviji v enakem deležu 50 %.

Comments: The exam may be replaced by a midterm examinations in the weight of 50 %.

Reference nosilca / Lecturer's references:

• HERZOG, Jana, BREST, Janez, BOŠKOVIĆ, Borko. Analysis based on statistical distributions: A practical approach for stochastic solvers using discrete and continuous problems. Information Sciences. [Online ed.]. Available online 15 March 2023, 49 str. ISSN 1872-6291. DOI: 10.1016/j.ins.2023.03.081. [COBISS.SI-ID 145298947]

• POPIČ, Jan, BOŠKOVIĆ, Borko, BREST, Janez. Improving mutation strategies in differential evolution with a new pbest selection mechanism. Applied soft computing. [Online ed.]. Dec. 2025, vol. 185, part b, [article no.] 113978, 17 str., ilustr. ISSN 1872-9681. https://dk.um.si/IzpisGradiva.php?id=95839, DOI: doi.org/10.1016/j.asoc.2025.113978. [COBISS.SI-ID 255045123] project: The authors acknowledge the financial support from the Slovenian Research and Innovation Agency (Research Core Funding No. P2-0041 – Computer Systems, Methodologies, and Intelligent Services).

• PŠENIČNIK, Blaž, MLINARIČ, Rene, BREST, Janez, BOŠKOVIĆ, Borko. Dual-step optimization for binary sequences with high merit factors. Digital signal processing. Oct. 2025, vol. 165, [article no.] 105316, 9 str., ilustr. ISSN 1095-4333. DOI: 10.1016/j.dsp.2025.105316. [COBISS.SI-ID 236425219] project: The authors (J.B. and B.B.) acknowledge the financial support from the Slovenian Research and Innovation Agency (Research Core Funding No. P2-0041 -- Computer Systems, Methodologies, and Intelligent Services). The authors would like to acknowledge the Slovenian Initiative for National Grid (SLING) for using computational resources for performing some experiments in this paper.

• BREST, Janez, SEPESY MAUČEC, Mirjam. Comparative study of modern differential evolution algorithms : perspectives on mechanisms and performance. Mathematics. 2025, vol. 13, iss. 10, [article no.] 1556, 21 str. ISSN 2227-7390. DOI: 10.3390/math13101556. [COBISS.SI-ID 235619075] project: This work was supported by the Slovenian Research and Innovation Agency (research core funding No. P2-0069—Advanced Methods of Interaction in Telecommunications and P2-0041— Computer Systems, Methodologies, and Intelligent Services).