UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2016/17)			
Predmet:	Arhitektura računalniških sistemov		
Course title:	Computer systems architecture		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	1	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	1	second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	63212

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

Nosilec predmeta / Lecturer:	prof. dr. Branko Šter

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Kako so narejeni računalniki in kako delujejo? Zakaj se princip delovanja od prvih računalnikov do danes skoraj ni spremenil? Kaj se dogaja v stroju med reševanjem problemov? To so samo nekatera od vprašanj, na katera odgovarja predmet Arhitektura računalniških sistemov.	How are computers designed and how they work? Why has the principle of operation remained almost unchanged from the first computers to today? What is going on in the machine during problem solving? These are only some of the questions that are answered by the Computer Systems Architecture course.
Pri predmetu bodo študenti v teoriji in na praktičnih primerih spoznali naslednje vsebine:	During the course the students will in theory and on practical examples study the following topics:
Narava računanja, kompleksnost, omejitve, teoretični modeli računanja.	Nature of computation, complexity, limitations, theoretical models of computation.
Zgodovinski pregled dosedanjega razvoja strojev za računanje.	Survey of historical development of computing machines.
Von Neumannov arhitekturni model, osnovni principi delovanja. Vhod in izhod, prekinitve, lokalnost pomnilniških dostopov, Amdahlov zakon, strojna in programska oprema.	Von Neumann architecture model and basic principles of operation. Input and output, interrupts, locality of memory references, Amdahl's law, hardware and software.
Predstavitev informacije in osnove računalniške aritmetike.	Representation of information and basic computer arithmetic.
Ukazi in strojni jezik: načini naslavljanja, operacije, formati, RISC-CISC	Instructions and machine language: addressing modes, operations, formats, RISC-CISC.
Centralna procesna enota: podatkovna enota, aritmetično-logična enota, kontrolna enota.	Central processing unit: datapath with arithmetic-logic unit, control unit.
Analiza zgradbe in delovanja CPE na primeru RISC računalnika.	Analysis of CPU design and operation using a RISC computer as an example.
Paralelizem na nivoju ukazov: cevovod, cevovodne nevarnosti, odpravljanje cevovodnih nevarnosti, dinamično razvrščanje, špekulativno izvrševanje, večizstavitveni procesorji. Paralelizem na nivoju niti	Instruction level parallelism: pipeline, pipeline hazards. Pipeline hazard elimination, dynamic scheduling, register renaming, speculative execution, multiple-issue processors. Thread level parallelism.
Glavni pomnilnik: tehnologija, organizacija, zaščita	Main memory: technology, organization,
Predpomnilniki: princip delovanja, vrste	

zgrešitev, zgrešitvena kazen, problem skladnosti Navidezni pomnilnik	protection. Cache memories: principles of operation, types of cache misses, miss penalty, coherency problem. Virtual Memory

Temeljni literatura in viri / Readings:

D. Kodek: Arhitektura in organizacija računalniških sistemov, Bi-Tim, Ljubljana 2008, poglavja 1 do 8.

Dodatna literatura:

J. L. Hennessy, D. A. Patterson: Computer Architecture: A Quantitative Approach, 4. izdaja, Morgan Kaufmann, San Francisco 2007.

D. A. Patterson, J. L. Hennessy: Computer Organization and Design: The Hardware/Software Interface, 4. izdaja, Morgan Kaufmann, Burlington 2009.

Cilji in kompetence:	**Objectives and competences:**
Namen predmeta je predstaviti študentom področje arhitekture računalniških sistemov. To področje je osnovnega pomena za vse študente računalništva, ker daje razumevanje o tem, kaj stroj za računanje je. Na koncu predmeta bo vsak študent poznal osnovne elemente računalnika, kako so ti deli med seboj povezani, razlikoval različne nivoje programiranja in razumel osnovno zgradbo strojev za računanje. Kompetence: Razvoj veščin kritičnega, analitičnega in sintetičnega mišljenja. Zmožnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov v	The aim of the course is to introduce students to the field of computer systems architecture. This is a fundamental field for all computer science students since it gives understanding of what a computing machine is. At the end of this course the students will know the basic elements of a computer, comprehend how this elements link together, distinguish different levels of programming, and understand the basis of computing machines design. Competences: Developing skills in critical, analytical and synthetic thinking. The ability to define, understand and solve creative professional challenges in computer and

računalništvu in informatiki. Osnovne veščine v računalništvu in informatiki. Praktično znanje in veščine, potrebne za uspešno profesionalno delo v računalništvu in informatiki.	information science. Basic skills in computer and information science. Practical knowledge and skills necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Sposobnost samostojnega razvoja programov, poznavanje osnovnih podatkovnih struktur in algoritmov. Uporaba: Pisanje programov za reševanje zmerno težkih programskih nalog. Refleksija: Razumevanje osnovnih principov načrtovanja programov in algoritmov in razumevanje njihove vloge pri razvoju programskih sistemov. Prenosljive spretnosti - niso vezane le na en predmet: Zmožnost načrtovanja rešitve različnih problemov s programi in algoritmi, zmožnost uporabe predstavljenih principov pri programiranju v poljubnem programskem jeziku.	Knowledge and understanding: Understanding of computer systems architecture and basic tools for development of computing machines. These include quantitative methods for comparison and evaluation of different computer architectures. Application: Understanding of how computers work and what are their limitations represents the basis for high quality software development. It is also important for computer procurement. Reflection: Preventing a common situation where a computer is treated as a black box that executes programs in some mysterious way. Transferable skills: The course is complemented with courses teaching programming, algorithms and digital circuits.

Metode poučevanja in učenja:	**Learning and teaching methods:**

Predavanja, laboratorijske vaje in domače naloge.	Lectures, laboratory work and homeworks.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Sprotno delo poteka v obliki laboratorijskih vaj, domačih nalog in kolokvijev. Končno preverjanje (računski in teoretični izpit) Ocene: 6-10 pozitivno, 1-5 negativno.	1/3 1/3 + 1/3	Type (examination, written and oral): Continuing (midterm exams) Final (written exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

ŠTER, Branko. Selective recurrent neural network. Neural processing letters, ISSN 1370-4621. [Print ed.], 2013, vol. 38, no. 1, str. 1-15, graf. prikazi. [COBISS.SI-ID 10113876]

OLSZEWSKI, Dominik, ŠTER, Branko. Asymmetric clustering using the alpha-beta divergence. Pattern recognition, ISSN 0031-3203. [Print ed.], 2013, vol. 47, no. 5, str. 2031-2041. [COBISS.SI-ID 10382164]

GABER, Rok, LEBAR, Tina, MAJERLE, Andreja, ŠTER, Branko, DOBNIKAR, Andrej, BENČINA, Mojca, JERALA, Roman. Designable DNA-binding domains enable construction of logic circuits in mammalian cells. Nature chemical biology, ISSN 1552-4450, Mar. 2014, vol. 10, no. 3, str. 203-208, ilustr. , doi: . [COBISS.SI-ID 5408026]

DOBNIKAR, Andrej, ŠTER, Branko. Structural properties of recurrent neural networks. Neural processing letters, ISSN 1370-4621. [Print ed.], 2009, vol. 29, no. 2, str. 75-88, graf. prikazi. [COBISS.SI-ID 7085652]

ZUPANC, Jernej, DROBNE, Damjana, ŠTER, Branko. Markov random field model for segmenting large populations of lipid vesicles from micrographs. Journal of liposome research, ISSN 0898-2104, 2011, vol. 21, no. 4, str. 315-323, doi: . [COBISS.SI-ID 6705529]