UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Snovanje vgradnih sistemov
Course title:	Embedded System Design

Študijski program in stopnja Study programme and level	Modul Module	Letnik Academic year	Semester Semester
Informacijske in komunikacijske tehnologije, 3. stopnja	Računalniške strukture in sistemi	1	1
Information and Communication Technologies, 3rd cycle	Computer Structures and Systems	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: IKT3-699

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Druge oblike	Samost. delo Individ. work	ECTS
15	15			15	105	5

*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: Doc. dr. Anton Biasizzo

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Zaključen študij druge stopnje s področja informacijskih ali komunikacijskih tehnologij ali zaključen študij druge stopnje na drugih področjih z znanjem osnov s področja predmeta. Potrebna so tudi osnovna znanja matematike, računalništva in informatike.	Completed second cycle studies in information or communication technologies or completed second cycle studies in other fields with knowledge of fundamentals in the field of this course. Basic knowledge of mathematics, computer science and informatics is also requested.

Vsebina:	**Content (Syllabus outline):**

Vgradni sistemi:
    uvod, pregled področja snovanja vgradnih sistemov, pregled glavnih smeri razvoja, trendov in tehnologij vgradnih sistemov
Strojna oprema vgradnih sistemov:
    vgradni procesorji, mikrokrmilniki, RISC in DSP procesorji, pomnilnik in neizbrisljiv pomnilnik, vhodno/izhodne naprave, prekinitve, vmesniki, časovniki, pretvorniki, krmiljenje napajanja
	Embedded system:
	    introduction, embedded system design survey, new research areas, trends and technologies in embedded system design
	Embedded system hardware:
	    embedded processors, microcontrollers, RISC and DSP processors, RAM memory and nonvolatile memory, peripheral devices, interrupts, interfaces, timers, converters, power

Napredne strukture vgradnih sistemov:
    večprocesorski vgradni sistemi, zanesljivi
    vgradni sistemi, namenska strojna jedra,
    rekonfigurabilni sistemi
Izvedba s programirljivimi vezji FPGA: vezja FPGA,
    jezik za opis strojne opreme VHDL, mehka
    procesorska jedra, jedra zunanjih naprav,
    razvijalska vezja FPGA
Izvedbe zmogljivejših vgradnih sistemov:
- ARM procesorji
- FPGA strojni pospeševalniki
- Sistemi z nizko porabo energije
Programska oprema vgradnih sistemov:
    operacijski sistem, razvrščevalnik opravil,
    obdelava prekinitev in izjem, latentnost
    prekinitev, operacijski sistemi v realnem času,
    gonilniki.
Snovanja programske opreme: tok razvoja
    programske opreme, prevajanje izvorne kode
    in križni prevajalniki, prilagoditev jedra
    operacijskega sistema, simulacija in emulacija,
    razhroščevanje
Napredno snovanje vgradnih sistemov:
    sočasno načrtovanje programske in strojne
    opreme

control
Advanced embedded system structures:
    multiprocessor embedded system, dependable
    embedded system, application specific hardware
    cores, reconfigurable systems
FPGA based implementation: FPGA circuits, VHDL
    hardware description language, soft processor
    cores, peripheral cores, FPGA development
    boards
Advanced embedded system implementations:
- ARM processors
- FPGA hardware accelerators
- Low power design
Embedded system software:
    operating system, task scheduler, interrupt and
    exception servicing, interrupt latency, real-time
    operating system, device drivers.
Embedded system software design:
    software design flow, source code compilation
    and cross-compilers, operating system kernel
    porting, simulation and emulation, debugging
Advanced topics in embedded system design:
    hardware/software co-design

Temeljna literatura in viri / Readings:

Izbrana poglavja iz naslednjih knjig: / Selected chapters from the following books:
- S. Heath, *Embedded Systems Design*. Newnes, 2003. ISBN 0-750-65546-1
- K. Iniewski, *Embedded Systems: Hardware, Design and Implementation*. Wiley, 2013. ISBN 978-1-118-35215-1
- A.A. Jerraya and W. Wolf, *Multiprocessor Systems-on-Chips*. Elsevier, Morgan Kaufmann Publishers, 2005. ISBN 978-0-123-85251-9
- F. Vahid and T. Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*. John Wiley & Sons, 2002. ISBN 0-471-38678-2
- S. Hauck and A. DeHon, *Reconfigurable Computing: The Theory and Practice of FPGA-Based Computing*. Morgan Kaufmann, 2008. ISBN 978-0-123-70522-8
- J.G. Ganssle, *The Art of Designing Embedded Systems*. Newnes, 2008. ISBN 0-080-56879-3

Cilji in kompetence:

Cilj predmeta je nadgraditi znanje s področja vgradnih sistemov ter pridobiti poglobljeno znanje o naprednih metodah snovanja stojne ter programske opreme vgradnih sistemov.

Kompetence študenta z uspešno zaključenim predmetom bodo vključevale poznavanje zmogljivih vgradnih sistemov, sposobnost snovanja napredne strojne opreme, sposobnost snovanja

Objectives and competences:

The goal of the course is to upgrade the knowledge of the field of embedded system and to gain deeper knowledge of the advanced embedded system hardware and software design methods.

The competencies of the students completing this course successfully would include the knowledge of the state-of-the art embedded systems, the ability to design advanced embedded system hardware, to

namenskih strojnih jeder in snovanja programske opreme vgradnih sistemov.	design application specific hardware cores, and to design embedded system software.

Predvideni študijski rezultati:

Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:
- poglobljeno poznavanje področja vgradnih sistemov
- poznavanje zgradbe in delovanja strojne opreme naprednih vgradnih sistemov
- poznavanje programskih komponent naprednih vgradnih sistemov in njihove povezanosti s strojno opremo
- sposobnost snovanja strojne opreme vgradnih sistemov za dano aplikacijo
- poznavanje sistemov-v-čipu in večprocesorskih vgradnih sistemov
- poznavanje okolij za razvoj programske opreme vgradnih sistemov
- sposobnost snovanja, simuliranja in razhroščevanja programske opreme vgradnih sistemov
- sposobnost snovanja realno-časovne programske opreme za vgradne sisteme
- sposobnost razvoja vgradnega sistema s programirljivimi vezji FPGA z rekonfigurabilnimi moduli

Intended learning outcomes:

Students successfully completing this course will acquire:
- In-depth knowledge of the field of the embedded systems
- Knowledge of the structure and operation of the advanced embedded system hardware
- Knowledge of software components of the advanced embedded system and their interaction with hardware
- Ability to design application specific embedded system hardware
- Knowledge of system-on-chip and multiprocessor embedded systems
- Knowledge of the design environments for the embedded system software design
- Ability to design, simulate, and debug the embedded system software
- Ability to design real-time software for the embedded system.
- Ability to develop custom embedded system based on FPGA devices using reconfigurable modules

Metode poučevanja in učenja:

Predavanja, seminar, konzultacije, individualno delo

Learning and teaching methods:

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:

- U. Legat, **A. Biasizzo**, and F. Novak, "SEU recovery mechanism for SRAM-based FPGAs",*IEEE trans. on nuclear science*, vol. 59, no 5, pp. 2562-2571, 2012.
- **A. Biasizzo** and F. Novak, "Hardware accelerated compression of LIDAR data using FPGA devices", *Sensors*, vol. 13, no. 5, pp. 6405-6422, 2013.
- **A. Biasizzo**, " On-line testing and recovery of systems with dynamic partial reconfiguration = Sprotno preiskušanje in popravljanje sistemov z dinamično delno rekonfiguracijo", *Informacije MIDEM*, vol. 43, no. 4, pp. 259-266, 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
- **A. Biasizzo** and F. Novak, "Security problems of scan design and accompanying measures", *Journal of electrical engineering*, vol. 67, no. 3, pp 192-198, 2016