## UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| **Predmet:** | Vgradni sistemi |
| **Course title:** | Embedded Systems |

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

**Vrsta predmeta / Course type**  | Izbirni / Elective

**Univerzitetna koda predmeta / University course code:** | IKT2-694

| Predavanja<br>Lectures | Seminar<br>Seminar | Sem. vaje<br>Tutorial | Lab. vaje<br>Laboratory work | Druge oblike | Samost. delo<br>Individ. work | ECTS |
|---|---|---|---|---|---|---|
| 30 | 30 | | | 30 | 210 | 10 |

*\*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 /** | **Predavanja / Lectures:** | slovenščina, angleščina / Slovenian, English |
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| **Languages:** | **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. |
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**Vsebina:**

**Content (Syllabus outline):**

Vgradni sistemi:
  uvod, zgodovinski razvoj področja, osnovna zgradba vgradnih sistemov, programska oprema vgradnih sistemov

Strojna oprema vgradnih sistemov:
  vgradni procesorji, pomnilnik in neizbrisljiv pomnilnik, vmesniki, časovniki, AD pretvorniki.

Prekinitve in izjeme:
  viri prekinitev, obdelava prekinitev.

Izvedbe vgradnih sistemov:

Embedded system:
introduction, history of development of the area, basic embedded system structure, embedded system software.

Embedded system hardware:
  embedded processors, RAM memory and nonvolatile memory, interfaces, timers, AD converters.

Interrupts and exceptions:
  interrupt sources, interrupt servicing.

Embedded system implementations:

AVR Atmega8 mikrokontroler (Arduino), PIC mikrokontroler, 8051 mikrokontroler

Izvedba s programirljivimi vezji FPGA:
vezja FPGA, prototipna vezja FPGA, jezik za opis strojne opreme VHDL, picoBlaze procesor.

Programska oprema vgradnih sistemov:
izvedba s končnim avtomatom stanj.

Snovanja programske opreme:
tok razvoja programske opreme, prevajanje izvorne kode in križni prevajalniki, knjižnice, izvedba aplikacije, prenos aplikacije.

Razhroščevanje programske opreme:
strojni razhroščevalnik, omejitve razhroščevalnika, povezava z razvojnim sistemom

AVR Atmega8 microcontroller (Arduino), PIC microcontroler, 8051 microcontroler

FPGA based implementation:
FPGA circuits, FPGA development boards, VHDL hardware description language, picoBlaze processor.

Embedded system software:
finite state machine implementation.

Embedded system software design:
software design flow, source code compilation and cross-compilers, libraries, application implementation, application download.

Software debugging:
Hardware debugger, limitations of the hardware debugger, connection with the development system.

### 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
- L. Edwards, *Embedded System Design on a Shoestring*. Newnes, 2003. ISBN 0-750-67609-4
- J.G. Ganssle, *The Art of Designing Embedded Systems*. Newnes, 2008. ISBN 0-080-56879-3
- K. Iniewski, *Embedded Systems: Hardware, Design and Implementation*. Wiley, 2013. ISBN 978-1-118-35215-1
- F. Vahid and T. Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*. John Wiley & Sons, 2002. ISBN 0-471-38678-2

### Cilji in kompetence:

Cilj predmeta je seznaniti študenta s področjem vgradnih sistemov, z osnovnimi metodami snovanja stojne opreme ter z metodami snovanja programske opreme vgradnih sistemov.

Kompetence študenta z uspešno zaključenim predmetom bodo vključevale poznavanje vgradnih sistemov, znanje o metodah snovanja strojne in programske opreme vgradnih sistemov.

### Objectives and competences:

The goal of the course is to familiarize the student with the field of embedded system, basic embedded system hardware design methods, and software design methods.

The competencies of the students completing this course successfully would include the knowledge of embedded systems, the knowledge of embeded system hardware and software design methods.

### Predvideni študijski rezultati:

Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:
- pregled področja vgradnih sistemov
- poznavanje zgradbe in delovanja strojne opreme vgradnih sistemov

### Intended learning outcomes:

Students successfully completing this course will acquire:
- Overview of the field of the embedded systems
- Knowledge of the structure and operation of the embedded system hardware

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| • poznavanje glavnih programskih komponent vgradnih sistemov in njihove povezanosti s strojno opremo | • Knowledge of the main software components of the embedded system and their interaction with hardware |
| • sposobnost izbire strojne platforme za izvedbo vgradnega sistema za dano aplikacijo | • Ability to select hardware platform for embedded system implementation for given application. |
| • poznavanje okolij za razvoj programske opreme vgradnih sistemov | • Knowledge of the design environments for the embedded system software design |
| • sposobnost snovanja programske opreme vgradnih sistemov | • Ability to design embedded system software |
| • sposobnost razhroščevanja razvitega vgradnega sistema | • Ability to debug designed embedded system |
| • sposobnost razvoja preprostega vgradnega sistema s programirljivimi vezji FPGA | • Ability to develop simple embedded system based on FPGA devices |

| **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:**

- 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