## UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| **Predmet:** | Internet stvari in kiberfizični sistemi |
| **Course title:** | Internet of Things and Cyber-Physical Systems |

| Študijski program in stopnja<br>Study programme and level | Študijska smer<br>Study field | Letnik<br>Academic year | Semester<br>Semester |
|---|---|---|---|
| Informatika v sodobni družbi, visokošolski strokovni študijski program prve stopnje | - | Drugi | Četrti |
| Informatics in Contemporary Society, first cycle Professional Study Programme | - | Second | Fourth |

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

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| **Univerzitetna koda predmeta / University course code:** | 1-ISD-VS-IP-ISKS-2020-05-14 |

| Predavanja<br>Lectures | Seminar<br>Seminar | Vaje<br>Tutorial | Klinične vaje<br>work | Druge oblike študija | Samost. delo<br>Individ. work | ECTS |
|---|---|---|---|---|---|---|
| 30 | - | 45 | - | - | 105 | 6 |

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| **Nosilec predmeta / Lecturer:** | prof. dr. Andrej Škraba, izr. prof. dr. Davorin Kofjač |

| **Jeziki /**<br>**Languages:** | **Predavanja /**<br>**Lectures:** | Slovenski / Slovenian |
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| | **Vaje / Tutorial:** | Slovenski / Slovenian |

| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | **Prerequisits:** |
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| Pogoj za vključitev v delo je vpis v 2. letnik oz. 3. letnik študija. | The condition for attendance is enrolment in the 2nd year or in the 3rd year of studies. |

**Vsebina:**

- Definicija interneta stvari in kiberfizičnih sistemov
- Node.js na operacijskem sistemu Linux in ARM strojni opremi
- Spletno integrirano razvojno okolje cloud9
- Arduino mikrokontroler in Firmata
- IoT Modul ESP32
- Programski jezik javaScript / ECMA Script
- Interakcija s strojno opremo preko mehanizma zahtevek/odgovor

**Content (Syllabus outline):**

- Definition of Internet of Things and Cyber-physical Systems (CPS and IoT)
- Node.js on Linux operational system and ARM hardware
- Web Integrated Development Environment cloud9
- Arduino microcontroller and Firmata
- IoT Modul ESP32
- JavaScript / ECMA Script programming language
- Interaction with hardware via request/response mechanism

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| • Interakcija s strojno opremo preko spletnega vtičnika<br>• MQTT protokol<br>• Iskanje v omrežjih<br>• Razvoj grafičnega uporabniškega vmesnika<br>• Branje in pisanje na digitalnih vhodno/izhodnih priključkih<br>• Objektno orientirani razvoj interaktivnih grafov za prikazovanje podatkov v realnem času<br>• Branje in pisanje na analognih vhodno/izhodnih priključkih<br>• Serijski, I2C, SPI protokoli<br>• Senzorji in aktuatorji<br>• Upravljanje enosmernega motorja s H-krmiljem<br>• Opis kontrole pozicije enosmernega motorja<br>• Razvoj kontrolnih sistemov v okolju interneta stvari<br>• Uporaba oblačnih tehnologij<br>• Uporaba družbenih omrežij za upravljanje interneta stvari in kiberfizičnih sistemov<br>• Opis primerov uporabe na področju informacijskih sistemov v organizacijah | • Interaction with hardware with web socket<br>• MQTT protocol<br>• Network search<br>• Development of Graphical User Interface<br>• Reading and writing on digital I/O pins<br>• Object oriented development of interactive charts for data visualization in real time<br>• Reading and writing of analog I/O pins<br>• Serial, I2C and SPI protocols<br>• Sensors and actuators<br>• Control of DC motor with H-bridge<br>• Description of DC motor position control problem<br>• Development of control systems in the Internet of Things landscape<br>• Application of cloud technologies<br>• Application of social media for control of Internet of Things and Cyber-physical Systems<br>• Description of the applications in the framework of organizational information systems |

**Temeljni literatura in viri / Readings:**

- Lakhwani, K., Gianey, H. K., Wireko, J. K. & Hiran, K. K. (2020). *Internet of Things (IoT): Principles, Paradigms and Applications of IoT.* BPB Publications.
- Alur, R. (2015). *Principles of Cyber-Physical Systems.* MIT Press.
- Rowland, C., Goodman, E., Charlier, M., Light A. & Lui, A. (2015). *Designing Connected Products: UX for the Consumer Internet of Things.* O'Reilly Media.
- Kranz, M. (2016). *Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry.* Wiley.

| **Cilji in kompetence:** | **Objectives and competences:** |
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| *Učna enota prispeva k razvoju naslednjih splošnih in predmetno-specifičnih kompetenc:*<br><br>*Splošne kompetence:*<br>  • Razumevanje informatizacije z implementacijo celovitih informacijskih rešitev in e-poslovanja v praksi.<br>  • Razumevanje in uporaba računalniških sistemov in arhitektur. | *The instructional unit contributes to the development of the following general and subject-specific competences:*<br><br>*General competences:*<br>  • Understanding of informatisation with the implementation of comprehensive information and e - business solutions in practice.<br>  • Understanding and use of computer systems and architectures. |

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| *Predmetno-specifične kompetence:*<br>• Pridobljeno znanje s hitro razvijajočega področja interneta stvari in kiberfizičnih sistemov, ki bo omogočilo takojšnjo uvedbo rešitev v obstoječe informacijske sisteme izbranih organizacij.<br>• Spoznanje osnovnih pojmov in gradnikov, ki niso neposredno s področja klasičnih organizacijskih informacijskih sistemov vendar pa so le-ti ključni za razumevanje interneta stvari in kiberfizičih sistemov.<br>• Pridobljeno praktično in teoretično znanje, ki bo slušateljem omogočilo zasnovo novih informacijskih sistemov v okolju industrije 4.0 | *Subject-specific competences:*<br>• Acquired knowledge in the fast evolving field of Internet of Things and Cyber-physical systems, which will enable the student to instantly implement solutions into the existent organizational information systems.<br>• Acquired knowledge about basic technological building blocks that are necessary for understanding of Internet of Things and Cyber-physical systems.<br>• Acquired practical and theoretical knowledge that will enable students to design and create new information systems in the Industry 4.0 landscape. |

| **Predvideni študijski rezultati:** | **Intended learning outcomes:** |
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| Znanje in razumevanje:<br><br>*Študent/študentka:*<br>• razume osnovne principe delovanja in zasnove interneta stvari in kiberfizičnih sistemov<br>• pozna ključne tehnologije potrebne za uspešno realizacijo projektov interneta stvari in kiberfizičnih sistemov<br>• razume teoretični opis kontrolnega sistema upravljanja interneta stvari in kiberfizičnih sistemov<br>• pridobi znanja o programiranju za upravljanje z aktuatorji in delo s senzorji<br>• pridobi znanje za uspešno uvedbo interneta stvari in kiberfizičnih sistemov v organizacijski informacijski sistem<br>• pridobi znanje o uvedbi projektov v realnem okolju na različnih področjih aplikacije<br><br>Prenesljive/ključne spretnosti in drugi atributi: | Knowledge and understanding:<br><br>*The student:*<br>• understands the basic operational and design principles of Internet of Things and Cyber-physical Systems<br>• understands the key technologies that are needed for successful realization of Internet of Things and Cyber-physical Systems projects<br>• understands a theoretical description of control system and control of Internet of Things and Cyber-physical Systems<br>• acquires the knowledge about programming for application of actuators and sensors<br>• acquires the knowledge for successful introduction of Internet of Things and Cyber-physical Systems into organizational systems<br>• acquires the knowledge about the project realization in the real-world environment.<br><br>Transferable/Key Skills and other attributes:<br>• acquired knowledge will enable the students to implement Internet of Things and Cyber-physical Systems solutions |

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| • pridobljeno znanje bo slušateljem omogočilo takojšnjo uvedbo interneta stvari in kiberfizičnih sistemov v informacijski sistem izbrane organizacije | into the existing organizational information system |

| **Metode poučevanja in učenja:** | **Learning and teaching methods:** |
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| • predavanja v opremljeni računalniški predavalnici <br> • vaje | • lectures in computer lecture room <br> • tutorials |

| **Načini ocenjevanja:** | Delež (v %) / Weight (in %) | **Assessment:** |
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| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| • pisni izpit | 80 | • written exam |
| • seminarska naloga | 20 | • seminar work |

**Reference nosilca / Lecturer's references:**

- KOLOŽVARI, Andrej, STOJANOVIĆ, Radovan, ZUPAN, Anton, SEMENKIN, Eugene S., STANOVOV, Vladimir V., KOFJAČ, Davorin, ŠKRABA, Andrej. Speech-recognition cloud harvesting for improving the navigation of cyber-physical wheelchairs for disabled persons. Microprocessors and microsystems, 2019, vol. 69, str. 179-187.
- Škraba, Andrej, Stanovov, Vladimir, Semenkin, Eugene. Development of control systems kit for study of PID controller in the framework of cyber-physical systems. IOP Conference Series: Materials Science And Engineering, 2020, 734, 012105. doi: 10.1088/1757-899x/734/1/012105
- ŠKRABA, Andrej, STANOVOV, Vladimir V., SEMENKIN, Eugene S. Modelling of DC motor and educational application in cyber-physical systems. V: International Workshop "Advanced Technologies in Material Science, Mechanical and Automation Engineering - MIP: Engineering - 2019" 4-6 April 2019, Krasnoyarsk, Russian Federation. Bristol: IOP, 2019. Vol. 537, 7 str., ilustr. IOP conference series, Materials science and engineering, vol. 537.
- ŠKRABA, Andrej, STANOVOV, Vladimir V., SEMENKIN, Eugene S., KOLOŽVARI, Andrej, KOFJAČ, Davorin. Development of algorithm for combination of cloud services for speech control of cyber-phisical systems. International Journal on Information Technologies and Security, 2018, vol. 10, no. 1, str. 73-82.
- KOFJAČ, Davorin, STOJANOVIĆ, Radovan, KOLOŽVARI, Andrej, ŠKRABA, Andrej. Designing a low-cost real-time group heart rate monitoring system. Microprocessors and microsystems, 2018, vol. 63, str. 75-84
- ŠKRABA, Andrej, STOJANOVIĆ, Radovan, ZUPAN, Anton, KOLOŽVARI, Andrej, KOFJAČ, Davorin. Speech-controlled cloud-based wheelchair platform for disabled persons. Microprocessors and microsystems, ISSN 0141-9331. [Print ed.], nov. 2015, vol. 39, no. 8, pp. 819-828. http://www.sciencedirect.com/science/article/pii/S0141933115001581, doi: 10.1016/j.micpro.2015.10.004.