

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

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|----------------------|---|
| <b>Predmet:</b>      | Internet stvari in kiberfizični sistemi       |
| <b>Course title:</b> | Internet of Things and Cyber-Physical Systems |

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

**Vrsta predmeta / Course type**

Izbirni / Elective

**Univerzitetna koda predmeta / University course code:**

1-ISD-VS-IP-ISKS-2024-09-12

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

**Nosilec predmeta / Lecturer:**

prof. dr. Andrej Škraba

**Jeziki / Languages:****Predavanja / Lectures:** Slovenski / Slovenian**Vaje / Tutorial:** Slovenski / Slovenian**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Pogoj za vključitev v delo je osvojitve predmetnih vsebin Programiranja 1.

**Prerequisites:**

The prerequisite is mastering the subject content of the Programming 1.

**Vsebina:**

- Definicija interneta stvari in kiberfizičnih sistemov
- Node.js na operacijskem sistemu Linux in ARM strojni opremi
- Integrirano razvojno okolje Visual Studio Code s Platform IO
- Arduino mikrokontroler in Firmata
- IoT Modul ESP32
- Programski jezik C++ za mikrokontrolerje
- Programski jezik JavaScript / ECMA Script
- Interakcija s strojno opremo preko mehanizma zahtev/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
- Integrated Development Environment Visual Studio Code with platform IO
- Arduino microcontroller and Firmata
- IoT Modul ESP32
- Programski jezik C++ za mikrokontrolerje
- JavaScript / ECMA Script programming language
- Interaction with hardware via request/response mechanism

- Interakcija s strojno opremo preko spletnega vtičnika
- MQTT protokol
- esp-now protokol
- Iskanje v omrežjih
- Razvoj grafičnega uporabniškega vmesnika
- Branje in pisanje na digitalnih vhodno/izhodnih priključkih
- Objektno orientirani razvoj interaktivnih grafov za prikazovanje podatkov v realnem času
- Branje in pisanje na analognih vhodno/izhodnih priključkih
- Serijski, I2C, SPI protokoli
- Tipala in izvršilni členi
- Definicija strukture kontrolnega sistema
- Upravljanje enosmernega motorja s H-krmiljem
- Opis upravljanja pozicije enosmernega motorja
- Opis upravljanja hitrosti vrtenja enosmernega motorja
- Razvoj kontrolnih sistemov v okolju interneta stvari
- Uporaba oblračnih tehnologij
- Uporaba družbenih omrežij za upravljanje interneta stvari in kiberfizičnih sistemov
- Opis primerov uporabe na področju informacijskih sistemov v organizacijah

- Interaction with hardware with web socket
- MQTT protocol
- esp-now protokol
- Network search
- Development of Graphical User Interface
- Reading and writing on digital I/O pins
- Object oriented development of interactive charts for data visualization in real time
- Reading and writing of analog I/O pins
- Serial, I2C and SPI protocols
- Sensors and actuators
- Definition of control system structure
- Control of DC motor with H-bridge
- Description of DC motor position control problem
- Description of DC motor speed control problem
- Development of control systems in the Internet of Things landscape
- Application of cloud technologies
- Application of social media for control of Internet of the Things and Cyber-physical Systems
- Description of the applications in the framework of organizational information systems

### Temeljni literatura in viri / Readings:

- Greengard S. (2021) *The Internet of Things*, revised and updated edition. MIT Press.
- Lakhwani, K., Gianey, H. K., Wireko, J. K. & Hiran, K. K. (2020). *Internet of Things (IoT): Principles, Paradigms and Applications of IoT*. BPB Publications.
- Roy S., Das S.K. (2020) *Principles of Cyber-Physical Systems. An Interdisciplinary Approach*. Cambridge University Press.
- Alur, R. (2015). *Principles of Cyber-Physical Systems*. MIT Press.
- Kranz, M. (2016). *Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry*. Wiley.

### Cilji in kompetence:

Učna enota prispeva k razvoju naslednjih splošnih in predmetno-specifičnih kompetenc:

#### Splošne kompetence:

- poznavanje in razumevanje širokega nabora aplikacij

### Objectives and competences:

The instructional unit contributes to the development of the following general and subject-specific competences:

#### General competences:

- knowledge and understanding of a wide range of applications of

informacijsko komunikacijske tehnologije v sodobni družbi

- poznavanje in razumevanje interakcij med informacijsko komunikacijsko tehnologijo in sodobno družbo
- usposobljenost za načrtovanje organizacijskih in informacijskih sprememb v organizaciji, ki so potrebne pri uvajanju informacijsko komunikacijske tehnologije ter kakovostni uporabi le-te

*Predmetno-specifične kompetence:*

- Pridobljeno znanje s hitro razvijajočega področja interneta stvari in kiberfizičnih sistemov, ki bo omogočilo takojšnjo uvedbo rešitev v obstoječe informacijske sisteme izbranih organizacij.
- Spoznanje osnovnih pojmov in gradnikov, ki niso neposredno s področja klasičnih informacijskih sistemov, vendar pa so le-ti ključni za razumevanje interneta stvari in kiberfizičnih sistemov.
- Pridobljeno praktično in teoretično znanje, ki bo slušateljem omogočilo zasnovo novih informacijskih sistemov v okolju industrije 4.0

information communication technology in the modern society

- knowledge and understanding of interactions between ICT and the modern society
- competence for planning of organisational and information changes in an institution, which are required in the introduction of information communication technology and a quality use thereof

*Subject-specific competences:*

- 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.
- Acquired knowledge about basic technological building blocks that are necessary for understanding of Internet of Things and Cyber-physical systems.
- 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:**

Znanje in razumevanje:

*Študent/študentka:*

- razume osnovne principe delovanja in zasnove interneta stvari in kiberfizičnih sistemov
- pozna ključne tehnologije potrebne za uspešno realizacijo projektov interneta stvari in kiberfizičnih sistemov
- razume teoretični opis kontrolnega sistema upravljanja interneta stvari in kiberfizičnih sistemov

**Intended learning outcomes:**

Knowledge and understanding:

*The student:*

- understands the basic operational and design principles of Internet of Things and Cyber-physical Systems
- understands the key technologies that are needed for successful realization of Internet of Things and Cyber-physical Systems projects
- understands a theoretical description of control system and control of Internet of Things and Cyber-physical Systems

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|--|---|
| <ul style="list-style-type: none"> <li>• pridobi znanja o programiranju za upravljanje z izvršilnimi členi in delo s tipali</li> <li>• pridobi znanje za uspešno uvedbo interneta stvari in kiberfizičnih sistemov v organizacijski informacijski sistem</li> <li>• pridobi znanje o uvedbi projektov v realnem okolju na različnih področjih aplikacije</li> </ul> <p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> <li>• pridobljeno znanje bo slušateljem omogočilo takojšnjo uvedbo interneta stvari in kiberfizičnih sistemov v informacijski sistem izbrane organizacije</li> </ul> | <ul style="list-style-type: none"> <li>• acquires the knowledge about programming for application of actuators and sensors</li> <li>• acquires the knowledge for successful introduction of Internet of Things and Cyber-physical Systems into organizational systems</li> <li>• acquires the knowledge about the project realization in the real-world environment.</li> </ul> <p>Transferable/Key Skills and other attributes:</p> <ul style="list-style-type: none"> <li>• acquired knowledge will enable the students to implement Internet of Things and Cyber-physical Systems solutions into the existing organizational information system</li> </ul> |
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**Metode poučevanja in učenja:**

- predavanja v opremljeni računalniški predavalnici
- vaje

**Learning and teaching methods:**

- lectures in computer lecture room
- tutorials

**Načini ocenjevanja:**

- Način (pisni izpit, ustno izpraševanje, naloge, projekt):
- pisni izpit
  - seminarska naloga

Delež (v %) /  
Weight (in %)

**Assessment:**

- Type (examination, oral, coursework, project):
- written exam
  - seminar work

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

- R. Stojanović, J. Djurković, S. Mijušković, B. Lutovac and A. Škraba, "SYNTROFOS: A Wearable Device for Vital Sign Monitoring, Hardware and Signal Processing Aspects," 2023 12th Mediterranean Conference on Embedded Computing (MECO), Budva, Montenegro, 2023, pp. 1-6, doi: 10.1109/MECO58584.2023.10154966.
- KOLOŽVARI, Andrej, STOJANOVIĆ, Radovan, ZUPAN, Anton, SEMENKIN, Eugene S., STANOVVOV, 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, STANOVVOV, 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-physical 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.