



### UČNI NAČRT PREDMETA / COURSE SYLLABUS

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

| Študijski program in stopnja<br>Study programme and level  | Študijska smer<br>Study field                                     | Študijsko leto<br>Academic year |
|--|---|---------------------------------|
| NOO projekt piloti: Naprednejša računalniška znanja (nivo: visokošolski strokovni študijski program) | Digitalizacija, internet stvari ter industrijska avtomatizacija   | 2022/23                         |
| RRP pilot project: Advanced computer skills (level: first cycle professional study programme)        | Digitalization, Internet of Things, and Industrial Automatization | 2022/23                         |

**Vrsta predmeta / Course type** Obvezni/Obligatory

**Univerzitetna koda predmeta / University course code:** NOO-DISIA-VS-ISKS-2022-23

| Predavanja<br>Lectures | Seminar<br>Seminar | Vaje<br>Tutorial | Klinične vaje<br>work | Druge oblike študija | Samost. delo<br>Individ. work | ECTS |
|------------------------|--------------------|------------------|-----------------------|----------------------|-------------------------------|------|
| 30                     | -                  | 30               | -                     | -                    | 120                           | 6    |

**Nosilec predmeta / Lecturer:** prof. dr. Andrej Škraba

**Jeziki / Languages:**

|                               |                       |
|-------------------------------|-----------------------|
| <b>Predavanja / Lectures:</b> | Slovenski / Slovenian |
| <b>Vaje / Tutorial:</b>       | Slovenski / Slovenian |

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Pogoj za vključitev v delo je osvojitve predmetnih vsebin Osnov programiranja.

**Prerequisits:**

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

**Vsebina:**

**Content (Syllabus outline):**



- Definicija interneta stvari in kiberfizičnih sistemov
- Node.js na operacijskem sistemu Linux in ARM strojni opremi
- Integrirano razvojno okolje Visual Studio Code
- Arduino mikrokontroler in Firmata
- IoT Modul ESP32
- Programski jezik C++ za mikrokontrolerje
- Programski jezik JavaScript / ECMA Script
- Interakcija s strojno opremo preko mehanizma zahtevkov/odgovor
- 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
- 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 oblačnih tehnologij
- Uporaba družbenih omrežij za upravljanje interneta stvari in kiberfizičnih sistemov
- Opis primerov uporabe na področju informacijskih sistemov v organizacijah

- 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
- Arduino microcontroller and Firmata
- IoT Modul ESP32
- Programski jezik C++ za mikrokontrolerje
- JavaScript / ECMA Script programming language
- Interaction with hardware via request/response mechanism
- 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
- 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 Things and Cyber-physical Systems
- 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:**

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

#### *Splošne kompetence:*

- Razumevanje informatizacije z implementacijo celovitih informacijskih rešitev in e-poslovanja v praksi.
- Razumevanje in uporaba računalniških sistemov in arhitektur.

#### *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

### **Objectives and competences:**

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

#### *General competences:*

- Understanding of informatisation with the implementation of comprehensive information and e-business solutions in practice.
- Understanding and use of computer systems and architectures.

#### *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:**

### **Intended learning outcomes:**



|  |
|--|
| <p>Znanje in razumevanje:</p> <p><i>Študent/študentka:</i></p> <ul style="list-style-type: none"><li>• razume osnovne principe delovanja in zasnove interneta stvari in kiberfizičnih sistemov</li><li>• pozna ključne tehnologije potrebne za uspešno realizacijo projektov interneta stvari in kiberfizičnih sistemov</li><li>• razume teoretični opis kontrolnega sistema upravljanja interneta stvari in kiberfizičnih sistemov</li><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> |
|--|

|  |
|--|
| <p>Knowledge and understanding:</p> <p><i>The student:</i></p> <ul style="list-style-type: none"><li>• understands the basic operational and design principles of Internet of Things and Cyber-physical Systems</li><li>• understands the key technologies that are needed for successful realization of Internet of Things and Cyber-physical Systems projects</li><li>• understands a theoretical description of control system and control of Internet of Things and Cyber-physical Systems</li><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> |
|--|

|   |
|---|
| <p><b>Metode poučevanja in učenja:</b></p> <ul style="list-style-type: none"><li>• predavanja v opremljeni računalniški predavalnici</li><li>• vaje</li></ul> |
|---|

|  |
|--|
| <p><b>Learning and teaching methods:</b></p> <ul style="list-style-type: none"><li>• lectures in computer lecture room</li><li>• tutorials</li></ul> |
|--|

|                                   |   |
|-----------------------------------|---|
| <p><b>Načini ocenjevanja:</b></p> | <p>Delež (v %) /<br/>Weight (in %) <b>Assessment:</b></p> |
|-----------------------------------|---|



|   |          |   |
|---|----------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):                                 |          | Type (examination, oral, coursework, project):  |
| <ul style="list-style-type: none"><li>• pisni izpit</li><li>• seminarska naloga</li></ul> | 80<br>20 | <ul style="list-style-type: none"><li>• written exam</li><li>• seminar work</li></ul> |

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

- Stojanović, R., Škraba, A., & Lutovac, B. (2020, June). A headset like wearable device to track COVID-19 symptoms. In 2020 9th Mediterranean Conference on Embedded Computing (MECO) (pp. 1-4). IEEE.
- 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-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.