

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Študijsko leto Academic year
NOO projekt piloti: Naprednejša računalniška znanja (nivo: visokošolski strokovni študijski program)	Digitalizacija, internet stvari ter industrijska avtomatizacija	2023/24
RRP pilot project: Advanced computer skills (level: first cycle professional study programme)	Digitalization, Internet of Things, and Industrial Automatization	2023/24

Vrsta predmeta / Course type

Obvezni/Obligatory

Univerzitetna koda predmeta / University course code:

NOO-DISIA-VS-ISKS-2023-24

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	30	-	-	120	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 Osnov programiranja.

Prerequisites:

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

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

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 PlatformIO
- Arduino microcontroller and Firmata
- IoT Modul ESP32
- Programski jezik C++ za mikrokontrolerje
- JavaScript / ECMA Script programming language

- 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
- 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 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
- 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 the Internet of 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:

Objectives and competences:

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

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

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:

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
- pridobi znanja o programiranju za upravljanje z izvršilnimi členi in delo s tipali
- pridobi znanje za uspešno uvedbo interneta stvari in kiberfizičnih

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
- acquires the knowledge about programming for application of actuators and sensors
- acquires the knowledge for successful introduction of Internet of

<p>sistemov v organizacijski informacijski sistem</p> <ul style="list-style-type: none"> • pridobi znanje o uvedbi projektov v realnem okolju na različnih področjih aplikacije <p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> • pridobljeno znanje bo slušateljem omogočilo takojšnjo uvedbo interneta stvari in kiberfizičnih sistemov v informacijski sistem izbrane organizacije 	<p>Things and Cyber-physical Systems into organizational systems</p> <ul style="list-style-type: none"> • acquires the knowledge about the project realization in the real-world environment. <p>Transferable/Key Skills and other attributes:</p> <ul style="list-style-type: none"> • acquired knowledge will enable the students to implement Internet of Things and Cyber-physical Systems solutions into the existing organizational information system
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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., 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.