

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Vodenje sistemov in obdelava signalov
Course title:	Control Systems and Signal Processing

Študijski program in stopnja Study programme and level	Modul Module	Letnik Academic year	Semester Semester
Informacijske in komunikacijske tehnologije, 3. stopnja	Inteligentni sistemi in robotika	1	1
Information and Communication Technologies, 3 rd cycle	Intelligent Systems and Robotics	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: IKT3-625

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Druge oblike	Samost. delo Individ. work	ECTS
15	15			15	105	5

**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 transferred to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Đani Juričić
Prof. dr. Juš Kocijan
Doc. dr. Damir Vrančič

Jeziki / Languages: **Predavanja / Lectures:** slovenščina, angleščina / Slovenian, English
Vaje / Tutorial:

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

Zaključen študij druge stopnje s področja informacijskih ali komunikacijskih tehnologij ali zaključen študij druge stopnje na drugih področjih z znanjem osnov s področja predmeta. Potrebna so tudi osnovna znanja matematike, računalništva in informatike.

Prerequisites:

Completed second cycle studies in information or communication technologies or completed second cycle studies in other fields with knowledge of fundamentals in the field of this course. Basic knowledge of mathematics, computer science and informatics is also requested.

Vsebina:

Uvod:
temeljni koncepti, dinamični modeli, digitalna obdelava signalov, osnovni gradniki sodobnih tehnologij vodenja
Modeliranje dinamičnih sistemov:
vrste modelov dinamičnih sistemov, stabilnost, vodljivost, kompleksna dinamika, učenje linearnih in nelinearnih dinamičnih

Content (Syllabus outline):

Introduction:
basic concepts, models of dynamical systems, signal processing and building blocks of modern control systems
Modeling of dynamical systems:
types of dynamical models, stability and controllability concepts, complex dynamics, linear and nonlinear model estimation and

modelov iz podatkov
 Digitalna obdelava signalov:
 vzorčenje signalov, analiza v časovnem in frekvenčnem prostoru, teorija naključnih procesov, Fourierjeva transformacija, valčna transformacija, ocenjevanje stanj dinamičnih sistemov, virtualni senzorji
 Sistemi vodenja:
 specifikacije, načrtovanje in implementacija sistemov vodenja, vodenje kompleksnih dinamičnih sistemov, PID regulatorji, regulator stanj, adaptivni regulatorji, prediktivni regulatorji
 Praktično usposabljanje:
 praktična uporaba izbranih tehnik modeliranja in načrtovanja vodenja na eksperimentalnih napravah.

system identification
 Signal processing:
 digital sampling, time- and frequency-domain analysis, random processes, Fourier transform, wavelet transform, state estimation of dynamical systems, virtual sensors
 Control systems:
 specification, design and implementation of control systems, control of complex dynamical systems, PID control, state control, adaptive control, predictive control
 Practical training:
 use of selected tools for modeling, signal processing and control systems design and validation on experimental test rigs.

Temeljni literatura in viri / Readings:

Izbrana poglavja iz naslednjih knjig: / Selected chapters from the following books:

- Strmčnik, S. and Juričić, Đ. (eds.). Case Studies in Control: Putting Theory to Work. Springer-Verlag London, 2013, ISBN 978-1-4471-5175-3
- Levine, W. S. The Control Handbook: Control System Fundamentals. CRC Press, Boca Raton, FL, 2011. ISBN 9781420073607
- Nise, N.S. Control Systems Engineering. John Wiley & Sons, Hoboken, NJ, 2011, ISBN-10: 0470917695
- Isermann, R. and Münchhof, M. Identification of Dynamic Systems: An Introduction with Applications, Springer London, 2011, ISBN 978-3-540-78879-9
- Vetterli, M., Kovačević, HJ. and Goyal, V.K. Foundations of Signal Processing, Cambridge University Press, Cambridge, 2014, ISBN 9781107038608

Cilji in kompetence:

Cilji predmeta so (a) uporaba matematičnih modelov dinamičnih sistemov, (b) predstavitev osnovnih metod za digitalno obdelavo signalov, (c) predstavitev inteligentnih metod vodenja sistemov in (d) predstavitev problematike vodenja kompleksnih sistemov.

Študenti bodo obvladali osnove teorije vodenja sistemov in bodo usposobljeni za praktično uporabo izbranih orodij za matematično modeliranje, digitalno obdelavo signalov in sistemov za vodenje.

Pridobljena znanja, predstavljajo ključne gradnike razvoja novih tehnologij, vgrajenih sistemov, inteligentnih industrijskih sistemov vodenja, odkrivanja napak, nadzora proizvodnje in upravljanja kompleksnih sistemov.

Objectives and competences:

The goals of the course are (a) to demonstrate the use of mathematical models of dynamical systems, (b) to present methods for digital signal processing, (c) to introduce the intelligent control systems and (d) to present the basic problems of control of complex systems.

The students will master the basic theory of control systems and will be capable of using the selected methods for modeling, signal processing and control to solve practical problems.

The acquired knowledge is essential for the development of new technologies, intelligent industrial control systems, embedded systems, fault detection and management of complex systems

Predvideni študijski rezultati:

Predmet zajema osnove načrtovanja in analize nadzora, praktične in teoretične vidike. Do zaključka predmeta bodo študenti sposobni obvladati osnovne tehnike obdelave signalov, načrtovanja krmilnika in ovrednotenja učinkovitosti krmilnika.

Pridobil bodo tudi naslednje sposobnosti:

- Uporaba izbranih metod in tehnik vodenja sistemov in obdelave signalov
- Usposobljenost za praktično uporabo izbranih orodij
- Uporaba pridobljenih znanj za reševanje praktičnih problemov s področja predmeta

Intended learning outcomes:

This course covers the fundamentals of control design and analysis. This includes both the practical and theoretical aspects of the topic. By the end of the course, the student should be able to master basic signal processing techniques, controller design and evaluate the performance of the controller.

They will also get the following skills:

- Ability to apply selected methods and techniques for systems control and signal processing
- Competence for practical use of selected tools
- Ability to apply acquired knowledge to solve practical problems from the research field of this course

Metode poučevanja in učenja:

Predavanja, konzultacije in seminarska naloga

Learning and teaching methods:

Lectures, consultancy, and seminar work

Načini ocenjevanja:

Delež (v %) /

Weight (in %)

Assessment:

Seminarska naloga

80 %

Seminar work

Ustni zagovor

20 %

Oral defense

Reference nosilca / Lecturer's references:

- Dolenc, Boštjan, Boškosi, Pavle, Stepančič, Martin, Pohjoranta, Antti, Juričić, Đani. State of health estimation and remaining useful life prediction of solid oxide fuel cell stack. *Energy conversion and management*, ISSN 0196-8904. 2017, vol. 148, str. 993-1002
- Mileva-Boshkoska, B., Boškosi, P., Debenjak, A., Juričić, Đ. Dependence among complex random variables as a fuel cell condition indicator. *Journal of Power Sources*, [in press], 26 str., 2015.
- Debenjak, A., Boškosi, P., Musizza, B., Petrovčič, J., Juričić, Đ. Fast measurement of proton exchange membrane fuel cell impedance based on pseudo-random binary sequence perturbation signals and continuous wavelet transform. *Journal of Power Sources*, 254, 112-118, 2014.
- Boškosi, P., Gašperin, M., Petelin, D., Juričić, Đ. Bearing fault prognostics using Rényi entropy based features and Gaussian process models. *Mechanical Systems and Signal Processing*, 11 str., 2014
- Dolenc, Boštjan, Boškosi, Pavle, **Juričić, Đani**. Distributed bearing fault diagnosis based on vibration analysis. *Mechanical systems and signal processing : MSSP*, ISSN 0888-3270. [Tiskana izd.], 2016, vol. 66/67, str. 521-532