UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Modeliranje dinamičnih sistemov
Course title:	Modelling of Dynamic Systems

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, 3rd cycle	Intelligent Systems and Robotics	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: IKT3-624

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	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 transfered to individual work.*

Nosilec predmeta / Lecturer: Doc. dr. Damir Vrančić

Jeziki / Languages:	
Predavanja / Lectures:	Slovenski/English
Vaje / Tutorial:	Slovenski/English

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.

Prerequisits:

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:

1. Uvod
- Uvod v sisteme
- Lastnosti dinamičnih sistemov
- Pristopi k modeliranju dinamičnih sistemov
- Faze procesa sinteze modela dinamičnega sistema

2. Dinamični sistemi
- Tipologija dinamičnih sistemov
- Linearni dinamični sistemi

Content (Syllabus outline):

1. Introduction
- Introduction to systems
- Properties of dynamic systems
- Approaches to modelling dynamic systems
- Phases of process model dynamic system synthesis

2. Dynamic systems
- Typology of dynamical systems
- Linear dynamic systems

- Nelinearni dinamični sistemi
- Stohastični dinamični sistemi

3. Simulacija dinamičnih sistemov
- Osnove numerične integracije
- Simulacija dinamičnih sistemov
- Orodja za simulacijo dinamičnih sistemov

4. Modeliranje dinamičnih sistemov
- Metode modeliranja dinamičnih sistemov
- Linearne metode identifikacije
- Nelinearne metode identifikacije
- Optimizacija modela dinamičnega sistema
- Validacija modelov
- Primeri modeliranja iz prakse

- Nonlinear dynamic systems
- Stohastic dynamic systems

3. Simulation of dynamic systems
- Basics of numeric integration
- Simulation of dynamic systems
- Tools for simulation of dynamic systems

4. Modelling of dynamic systems
- Methods of dynamic systems modelling
- Linear identification methods
- Nonlinear identification methods
- Optimisation of dynamic system model
- Models validation
- Examples of modelling in practice

Temeljni literatura in viri / Readings:

Knjige/Books:
- S. Strmčnik and Đ. Juričić (Eds.) (2013). Case studies in Control – Putting Theory to Work. Springer
- E. Cumberbatch and A. Fitt (2001). Mathematical Modelling: Case Studies from Industry. University Press, Cambridge.
- Hangos, K.M. and I.T. Cameron (2001). Process Modelling and Model Analysis. Academic Press, London.
- J. Kocijan (2016). Modelling and control of dynamic systems using Gaussian process models. Springer
- E. Zauderer (2006). Partial Differential Equations of Applied Mathematics. Willey&Sons, New Jersey.
- A. M. Law, W. D. Kelton (2000). Simulation modeling and analysis, McGraw-Hill.

Cilji in kompetence:

Cilji predmeta so:
- seznanjanje z lastnostmi dinamičnih sistemov
- usposobljenost za modeliranje linearnih in nelinearnih dinamičnih sistemov in validacijo modelov
- kompetentnost za delo s simulacijskimi orodji

Pridobljene kompetence:
- poznavanje osnovnih konceptov dinamičnih sistemov
- poznavanje metod za modeliranje dinamičnih sistemov iz podatkov
- sposobnost uporabe identifikacijskih in optimizacijskih algoritmov
- zmožnost uporabe simulacijskih orodij

Objectives and competences:

Course objectives:
- understanding dynamic system characteristics
- qualification for modeling linear and nonlinear dynamic systems and validation of models
- competence for work with simulation tools

Competences:
- knowledge of basic concepts of dynamic systems
- knowledge of methods for modeling dynamic systems from data
- ability to use the identification and optimization algorithms
- the ability to use simulation tools

Predvideni študijski rezultati:

Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:
- osnovno znanje o dinamičnih sistemih
- znanja o modeliranju dinamičnih sistemov

Intended learning outcomes:

Students successfully completing this course will acquire:
- basic knowledge about dynamic systems
- knowledge about dynamic systems modelling

• znanja o nekaterih identifikacijskih in optimizacijskih algoritmih • razumevanje pravilnega vrednotenja modela • razumevanje konceptov regulacije • sposobnost uporabe identifikacijskih in optimizacijskih algoritmov • zmožnost uporabe simulacijskih orodij	• knowledge about some identification and optimisation algorithms • ability for their selection and proper use • understanding the proper evaluation of the model • understanding control concepts • ability to use the identification and optimization algorithms • ability to use simulation tools

Metode poučevanja in učenja:	**Learning and teaching methods:**
Interaktivno delo s študentom v okviru predavanj in seminarske naloge z vključevanjem metod komparativne analize, sinteze in prepoznavanja struktur in vzorcev znanja ter usmerjanega reševanja realnih problemov.	Interactive work with a student in the frame of lectures and seminar work, including methods of comparative analysis, synthesis and recognition of knowledge structures and patterns, and supervised solving of real problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
• Seminarska naloga s predstavitvijo in zagovorom rešitve izbranega primera iz študentovega raziskovalnega dela • S pisnim delom izpita se preverjajo teoretična in praktična znanja o senzorjih v procesnem vodenju	50 % 50 %	• Seminar work with presentation and defence of the proposed solving of the selected problem from student's research work • Written exam, which assesses knowledge of the theory and the implementation of concepts of sensors in process control

Reference nosilca / Lecturer's references:

- GLAVAN, Miha, GRADIŠAR, Dejan, INVITTO, Serena, HUMAR, Iztok, JURIČIĆ, Đani, PIANESE, Cesare, VRANČIĆ, Damir. Cost optimisation of supermarket refrigeration system with hybrid model. *Applied thermal engineering*, ISSN 1359-4311. [Print ed.], 2016, vol. 103, str. 56-66, doi: 10.1016/j.applthermaleng.2016.03.177.
- VREČKO, Darko, DOLANC, Gregor, DOLENC, Boštjan, VRANČIĆ, Damir, PREGELJ, Boštjan, MARRA, Dario, SORRENTINO, Marco, PIANESE, Cesare, POHJORANTA, Antti, JURIČIĆ, Đani. Feedforwardf- feedback control of a SOFC power system : a simulation study. V: SINGHAL, Subhash C. (ur.), EGUCHI, K. (ur.). *Papers presented at 14th International Symposium on Solid Oxide Fuel Cells, SOFC-XIV, July 26-31, 2015, Glasgow, Scotland, UK*, (ECS transactions, ISSN 1938-6737, Vol. 68, no. 1, 2015). Pennington: Electrochemical Society, 2015, vol. 68, no. 1, str. 3151-3163, doi: 10.1149/06801.3151ecst.
- RAUBAR, Edvin, VRANČIĆ, Damir. Anti-sway system for ship-to-shore cranes. *Strojniški vestnik*, ISSN 0039-2480, maj 2012, vol. 58, no. 5, str. 338-344, SI 66, ilustr., doi: 10.5545/sv-jme.2010.127.
- VRANČIĆ, Damir, STRMČNIK, Stanko, JURIČIĆ, Đani. A magnitude optimum multiple integration tuning method for filtered PID controller. *Automatica*, ISSN 0005-1098. [Print ed.], 2001, vol. 37, str. 1473-1479.
- KINNAERT, Michael, VRANČIĆ, Damir, DENOLIN, E., JURIČIĆ, Đani, PETROVČIČ, Janko. Model-based fault detection and isolation for a gas-liquid separation unit. *Control engineering practice*, ISSN 0967-0661. [Print ed.], 2000, vol. 8, str. 1273-1283.