|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Modul A: Identifikacija | | | | | | | | | | | | | | |
| **Course title:** | | | Module A: Identification | | | | | | | | | | | | | | |
|  | | | | |  | | | | | | | |  | |  | | |
| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Vse smeri | | | | | | | | 1 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | All study fields | | | | | | | | 1 | | 1 | | |
|  | | | | | | | | | | | | | | | | | |
| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni-strokovni /elective professional | | | | | |
|  | | | | | | | | | | | |  | | | | | |
| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64259 | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** |  | | | **30** | | |  | | | |  | | | **75** | |  | **6** |
|  | | | | | | | | | | | | | | | | | |
| **Nosilec predmeta / Lecturer:** | | | | | Sašo Blažič | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Angleški (s konzultacijami v slovenščini) / English (with consultations in Slovene) | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | Angleški (s konzultacijami v slovenščini) / English (with consultations in Slovene) | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Vrste analize procesov in definicije, delitev postopkov, analiza uporabljenih signalov (vzbujevalnih in motilnih), področja uporabe.  Enostavne metode:  - Strejceva metoda odziva na stopničasto vzbujanje,  - Åströmova metoda z relejem v povratni zanki,  - Metoda s prilagajanjem modela.  Metoda najmanjših kvadratov, regresijske metode, pristranskost in konsistenca ocen.  Ocenjevanje parametrov dinamičnih modelov, parametriranje modelov, metoda razširjenih najmanjših kvadratov, metoda pomožnih spremenljivk, rekurzivne verzije metod, prilagoditev metod za časovno spremenljive procese – metoda uteženih najmanjših kvadratov in eksponentno pozabljanje, neznane ustaljene vrednosti, numerični problemi.  Identifikacija neparametričnih modelov, analize frekvenčnega odziva, metode Fourierove, korelacijske in spektralne analize.  Identifikacija nestabilnih modelov in identifikacija v zaprti zanki, identifikabilnost parametričnih in neparametričnih modelov.  Identifikacija z razpoznavanjem vzorcev.  Praktični vidiki, izbira časa vzorčenja, predhodna obdelava signalov, izbira modela, preskus njegove veljavnosti in izbira strukture, časovne zakasnitve, robustnost, izbira metode. | | | | | | | |  | | System analysis classification, algorithm division, signal analysis (excitation and disturbance signals), the area of use.  Simple methods:  - Strejc method (based on a step response),  - Åström method with a relay in a closed-loop,  - model adaptation method.  Least squares method, regression method, bias and consistency of estimates.  Dynamical model parameter estimation, model parameterisation, extended least squares method, instrumental variables method, recursive versions of least squares, the adaptation for time varying systems – weighted least squares and exponential forgetting, the influence of unknown steady states, numerical problems.  Identification of non-parametric models (frequency response analysis, Fourier analysis, correlation analysis, spectral analysis).  Identification of unstable models and closed-loop identification, identifiability of parametric and non-parametric models.  Identification with pattern recognition.  Practical aspects of identification, sampling time selection, signal pre-processing, model choice, the test of model validity and its structure, the issue of time delays, robustness, the choice of an appropriate method. | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Karel J. Keesman, System Identification, An Introduction, Springer, 2013. 2. Rolf Isermann, Marco Münchhof, Identification of Dynamic Systems, An Introduction with Applications Springer, 2011. 3. Drago Matko, Identifikacije, Univerza v Ljubljani, Fakulteta za elektrotehniko, 1998. 4. Sašo Blažič, Drago Matko, Identifikacija, skripta, 2013. 5. Sašo Blažič, Identifikacije, Zbirka rešenih nalog, Univerza v Ljubljani, Fakulteta za elektrotehniko, 2007. 6. Lennart Ljung, System identification, Prentice Hall, 1999. 7. Torsten Söderström, Petre Stoica, System identification, Prentice Hall, 1994. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| * prikazati področje identifikacije sistemov, predvsem dinamičnih, * izpostaviti problem pristranskosti metod identifikacije v primeru neupoštevanja zunanjih pogojev in/ali neustreznega izbora parametrov metode, * podati metodo najmanjših kvadratov in prikazati njeno uporabnost na različnih področjih, * prikazati uporabnost metod za ocenjevanje parametrov dinamičnih sistemov, * podati metode identifikacije neparametričnih modelov, * prikazati probleme identifikacije nestabilnih sistemov in probleme identifikabilnosti v zaprti zanki, * seznaniti slušatelje s praktičnimi problemi identifikacije. | |  | | * To present the area of system identification, especially in relation to dynamical systems. * To expose the problem of biased identification results in case of ignoring external conditions and/or inappropriate choice of parameters. * To present the least squares method and show its applicability in different areas. * To show the applicability of parameter estimation methods for dynamical systems. * To present the methods of non-parametric model identification. * To expose the problems of identification of unstable systems and the problems of identifiability in a closed loop. * To introduce the practical problems of identification. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  poglobljena znanja iz identifikacij dinamičnih sistemov | | |  | Knowledge and understanding:  Deeper understanding of dynamical system identification | |
|  | | |  |  | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| predavanja in laboratorijske vaje | | |  | Lectures and laboratory work | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| ocena laboratorijskih vaj  seminar  ustno izpraševanje | 25%,  40%,  35% | | | | Laboratory work assessment  Seminar  Oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. BLAŽIČ, Sašo, MATKO, Drago, Identifikacija, skripta, 2013. 2. BLAŽIČ, Sašo, DOVŽAN, Dejan, ŠKRJANC, Igor. Cloud-based identification of an evolving system with supervisory mechanisms. V: The 2014 IEEE Control Systems Society Multiconference on Systems and Control : Nice/Antibes, France, October 8-10, 2014. Piscataway: IEEE, cop. 2014, str. 1906-1911. 3. BLAŽIČ, Sašo, ŠKRJANC, Igor, GERKŠIČ, Samo, DOLANC, Gregor, STRMČNIK, Stanko, HADJISKI, Mincho B., STATHAKI, Anna. Online fuzzy identification for an intelligent controller based on a simple platform. Eng. appl. artif. intell., Jun. 2009, vol. 22, no. 4/5, str. 628-638. 4. ŠKRJANC, Igor, BLAŽIČ, Sašo, AGAMENNONI, Osvaldo. Identification of dynamical systems with a robust interval fuzzy model. Automatica, 2005, vol. 41, str. 327-332. 5. BLAŽIČ, Sašo. Nekatere težave pri identifikaciji vzorčenih sistemov in pretvorbi identificiranih modelov v zvezni prostor. Elektrotehniški vestnik., 2006, letn. 73, št. 4, str. 195-200. | | | | | |