Fakulteta za industrijski inženiring
Faculty of Industrial Engineering

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Elektromehanski sistemi za vzdrževanje
Course title:	Electromechanical systems for maintenance

Študijski program Study programme and level	**Študijska smer** Study field	**Letnik** Academic year	**Semester** Semester
Inženiring in avtomobilska industrija		drugi	
Engineering and automotive industry		second	

Vrsta predmeta / Course type obvezni/obligatory

Univerzitetna koda predmeta / University course code: **MAG_21008**

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
45	-	30	-	-	135	7

Nosilec predmeta / Lecturer: **doc. dr. Damir Vrančić / Asst. Prof. Damir Vrančić**

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenski / slovenian
	Vaje/Tutorial:	Slovenski / slovenian

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

- vpis v drugi letnik študija,

Prerequisits:

- inscription in the second year of study,

Vsebina:

- Osnovni koncepti mehanike (translatorno-rotacijski sistemi).
- Osnovni koncepti elektromagnetike.
- Elektromehanske analogije
- Uvod v programski okolji Matlab/Simulink in SciLab/Xcos in simulacija sistemov
- Enosmerni in univerzalni kolektorski motor
- Asinhronski motor
- Sinhronski, koračni in brezkrtačni motor
- Dinamika in vodenje elektromehanskih sistemov

Content (Syllabus outline):

- Basic concepts of mechanics (translational and rotational systems).
- Basic concepts of electromagnetics.
- Electromechanical analogies.
- Introduction to Programming environments Matlab/Simulink and SciLab/XCos.
- DC motor
- Asynchonous motor
- Synchronous motor, stepper motors and BLDC motors
- Dynamics and control of electromagnetic systems
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Temeljni literatura in viri / Readings:

- S. E. Lyshevski: Electromechanical systems, electric machines, and applied mechatronics. CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431.
- L. Meirovitch: Methods of Analytical Dynamics. Dover Publications, 2004.
- R. Pušenjak: Elektrotehnika za strojnike, Univerza v Mariboru, Fakulteta za strojništvo, 2003.
- 4. N. Storey: Electronics. A Systems Approach. Third Edition.. Pearson Education Limited, 2006. Harlow, England.
- E-gradiva predmeta | E-Course material

Priporočljiva literatura / Recomended Textbooks

- R.M. Crowder: Electric drives and electromechanical systems. Oxford : Elsevier/Butterworth-Heinemann, 2006.
- H. Goldstein, C. Poole, J. Safko: Classical mechanics. San Francisco: Addison Wesley, 2002.

Cilji in kompetence: **Objectives and competences:**

Cilji	*Objectives*
- Pridobiti teoretična in praktična znanja iz elektromehanskih sistemov, gibajočih se elektromehanskih naprav, pretvornikov energije, električnih strojev ter znanja o modeliranju, analizi, simulaciji in upravljanju elektromehanskih sistemov.	- The course gives theoretical and practical knowledge of electromechanical systems, moving electromechanical devices, power inverters, electrical engineering and knowledge of modeling, analysis, simulation and management of electromechanical systems.
Kompetence	***Competences***
- Učna enota prispeva k razvoju naslednjih splošnih in specifičnih kompetenc: - sposobnost uporabe pridobljenega teoretičnega znanja v praksi, - sposobnost načrtovanja elektromehanskih sistemov, - sposobnost modeliranja, analize in simulacije elektromehanskih sistemov v programskih okoljih Matlab/Simulink oziroma SciLab/XCos, usposobljenost za implementacijo in upravljanje elektromehanskih sistemov.	- The learning unit contributes mainly to the development of generic and specific competences: - the ability to apply theoretical knowledge in practice, - ability to design electromechanical systems, - the ability of modeling, analysis and simulation of electromechanical systems in programming environments Matlab/Simulink or SciLab/XCos, qualification for the implementation and management of electromechanical systems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent / študentka: - pozna zgradbo in način delovanja elektromehanskih sistemov; - obvlada modeliranje, analizo in upravljanje elektromehanskih sistemov ter simulacije elektromehanskih sistemov v programskih okoljih Matlab/Simulink oz. SciLab/XCos; - zna načrtovati in implementirati elektromehanske sisteme; - zna uporabljati strokovno literaturo o elektromehanskih sistemih.	*Student:* - is familiar with the structure and principles of operation of electromechanical systems; - mastered modeling, analysis and management of electro-mechanical systems and simulation of electromechanical systems in programming environments Matlab/Simulink or SciLab/XCos; - be able to design and implement electromechanical systems; - knows how to use scientific literature on electro-mechanical systems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
- Predavanja z aktivno udeležbo študentov, ki vsebujejo razprave, diskusije, odgovore na vprašanja in prikaz praktičnih zgledov ob pomoči sodobnih pedagoških pripomočkov, - vaje za poglabljanje teoretičnih osnov in pridobitev praktičnih izkušenj pri modeliranju, analizi, simulacijah in upravljanju elektromehanskih sistemov, - individualno in skupinsko delo s študenti v obliki konzultacij, - seminarska naloga s praktičnim primerom modeliranja, analize in simulacije elektromehanskega sistema. Predmet je oblikovan na kombinirani način študija, ki vključuje aktivnosti preko elektronskega (on-line) okolja: te aktivnosti so sestavljene iz samostojnih in skupinskih aktivnosti z uporabo učnega okolja Moodle in drugih elektronskih vsebin. Praviloma vključujejo diskusije v forumih, spletne strani, ogled posnetih predavanj in vaj, preverjanje znanja, odgovori na vprašanja, iskanje po spletu (bazah) itd.	- Lectures with active participation of students, which include discussions, debates, answers to questions and show practical examples with the help of modern teaching aids, - tutorials with deepening of theoretical background and gain practical experience in the modeling, analysis, simulation and management of electromechanical systems, - individual and collective work in the form of consultations, - seminar with practical examples of modeling, analysis and simulation of electromechanical system. The course is designed as blended learning that includes online activities: Online activities consist of independent and group activities using the LMS Moodle and other electronic or online content. Activities usually include discussions in forums, websites, viewing of recorded lectures and tutorials, assessments, answering questions, searching the web (databases), etc.

Načini ocenjevanja:	**Delež/Weight (%)**	**Assessment:**
Pogoj za pristop k izpitu je pozitivno ocenjena seminarska naloga. - seminarska naloga - pisni izpit Ocenjevalna lestvica je skladna z ECTS in Pravilnikom o preverjanju in ocenjevanju znanja FINI NM.	20% 80%	The prerequisite for accession to the written exam is positively graded seminar work. - seminar work - written exam Evaluation scale in accordance with ECTS and the Rules on the Evaluation and Assessment of Knowledge FINI NM.

Sprememba potrjena na Senatu: 30.9.2019

Reference nosilca / Lecturer's references:

1. PENG, Y., VRANČIĆ, Damir, HANUS, Raymond. Anti-windup, bumpless, and conditioned transfer techniques for PID controllers. *Control systems magazine*, ISSN 0272-1708, 1996, vol. 16, str. 48-57.
2. PENG, Youbin, VRANČIĆ, Damir, HANUS, Raymond, WELLER, Steven R. Anti-windup designs for multivariable controllers. *Automatica*, ISSN 0005-1098. [Print ed.], 1998, vol. 34, str. 1559-1565.
3. VRANČIĆ, Damir, PENG, Youbin, STRMČNIK, Stanko. A new PID controller tuning method based on multiple integrations. *Control engineering practice*, ISSN 0967-0661. [Print ed.], 1999, vol. 7, str. 623-633.
4. VRANČIĆ, Damir, LIESLEHTO, J., STRMČNIK, Stanko. Designing a MIMO PI controller using the multiple integration approach. *Process control and quality*, ISSN 0924-3089, 2001, vol. 11, str. 455-468.
5. 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.
6. VRANČIĆ, Damir, STRMČNIK, Stanko, KOCIJAN, Juš. Improving disturbance rejection of PI controllers by means of the magnitude optimum method. *ISA transactions*, ISSN 0019-0578, 2004, vol. 43, str. 73-84.
7. VRANČIĆ, Damir, STRMČNIK, Stanko, KOCIJAN, Juš, MOURA OLIVEIRA, P. B. de. Improving disturbance rejection of PID controllers by means of the magnitude optimum method. *ISA transactions*, ISSN 0019-0578, 2010, vol. 49, no. 1, str. 47-56.
8. 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.
9. NERAT, Marko, VRANČIĆ, Damir. A novel fast-filtering method for rotational speed of the bldc motor drive applied to valve actuator. *IEEE/ASME transactions on mechatronics*, ISSN 1083-4435, 2016, vol. 21, no. 3, str. 1479-1486.
10. 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.
11. PETROVČIČ, Janko, VRANČIĆ, Damir. Temperature control in a plastic extruder control system. V: STRMČNIK, Stanko (ur.), JURIČIĆ, Đani (ur.). *Case studies in control : putting theory to work*, (Advances in industrial control, ISSN 1430-9491). London [etc.]: Springer, 2013, str. 157-183.
12. VRANČIĆ, Damir. Rapid prototyping environment for control systems implementation. V: STRMČNIK, Stanko (ur.), JURIČIĆ, Đani (ur.). *Case studies in control : putting theory to work*, (Advances in industrial control, ISSN 1430-9491). London [etc.]: Springer, 2013, str. 289-326.
13. GERKŠIČ, Samo, DOLANC, Gregor, VRANČIĆ, Damir, KOCIJAN, Juš, STRMČNIK, Stanko, BLAŽIČ, Sašo, ŠKRJANC, Igor, MARINŠEK, Zoran, BOŽIČEK, Miha, STATHAKI, Anna, KING, Robert Bruce, HADJISKI, Mincho B., BOSHNAKOV, Kosta. A PLC-based system for advanced control. V: STRMČNIK, Stanko (ur.), JURIČIĆ, Đani (ur.). *Case studies in control : putting theory to work*, (Advances in industrial control, ISSN 1430-9491). London [etc.]: Springer, 2013, str. 327-361.
14. VRANČIĆ, Damir. Magnitude optimum techniques for PID controllers. V: PANDA, Rames C. (ur.). *Introduction to PID controllers : theory, tuning and application to frontiers areas*. Rijeka: InTech, cop. 2012, str. 75-102.
15. PETROVČIČ, Janko, VRANČIĆ, Damir. *Reducing oscillations in a control system : patent EP 2356522 B1*. München: European Patent Office, 6. jan. 2016.
16. VRANČIĆ, Damir, NERAT, Marko, KRANČAN, Samo. *Postopek hitrega filtriranja signala rotacijske hitrosti s samodejnim izločanjem periodičnega odmika : patent SI 24580 (A), 2015-06-30*. Ljubljana: Urad RS za intelektualno lastnino, 30. jun. 2015.
17. RUŽIČ, Miloš, KOTAR-JORDAN, Berta, SMRKOLJ, Matej, GERKŠIČ, Samo, VRANČIĆ, Damir, BENEDIK, Milena, GRIČAR, Mira. *Process for preparing clopidrogel hydrogen sulfate of form I : EP patent no. EP1693375*. 2006; Rijswijk, Netherland: European patent Office.

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