Fakulteta za industrijski inženiring
Faculty of Industrial Engineering

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Avtomatizacija in robotizacija tehnoloških procesov
Course title:	Automation and robotisation of technology processes

Študijski program Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Inženiring in avtomobilska industrija		1.	2.
Engineering and automotive industry		1.	2.

Vrsta predmeta / Course type obvezni/obligatory

Univerzitetna koda predmeta / University course code: **MAG_21006**

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
45	**30**	**-**	**45**	**-**	**120**	**8**

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

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

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

- Vpis v 1. letnik študija,

Prerequisits:

- enrolled in first study year

Vsebina:

- Splošni koncepti sistemov in vodenja (sistemi, procesi, vhodi, izhodi, dinamika, krmiljenje, povratna zanka)
- Signali ter merilni in izvršni členi (vrste in oblike signalov, merilni sistemi, izvršni sistemi)
- Osnove logičnega in sekvenčnega vodenja
- Modeliranje in simulacija zveznih dinamičnih sistemov (modeli, vrste modeliranja, simulacije)
- Načrtovanje vodenja dinamičnih sistemov (zaprtozančni sistemi, PLK regulatorji, zvezni regulatorji, PID regulatorji in nastavljanje parametrov regulatorjev)
- Praktična implementacija PID algoritmov v praksi
- Učinki zaprtozančnega v vodenja v praksi

Content (Syllabus outline):

- General concepts of systems and feedback control (systems, processes, inputs, outputs, dynamics, control, feedback loop)
- Signals, sensors and actuators (type and classification of signals, measurement systems, actuator systems)
- Basics of logic and sequential control
- Modelling and simulation of continuous dynamic systems (models, types of modelling, simulation)
- Control design of dynamic systems (closed-loop systems, PLC controllers, continuous controllers, PID controllers and controller tuning)
- Implementation of PID control algorithms in practice
- Effects of the closed-loop feedback in practice

Temeljni literatura in viri / Readings:

J. Kocijan in S. Strmčnik: Osnove avtomatskega vodenja, Založba Univerze v Novi Gorici, 2016.
S. Strmčnik: Celostni pristop k računalniškemu vodenju procesov, Fakulteta za elektrotehniko v Ljubljani, 1998.
R. Karba, G. Karer, J. Kocijan, T. Bajd, M. Ž. Karer: Terminološki slovar avtomatike, Založba ZRC, 2014.ž
E-gradiva predmeta | E-Course material

Priporočljiva literatura / Recomended Textbooks

R. C. Dorf, R. H. Bishop: Modern Control Systems, 13th edition, Prentice Hall, New Jersey, 2016.
S. Strmčnik, Đ. Juričić: Case Studies in Control – Putting Theory to Work, Springer-Verlag London, 2013.
B. Zupančič: Zvezni regulacijski sistemi – 1. del, Fakulteta za elektrotehniko v Ljubljani, 2010.
B. Zupančič: Simulacije dinamičnih sistemov, Fakulteta za elektrotehniko v Ljubljani, 2010.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Predstaviti osnovne gradnike avtomatizacije in njihovo razvrstitev. - Prikazati uporabo sodobne avtomatizacije v različnih vejah industrije. - Uporaba krmilij in regulacij, ter robotov v industriji. - Izdelava projektne dokumentacije kot osnove za avtomatizacijo v samem tehnološkem procesu. ***Kompetence*** • sposobnost evidentiranja problema in njegove analize, • sposobnost obvladanja standardnih razvojnih metod, postopkov in procesov, • sposobnost uporabe pridobljenega teoretičnega znanja v praksi, • avtonomnost v strokovnem delu s področja merilnih tehnologij in sistemov, • sposobnost razumevanja in uporabe sodobnih teorij s področja tehniških, tehnoloških in naravoslovnih ved, • sposobnost matematičnega razumevanja tehničnih problemov in uporaba matematike pri reševanju le-teh, • sposobnost stalne uporabe informacijske in komunikacijske tehnologije na svojem strokovnem področju.	***Objectives*** - To present the basic building blocks of automatic control and their classification - demonstrate the use of modern control solutions in various branches of industry. - To apply the feed-forward and closed-loop controls, as well as robots, in industry. - To make project documentation for the technology process automation. ***Competences*** • the ability to find the root cause of the problem and its analysis, • ability to master standard development methods, procedures and processes, • the ability to apply theoretical knowledge in practice, • autonomy in the field of measurements and systems, • ability to understand and use modern theories in the field of engineering, technology and science, • mathematical ability to understand technical problems and use mathematics in solving them, • the ability to continuously use information and communication technologies in their field of competence.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent/študentka: - Pozna osnovne gradnike zaprtozančnih sistemov vključno z načrtovanjem le-teh. - Znati izvesti modeliranje procesa in	*Student:* - Knows the basic building blocks in the closed-loop systems including the closed-loop system design.

- Razvije sposobnost načrtovanja zaprtozančnega vodenja vključno z nastavljanjem parametrov sistema vodenja.	- Performe process modeling and feedback control design including the controller tuning via coursework.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• predavanja z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, reševanje nalog) ob pomoči sodobnih pedagoških pripomočkov ter vaje (praktičnimi primeri) za poglabljanje teoretičnih osnov, • seminarska naloga, praktičen zgled avtomatizacije 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 (explanation, discussion, questions, problem solving), with the help of modern teaching aids, and exercises (practical examples) to deepen the theoretical bases, • coursework (seminar work), practical example of the automation 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 oddana in 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%	A prerequisite for the written exam is positively graded seminar report. • Seminar work • Written examination Evaluation scale in accordance with ECTS and the Rules on the Evaluation and Assessment of Knowledge FINI NM.

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.