UČNI NAČRT PREDMETA/COURSE SYLLABUS	
Predmet:	OSNOVE MEHATRONIKE V LOGISTIKI
Course title:	FUNDAMENTALS OF MECHATRONICS IN LOGISTICS

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
GOSPODARSKA IN TEHNIŠKA LOGISTIKA 1.stopnja		1.	2.
PROFESSIONAL HIGHER EDUCATION STUDY PROGRAMME ECONOMIC AND TECHNICAL LOGISTICS 1st degree		1.	2.

Vrsta predmeta / Course type	OBVEZNI
Univerzitetna koda predmeta / University course code:	VS

Predavanja Lectures	Seminar Seminar	vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
20 e-P 40 a-P		5 e-V 15 a-V	10 l-V		90	6

Nosilec predmeta / Lecturer:	DARKO HERCOG
Jeziki / Languages: Predavanja / Lectures:	SLOVENSKI / SLOVENE
Vaje / Tutorial:	SLOVENSKI / SLOVENE

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisits:
Ni pogojev.	No special conditions.

Vsebina:	Content (Syllabus outline):
Vektorji, skalarni in vektorski produkt, osnovni elementi mehanike, Newtonovi zakoni, podajanje sil v ravnini in prostoru, razstavljanje sil, ravnotežje sil, moment (navor), ravnotežje momentov, drsno trenje. Pot, hitrost, pospešek, enakomerno gibanje, enakomerno pospešeno gibanje, gibanje s spremenljivim pospeškom, profili gibanja, krožno gibanje, kotna hitrost, kotni pospešek. Gibalna veličina, delo, povprečna in trenutna moč, potencialna in kinetična energija, ohranitev energije. Elektrostatično polje, električna napetost, kapacitivnost in kondenzator, enosmerni električni tok, Ohmov zakon, Kirchoffova zakona, enosmerna električna vezja, električna moč in delo, izmenična napetost in tok, magnetno polje, induktivnost tuljave, izmenični tokokrogi z idealnimi elementi, Mejna stikala, induktivni, kapacitivni, ultrazvočni in optični senzorji, inkrementalni in absolutni dajalniki, motorji na enosmerni in izmenični tok. Industrijski in kolaborativnih roboti, osnovne komponente in konfiguracije, prijemala.	Vectors, scalar and vector product, basic elements of mechanics, Newton's laws, forces in plane and space, decomposition of forces, balance of forces, moment (torque), balance of moments, sliding friction. Displacement, velocity, acceleration, uniform motion, uniformly accelerated motion, motion with varying acceleration, motion profiles, circular motion, angular velocity, angular acceleration**.** Momentum, work, average and instantaneous power, kinetic and potential energy**,** energy conservation. Electrostatic field, voltage, capacitance and capacitor, direct electric current, Ohm's law, Kirchoff's law, direct current circuits, electric power and work. Alternating voltage and current, magnetic field, coil inductance, alternating current circuits with ideal elements. Limit switches, inductive, capacitive, ultrasonic, and optical sensors, incremental and absolute encoders, direct current (DC) and alternating current (AC) motors. Industrial and collaborative robots, basic components, robot configurations, grippers.

Avtonomna in avtomatsko vodena vozila, konfiguracije pogonskega in krmilnega sistema, senzorji, aktuatorji, varnostni laserski skenerji, lokacijski sistemi.	Autonomous and automated-guided vehicles, configurations of drive and steering systems, sensors, actuators, safety laser scanners.

Temeljni literatura in viri / Readings:

E-gradivo predmeta.
Lerher, T. (2016) Mehatronski sistemi v logistiki. 1, Mehanika. Univerza v Mariboru, Fakulteta za logistiko.
Lerher, T., Potrč, I. (2017) Transportni sistemi v intralogistiki. Univerza v Mariboru, Fakulteta za logistiko.
Rojko, A., Hercog, D. (2010), Uvod v mehatroniko / Introduction to Mechatronics, Univerza v Mariboru, Fakulteta za elektrotehniko računalništvo in informatiko, ISBN 978-961-248-211-4.
Cetinkunt, S. (2015), Mechatronics with Experiments, 2nd Edition, Wiley, ISBN: 978-1118802465.
Bolton, W. (2016), Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 6th Edition, Pearson, ISBN: 978-1292076683.
Hibbeler, R.C. (2013) Mechanics of Materials, 9th edition, Pearson, ISBN: 978-0133254426.
Hibbeler, R.C. (2010) Engineering Mechanics - Dynamics, 12th edition, Pearson, ISBN: 978-0136077916.

Cilji in kompetence:	Objectives and competences:
Cilji predmeta so: • Nadgraditi znanje s področja statike, dinamike, kinematike in osnov elektrotehnike. • Pojasniti osnovne principe delovanja izbranih senzorjev in aktuatorjev. • Pojasniti osnovne principe delovanja industrijskih robotov in robotskih prijemal. • Pojasniti osnovne principe delovanja avtonomnih in avtomatsko vodenih vozil. Kompetence, ki jih študenti osvojijo: • Spozna in razume osnovne zakonitosti mehanike in elektrotehnike. • Spozna in razume osnovne principe delovanja izbranih senzorjev in aktuatorjev. • Spozna in razume osnovno delovanje industrijskih in mobilnih robotov.	Course objectives are: • Upgrade knowledge in the field of statics, kinematics, dynamics and basics of electrical engineering. • Explain the basic principles of operation of selected sensors and actuators. • Explain the basic principles of operation of industrial robots and robotic grippers. • Explain the basic principles of operation of autonomous and automatically guided vehicles. Competences acquired by students: • Knows and understands the basic laws of mechanics and electrical engineering. • Knows and understands the basic operation of selected sensors and actuators. • Knows and understands the basic operation of industrial and mobile robots.

Predvideni študijski rezultati:	Intended learning outcomes:
Študent je ob zaključku predmeta zmožen: Razumeti osnovne zakone mehanike in elektrotehnike, • Razumeti in razložiti delovanje različnih mehatronskih sistemov in njihovih komponent. • Pridobljeno znanje uporabiti pri reševanju praktičnih mehatronskih problemov v logistiki. • Uporabljati računalniška orodja za simulacijo in programiranje robotskih sistemov.	At the end of the course, the student is able to: Understand the basic laws of mechanics and electrical engineering, • Understand and explain principle of operation of various mechatronic systems and their components. • Use the acquired knowledge for solving professional mechatronic problems in logistics. • Use of computer tools for simulation and program of robotic systems.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja: pri predavanjih študent spozna teoretične vsebine predmeta. Del predavanj se izvaja na klasični način v predavalnici, del pa v obliki e-predavanj (e-predavanja se lahko izvajajo na videokonferenčni način ali s pomočjo posebej v ta namen didaktično pripravljenih e-gradiv v virtualnem elektronskem učnem okolju).	Lectures: students understand the theoretical frameworks of the course. Part of the lecture course is in a classroom while the rest is in the form of e-learning (e-lectures may be given via video-conferencing or with the help of specially designed e-material in a virtual electronic learning environment).

Vaje: pri vajah študent utrdi teoretično znanje in spozna aplikativne možnosti. Del vaj se izvaja na klasični način v predavalnici, del pa v obliki e-vaj (e-vaje se lahko izvajajo na videokonferenčni način ali s pomočjo posebej v ta namen didaktično pripravljenih e-gradiv v virtualnem elektronskem učnem okolju).	Tutorials: Students enhance their theoretical knowledge and are able to apply it. Part of the seminar is in a classroom while the rest is in the form of e-learning (e-tutorials may be given via video-conferencing or with the help of specially designed e-material in a virtual electronic learning environment).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
• Opravljene obveznosti e-predavanj in e-vaj so pogoj za pristop k izpitu.		• Successful competition of e-lectures and e-tutorials is a prerequisite for entering the exam.
• Pisni izpit, • ustni izpit, • laboratorijske vaje (za uspešno opravljen predmet je potrebno, da so vsi trije deli izpita ocenjeni več kot 50 %).	30 % 50 % 20 %	• Written exam, • oral exam, • laboratory work (to successfully pass the exam, all three parts of the exam needs to be evaluated above 50 %).

Reference nosilca / Lecturer's references:

Članki v revijah / Journal articles

- D. Hercog and B. Gergič, "A Flexible Microcontroller-Based Data Acquisition Device," Sensors, vol. 14, no. 6, pp. 9755-9775, 2014. [Online]. Available: http://www.mdpi.com/1424-8220/14/6/9755
- B. Gergič and D. Hercog, "Design and implementation of a measurement system for high-speed testing of electromechanical relays." Measurement, vol. 135, pp. 112-121, 2019.
- D. Hercog, B. Gergič, S. Uran, and K. Jezernik, "A DSP-based Remote Control Laboratory," IEEE Transactions on Industrial Electronics, vol. 54, no. 6, pp. 3057-3068, 2007.
- D. Hercog and K. Jezernik, "Rapid Control Prototyping using MATLAB/Simulink and a DSP-based Motor Controller," International Journal of Engineering Education, vol. 21, no. 4, pp. 596-605, 2005. [Online]. Available: http://www.ijee.ie/articles/Vol21-4/1649.pdf
- A. Rojko, D. Hercog, and K. Jezernik, "Power Engineering and Motion Control Web Laboratory: Design, Implementation and Evaluation of Mechatronics Course," IEEE Transactions on Industrial Electronics, vol. 57, no. 10, pp. 3343-3354, 2010.
- A. Rojko, D. Hercog, K. Jezernik, “E-training in mechatronics using innovative remote laboratory.” Math. comput. Simul., vol. 82, no. 3, pp. 508-516, 2011.

Knjige in poglavja v knjigah / Books and books chapters

- A. Rojko, D. Hercog, "Uvod v mehatroniko / Introduction to mechatronics", Univerza v Mariboru, Fakulteta za elektrotehniko računalništvo in informatiko, 2010.
- A. Rojko, D. Hercog, T. Zürcher, and R. Stebler, "Implementation of Remote Laboratories for Industrial Education,". V: AZAD, Abul K. M. (ur.), AUER, Michael E. (ur.), HARWARD, V. Judson (ur.). Internet accessible remote laboratories: scalable E-learning tools for engineering and science disciplines, (Premier reference source). Hershey: IGI Global: Engineering Science Reference, cop. 2012, pp. 84-107.
- A. Rojko and D. Hercog, "Teaching of robot control with remote experiments," in Web-Based Control and Robotics Education. vol. 38, S. G. Tzafestas, Ed.: Springer Netherlands, 2009, pp. 171-194.