

	UČNI NAČRT PREDMETA/COURSE SYLLABUS
Predmet	Inteligentni obdelovalni sistemi
Course title	Intelligent Manufacturing Systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Tehnologije in sistemi v strojništvu/ 2. stopnja	Ni smeri študija	2. letnik	3.
Technologies and systems in mechanical engineering/ 2 nd Cycle	No study field	2 nd year	3 rd

Vrsta predmeta/Course type

Izbirni/elective

Univerzitetna koda predmeta/University course code

TSS IP UN 7

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
30			30		120	6

Nosilec predmeta/Lecturer:

doc. dr. Gorazd Hlebanja

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

slovenski/Slovenian
slovenski/Slovenian

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

Prerequisites:

<ul style="list-style-type: none"> Vpis v prvi letnik študijskega programa. Študent mora pred izpitom pripraviti in predstaviti ter zagovarjati projektno seminarsko nalogo. 	<ul style="list-style-type: none"> A prerequisite for inclusion is enrolment in the first year of study. Student should prepare, present, and defend a project seminar before the exam.
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Vsebina:

Content (Syllabus outline):

<ul style="list-style-type: none"> <i>Uvod.</i> Proizvodni sistemi (PS), avtomatizacija PS, principi in strategije avtomatizacije, inteligenca v proizvodnji. <i>Sodobni obdelovalni sistemi.</i> Enostavne avtomatske obdelovalne celice, avtomatski montažni sistemi, FMS, CIM, rekonfigurabilni obdelovalni sistemi. <i>Inteligentni obdelovalni sistemi (IOS).</i> Zgodovina, definicija, cilji, sistemski pristop, nadaljnji razvoj. <i>Inteligentna in sonaravna proizvodnja.</i> <i>Statična in dinamična proizvodna okolja</i> in proizvodni cilji. <i>Deterministične in nedeterministične metode</i> za reševanje proizvodnih problemov. <i>Zgradba in delovanje IOS.</i> Virtualna in 	<ul style="list-style-type: none"> <i>Introduction.</i> Production systems (PS). automation of PS, principles and strategies of automation, intelligence in production. <i>Contemporary manufacturing systems.</i> Simple automated manufacturing cells, automated assembly systems, FMS; CIM, reconfigurable manufacturing systems. <i>Intelligent manufacturing systems (IMS).</i> History, definition, goals, system approach, future development. <i>Intelligent and sustainable production.</i> <i>Static and dynamic production environments</i> and production goals. <i>Deterministic and nondeterministic methods</i> for solving of production problems. <i>Structure and operation of IMS.</i> Virtual and
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<p>poudarjena resničnost, kibernetično-fizični sistemi, aditivna izdelava, velike količine podatkov, fleksibilni in rekonfigurabilni OS, umetna inteligenca, IoT, simulacije.</p> <ul style="list-style-type: none"> • <i>Podatki</i>. Zbiranje podatkov iz okolja, obdelava in inteligentno odločanje. Baze podatkov v IOS. • <i>Analiza OS</i>. Vrednotenje stanja OS. Učenje na osnovi znanih dejstev. • <i>Metodologije</i> za gradnjo, modeliranje, optimiranje, vodenje in nadzor IOS. Nevronske mreže, mehka logika, evolucijski algoritmi, inteligenca rojev, hibridni pristopi. • <i>Tehnološke vrzeli</i> med Industrijo 4.0 in sodobnimi obdelovalnimi sistemi. • <i>Študij primerov</i> različnih izvedb IOS. Primeri iz CAD/CAM, CNC sistemov, preoblikovanja, brizganja plastike, montaže, robotike, mehanske obdelave, razvrščanja strojev, vodenja procesov, itd. 	<p>augmented reality, cyber-physical systems, additive manufacturing, big data, flexible and reconfigurable MS, artificial intelligence, IoT, simulations.</p> <ul style="list-style-type: none"> • <i>Data</i>. Data acquisition from surrounding, data processing and intelligent decision making. Data bases in IMS. • <i>Analysis of MS</i>. MS state assessment. Learning based on known facts. • <i>Methodologies</i> for construction, modelling, optimization, control, and monitoring of IMS. Neural networks, fuzzy logic, evolution algorithms, swarm intelligence, hybrid approaches. • <i>Technological gaps</i> between Industry 4.0 and contemporary manufacturing systems. • <i>Case studies</i> of various IMS realizations. Examples of CAD/CAM, CNC systems, metal forming, injection molding, assembly, robotics, machining operations, machine sorting, process control, etc.
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Temeljna literatura in viri/Readings:

Temeljna literatura/Basic literature

- PHUYAL, S., D. BISTA in R. BISTA. Challenges, Opportunities and Future Directions of Smart Manufacturing: A State of Art Review. *Sustainable Futures (Elsevier)* **2** (2020) 100023, 1-15. [doi: 10.1016/j.sfr.2020.100023](https://doi.org/10.1016/j.sfr.2020.100023).
- WANG, B. The Future of Manufacturing: A New Perspective. *Engineering (Elsevier)* **4** (2018) 722–728. [doi: 10.1016/j.eng.2018.07.020](https://doi.org/10.1016/j.eng.2018.07.020).
- OZTEMEL, E. Intelligent manufacturing systems. V : L. Benyoucef, B. Grabot (ur.), *Artificial Intelligence Techniques for Networked Manufacturing Enterprises Management*. Springer Series in Advanced Manufacturing. Springer, 2010, str. 1-41, [doi: 10.1007/978-1-84996-119-6_1](https://doi.org/10.1007/978-1-84996-119-6_1).
- KOREN, Y. *The Global Manufacturing Revolution: Product-Process-Business Integration and Reconfigurable Systems*. Hoboken, NJ: Wiley, 2010. ISBN: 978-0-470-92080-0

Priporočljiva literatura/Recommended literature

- GROOVER, M. P. *Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition*. Boston: Pearson, 2016.
- BALIČ, J. *Inteligentni obdelovalni sistemi*. Maribor: Fakulteta za strojništvo, 2004. ISBN - 86-435-0579-X
- BREZOČNIK, M. *Uporaba genetskega programiranja v inteligentnih proizvodnih sistemih*. Maribor: Fakulteta za strojništvo, 2000. ISBN 978-86435-0306-5

Cilji in kompetence:

Učna enota prispeva predvsem k razvoju naslednjih splošnih in specifičnih kompetenc:

- sposobnost samostojnega in ustvarjalnega raziskovalno-razvojnega dela na področju strojništva,
- sposobnost samostojnega spremljanja in kritične presoje najnovejših dosežkov s področja strojništva in širše,

Objectives and competences:

The learning unit mainly contributes to the development of the following general and specific competences:

- ability of independent and creative research and development work in the field of mechanical engineering,
- ability to independently perceive and critically assess the latest achievements in the

<ul style="list-style-type: none"> • sposobnost aktivnega pisnega in ustnega sporazumevanja na visoki strokovni kot tudi na poljudni ravni, odvisno od ciljnega občinstva, • sposobnost timskega dela s strokovnjaki z različnih področij, • sposobnost učinkovite uporabe informacijsko-komunikacijske tehnologije, • sposobnost prevzeti odgovornost za lasten poklicni in osebni razvoj, • sposobnost delovanja v sozvočju s poklicno, okoljsko, socialno in etično odgovornostjo, • sposobnost samostojnega spremljanja in kritične presoje najnovejših dosežkov s področja inteligentnih obdelovalnih sistemov (IOS), • sposobnost aktivnega pisnega in ustnega sporazumevanja na visoki strokovni kot tudi na poljudni ravni, odvisno od ciljnega občinstva, • sposobnost učinkovite uporabe informacijsko-komunikacijske tehnologije s področja inteligentnih OS, • obvladovanje razvoja in napredka na področju inteligentnih OS, • avtonomnost v strokovnem delu s področja inteligentnih obdelovalnih sistemov, • sposobnost reševanja konkretnih delovnih problemov z uporabo standardnih strokovnih metod in postopkov s področja OS. 	<p>field of mechanical engineering and beyond,</p> <ul style="list-style-type: none"> • ability to actively communicate in writing and orally at a high professional as well as at a popular level, depending on the target audience, • ability to work in teams with experts from different fields, • ability to effectively use information and communication technology, • ability to take responsibility for one's own professional and personal development, • ability to work according to professional, environmental, social and ethical responsibility, • ability to independently monitor and critically assess the latest achievements in the field of intelligent manufacturing systems (IMS), • ability to actively communicate in writing and orally at a high professional as well as at a popular level, depending on the target audience, • ability to effectively use information and communication technology in the field of intelligent MS, • managing the development and progress in the field of intelligent MS, • autonomy in professional work in the field of intelligent machining systems, • ability to solve concrete work problems using standard professional methods and procedures in the field of intelligent MS.
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Predvideni študijski rezultati:

Študent/študentka:

- pozna in razume pojme iz področja inteligentnih OS, sestavne elemente IOS in njihovo medsebojno interakcijo,
- uporablja usvojene metode za reševanje konkretnih problemov,
- se usposobi za kritično presojo konkretnih primerov in zna zasnovati izboljššan koncept IOS.

Intended learning outcomes:

Students:

- knows and understands concepts in the field of intelligent MS, its components, and their interaction,
- uses adopted methods to solve concrete problems,
- is trained to critically assess concrete cases and is able to design an improved IOS concept.

Metode poučevanja in učenja:

- *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov),
- *laboratorijske vaje*: praktično reševanje več tipičnih problemov v laboratoriju (na računalniku),
- *seminar*: priprava, predstavitev in uspešen

Learning and teaching methods:

- *lectures* with active student participation (explanation, discussion, questions, examples, problem solving),
- *laboratory work*: practical solving of several typical problems in laboratory (on a computer),
- *seminar tutorial*: presentation and defence of

zagovor projektne/raziskovalne naloge, (reševanje problemov, študije primera, kritično presojanje, diskusija, refleksija izkušenj, vrednotenje, projektno delo, timsko delo),	project/research work (problem solving, studies, critical thinking, discussion, reflection of experience, evaluation, project work, team-work),
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Načini ocenjevanja:	Delež (v %) Weight (in %)	Assessment:
Načini: <ul style="list-style-type: none"> • laboratorijske vaje • projektno seminarsko delo • zagovor seminarja • pisni izpit Ocenjevalna lestvica: ECTS.	20 % 20 % 20 % 40 %	Types: <ul style="list-style-type: none"> • lab work • project seminar • defense of a seminar • written exam Grading scheme: ECTS.