

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	RAČUNALNIŠKO INTEGRIRANI OBDELOVALNI IN DELOVNI SISTEMI CIM/FMS
Course title:	COMPUTER INTEGRATED MANUFACTURING AND WORK SYSTEMS CIM/FMS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Strojništvo, tretja stopnja, doktorski	Proizvodno inženirske znanosti, kibernetika in mehatronika (smer)		Celoletni

Univerzitetna koda predmeta/University course code:

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
90					160	10

Nosilec predmeta/Lecturer:

Izvajalci predavanj:	Drago Bračun, Peter Butala, Rok Vrabič
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina, Angleščina
	Vaje/Tutorial:	Slovenščina, Angleščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Veljajo splošni pogoji za doktorski študij.	General prerequisites for the third level studies.

Vsebina:

Razvoj obdelovalnih in računalniških tehnologij. Nove proizvodne paradigme (holonski, biološki, fraktalni in kompleksni adaptivni sistemi). Strukturna in operacijska kompleksnost proizvodnje. Kibernetiko strukturiranje. Modeliranje sistemov. Digitalna tovarna. Distribuirane proizvodne strukture. Gradniki delovnih struktur: avtonomni delovni sistemi, elementarni delovni sistemi. Računalniško integrirani obdelovalni sistemi. Principi integracije. Integracija inženirskega informacijskega sistema, integracija s poslovnimi sistemi. Elektronsko poslovanje, vsepovsodni sistemi. Interoperabilnost. Delavniški Informacijski sistemi. Sistemi za spremljanje, nadzor in krmiljenje delovnih sistemov. Baze podatkov in znanja. Grupna tehnologija. Avtomatizacija, načrtovanje in optimizacija tehnoloških procesov. Avtomatizacija programiranja obdelovalnih in delovnih sistemov. Virtualizacija procesov in naprav.

Content (Syllabus outline):

Development of manufacturing, information and communication technologies. New manufacturing paradigms (Holonic, biological, fractal and complex adaptive systems). Structural and operational complexity of manufacturing systems. Cybernetic structuring. System modeling. Digital factory. Distributed manufacturing systems. Manufacturing systems building blocks: autonomous work systems, elementary work systems. Computer integrated manufacturing systems. Principles of integration E-(lectronic) manufacturing, U-(biquitous) manufacturing. Interoperability. Workshop information system. Manufacturing execution (MES) and supervisory control and data acquisition (SCADA) systems. Data and knowledge bases. Grup technology. Automation, process design and optimization of manufacturing processes. Programming of work systems. Virtualization of processes and systems.

<p>Mehatronske delovne naprave. Razvoj krmilnih sistemov za NC, CNC, AC in CIM. Mini in mikro procesorji kot krmilni moduli. Sprotna identifikacija procesov in optimiranje. Adaptivno krmiljenje. Modularna gradnja sistemov. Rekonfigurabilni delovni sistemi in celice. Stabiliteta natančnosti dimenzij, oblik in hrapavosti. Sistemi orodij. Sistemi vpenjal. Integracija in avtomatizacija materialnih tokov in logističnih funkcij v proizvodnji. Avtomatizacija merilnih procesov. Testirni sistemi.</p>	<p>Mechatronic manufacturing systems. Design of controllers for CNC, AC and CIM. Mini and microprocessors as control modules. On-line process identification and adaptive control. Modular design of systems. Reconfigurable manufacturing systems. Stability of dimensional and shape accuracy and surface roughness. Tool management systems. Clamping systems. Integration and automation of material flows and logistic functions in manufacturing. Automation of measuring processes. Testing systems.</p>
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Temeljna literatura in viri/Readings:

<p>[1] Bedworth, D. D., Henderson, M. R., Wolfe, P. M.: Computer-integrated design and manufacturing.- McGraw-Hill, 1991</p> <p>[2] BJORKE O., Manufacturing systems theory. Tapir Publishers, 1995</p> <p>[3] Bollinger, J. G., Duffie, N. A.: Computer control of machines and processes.- Addison-Wesley Publishing Company, 1988</p> <p>[4] Boothroyd, K., Dewhurst: Design for assembly</p> <p>[5] CIRP Manufacturing Systems Conferences proceedings (yearly) (different publishers), Current volumes.</p> <p>[6] CIRP annals. Elsevier. Current volumes.</p> <p>[7] Chrystolouris, G.: Manufacturing systems, Springer Verlag, 1992</p> <p>[8] Daschenko A. (Ed.), Manufacturing technologies for machines of the future. Springer, 2003</p> <p>[9] Foston, A. L., Smith, C. L., An, T.: Fundamentals of computer integrated manufacturing.- Prentice Hall, 1991</p> <p>[10] Ham, I., Hitomi, K., Yoshida, T.: Group technology: applications to production.- Klunier Nijhoff Publishing, 1985</p> <p>[11] International Workshops on Emergent Synthesis IWES</p> <p>[12] Koren Y.: Computer control of manufacturing systems, 3rd edition, McGraw Hill, 1986</p> <p>[13] Peklenik, J.: Manufacturing systems evolution: selected papers / Janez Peklenik; Ljubljana: Faculty of Mechanical Engineering, 1996</p>
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Cilji in kompetence:

<p>Cilji: Postaviti izhodišča za poglobljene raziskave na področju novih delovnih struktur v proizvodnji. Predstaviti temeljne principe kibernetnega strukturiranja in modeliranja delovnih sistemov. Podati osnove za raziskave in razvoj na področju integracije delovnih sistemov, avtomatizacije procesov in naprav. Sistematično uvesti principe razvoja modularnih in rekonfigurabilnih mehatronskih proizvodnih delovnih sistemov.</p> <p>Kompetence: Študent bo pridobil temeljno razumevanje novih proizvodnih konceptov in delovnih struktur, spoznal bo principe strukturiranja, krmiljenja in integracije proizvodnih delovnih sistemov. Spoznal bo vlogo računalniških tehnologij v obvladovanju proizvodnih informacij in krmiljenju procesov ter naprav. S tem bo pridobil temelj za poglobljeno raziskovanje na predmetnem področju ter nabor znanj za metodološko podprt in sistematičen razvoj proizvodnih delovnih sistemov.</p>	<p>Objectives and competences:</p> <p>Goals: The main goal is to provide a comprehensive basis for fundamental research in the field of new work structures in manufacturing. To explain the basic principles of cybernetic structuring and modeling of manufacturing systems. To give the basis for development of integrated systems and for automation of manufacturing processes and devices. To systematically introduce principles of design and development of modular reconfigurable mechatronic manufacturing systems.</p> <p>Competences: Students will gain the basic understanding of new manufacturing concepts and structures, and will learn principles of manufacturing systems' structuring, control and integration. They will learn the role of enabling information and communication technologies in management of manufacturing information, process control and automation. Thus, they will gain the basis for in-depth research in the field and knowledge for methodologically supported systematic design and development of manufacturing systems.</p>
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<p>Predvideni študijski rezultati:</p> <p>Študent bo pridobil temeljno razumevanje novih proizvodnih konceptov in delovnih struktur, spoznal bo principe strukturiranja, krmiljenja in integracije proizvodnih delovnih sistemov. Spoznal bo vlogo računalniških tehnologij v obvladovanju proizvodnih informacij in krmiljenju procesov ter naprav. S tem bo pridobil temelj za poglobljeno raziskovanje na predmetnem področju ter nabor znanj za metodološko podprt in sistematičen razvoj proizvodnih delovnih sistemov.</p>	<p>Intended learning outcomes:</p> <p>Students will gain the basic understanding of new manufacturing concepts and structures, and will learn principles of manufacturing systems' structuring, control and integration. They will learn the role of enabling information and communication technologies in management of manufacturing information, process control and automation. Thus, they will gain the basis for in-depth research in the field and knowledge for methodologically supported systematic design and development of manufacturing systems.</p>
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<p>Metode poučevanja in učenja:</p> <p>Predavanja, laboratorijske vaje, seminarsko delo, e-izobraževanje, konzultacije. Seminarsko delo v čim večji meri navezuje se na področje doktorskega raziskovanja. Študij z uporabo priporočene literature.</p>	<p>Learning and teaching methods:</p> <p>Lectures, laboratory practice & seminar work, e-education, consulting. The seminar work is related, as much as possible, to the student's doctoral research field. Study on a recommended literature basis.</p>
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Načini ocenjevanja:	Delež/Weight	Assessment:
<p>Ustni izpit, poročilo o seminarskem delu. Pogoj za opravljanje ustnega izpita je uspešno izdelano in pozitivno ocenjeno seminarsko delo. Način (pisni izpit, ustno izpraševanje, naloge, projekt) • projektni seminar (60%) • predstavitev rezultatov seminarja v okviru laboratorija (20%) • ustno izpraševanje (20%)</p>		<p>Oral exam, report on seminar work. The condition for admission to oral exam is successful completion of seminar work, rewarded with a passing grade. Method (written exam, oral examination, assignments, project) • project seminar (60%) • presentation of seminar results in the laboratory (20%) • oral examination (20%)</p>

Reference nosilca/Lecturer's references:

prof. dr. Peter BUTALA
 SELAK, Luka, BUTALA, Peter, SLUGA, Alojzij. Condition monitoring and fault diagnostics for hydropower plants. Computers in industry, ISSN 0166-3615. Aug. 2014, vol. 65, iss. 6, str. 924-936.
 ŽAPČEVIČ, Seid, BUTALA, Peter. Adaptive process control based on a self-learning mechanism in autonomous manufacturing systems. The international journal of advanced manufacturing technology, ISSN 0268-3768, Jun. 2013, vol. 66, iss. 9/12, str. 1725-1743.
 AHČAN, Uroš, BRAČUN, Drago, ŽIVEC, Katarina, PAVLIČ, Rok, BUTALA, Peter. The use of 3D laser imaging and a new breast replica cast as a method to optimize autologous breast reconstruction after mastectomy. The Breast, ISSN 0960-9776, apr. 2012, vol. 21, iss. 2, str. 183-189.
 ZUPANČIČ, Rok, SLUGA, Alojzij, BUTALA, Peter. A service network for the support of manufacturing operations. International journal of computer integrated manufacturing, ISSN 0951-192X. 2012, vol. 25, no. 9, str. 790-803.
 ZALETELJ, Viktor, SLUGA, Alojzij, BUTALA, Peter. A conceptual framework for the collaborative modeling of networked manufacturing systems. Concurrent engineering, ISSN 1063-293X, 2008, letn. 16, št. 1, str. 103-114.

doc.dr. Rok VRABIČ
 KOZJEK, Dominik, VRABIČ, Rok, KRALJ, David, BUTALA, Peter. Interpretative identification of the faulty conditions in a cyclic manufacturing process. *Journal of manufacturing systems*, ISSN 0278-6125, Apr. 2017, vol. 43, part 2, str. 214-224, ilustr. <http://www.sciencedirect.com/science/article/pii/S0278612517300304>, doi: [10.1016/j.jmsy.2017.03.001](https://doi.org/10.1016/j.jmsy.2017.03.001). [COBISS.SI-ID [15458075](https://www.cobiss.si/id/15458075)]
 VRABIČ, Rok, KOZJEK, Dominik, BUTALA, Peter. Knowledge elicitation for fault diagnostics in plastic injection moulding : a case for machine-to-machine communication. *CIRP annals*, ISSN 0007-8506, 2016, f. 1-4, ilustr. http://ac.els-cdn.com/S000785061730001X/1-s2.0-S000785061730001X-main.pdf?tid=cd2847e6-348c-11e7-aaa9-0000aacb360&acdnat=1494316680_7dd186475f057f97faa6af363539e6bb, doi: [10.1016/j.cirp.2017.04.001](https://doi.org/10.1016/j.cirp.2017.04.001). [COBISS.SI-ID [15490587](https://www.cobiss.si/id/15490587)]
 PUTNIK, Goran D., ŠKULJ, Gašper, VRABIČ, Rok, VARELA, Leonilde, BUTALA, Peter. Simulation study of large production network robustness in uncertain environment. *CIRP annals*, ISSN 0007-8506, 2015, vol. 64, iss. 1, str. 439-442, ilustr., doi: [10.1016/j.cirp.2015.04.118](https://doi.org/10.1016/j.cirp.2015.04.118). [COBISS.SI-ID [13971739](https://www.cobiss.si/id/13971739)]
 ŠKULJ, Gašper, VRABIČ, Rok, BUTALA, Peter, SLUGA, Alojzij. Decentralised network architecture for cloud

manufacturing. *International journal of computer integrated manufacturing*, ISSN 0951-192X. [Print ed.], 2015, str. [1-14], ilustr. <http://www.tandfonline.com/doi/pdf/10.1080/0951192X.2015.1066861>, doi: [10.1080/0951192X.2015.1066861](https://doi.org/10.1080/0951192X.2015.1066861). [COBISS.SI-ID [14075675](#)]

VRABIČ, Rok, ŠKULJ, Gašper, BUTALA, Peter. Anomaly detection in shop floor material flow : a network theory approach. *CIRP annals*, ISSN 0007-8506, 2013, vol. 62, iss. 1, str. 487-490, ilustr., doi: [10.1016/j.cirp.2013.03.131](https://doi.org/10.1016/j.cirp.2013.03.131). [COBISS.SI-ID [12827419](#)]