

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	KOMPLEKSNI MEHATRONSKI SISTEMI
<b>Course title:</b>	COMPLEX MECHATRONIC SYSTEMS

<b>Študijski programi in stopnja</b>	<b>Študijska smer</b>	<b>Letnik</b>	<b>Semestri</b>
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:	Janez Diaci
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:

<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Slovenščina, Angleščina
	Vaje/Tutorial:	Slovenščina, Angleščina

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

### Vsebina:

Sodobne tehnologije procesiranja podatkov v KMS. Strojna oprema za vgradne računalnike: procesorji, sestavne komponente, vmesniške komponente, pretvorniki, prikazovalniki, povezave med računalniki in drugimi enotami, omrežja, mikrokrmilniki. Programirljiva logična vezja visoke stopnje integracije kot strojna oprema v KMS. Programska oprema za vgradne računalnike: jeziki in metode programiranja, operacijski sistemi, delo v realnem času in hkratne dejavnosti. Metodologije načrtovanja in izvedb vgradnih računalniških sistemov za KMS: strojna in programska oprema. Izbrana poglavja iz algoritmov obdelave signalov, slik in 3D izmerkov oblike teles. Analiza 3D izmerkov in metode ekstrakcije karakterističnih dimenzij - značilk. Algoritmi združevanja podatkov iz večsenzorskih sistemov.

### Content (Syllabus outline):

Advanced data-processing technologies for CMS  
Embedded system hardware: processors, chip-sets, interfaces, converters, displays, communication interfaces, networks, microcontrollers. Field-programmable gate arrays as platforms for high-performance data processing in CMS.  
Embedded system software: programming languages and methods, operation systems, real-time operation, simultaneous tasks.  
Design and implementation methodologies for embedded systems in CMS: hardware and software.  
Selected topics in algorithms for signal and image processing. Processing of 3D data sets (clouds of points acquired during 3D shape measurements); analysis of 3D data sets and extraction of characteristic dimensions / features. Multi-sensor data fusion algorithms.  
Selected topics in modeling and simulation of CMS.

<p>Izbrana poglavja iz modeliranja in simulacije KMS. Opto-mehatronske sistemi. Opto-mehatronske tehnologije. Komponente: optične, opto-elektronske in elektro-optične, mehatronske. Optomehatronska integracija. Osnovne opto-mehatronske funkcionalne enote. Metodologije načrtovanja in izvedbe. Mikro izvedbe: mikro-opto-mehatronske sistemi. Izbrani primeri opto-mehatronskih sistemov.</p>	<p>Opto-mechatronic systems. Opto-mechatronic technologies. Components: optical, opto-electronic in electro-optic, mechatronic. Optomechatronic integration. Basic optomechatronic functional units. Design and implementation methodologies. Micro-scale implementations: micro-opto-mechatronic systems. Selected examples of opto-mechatronic systems.</p>
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### Temeljna literatura in viri/Readings:

<p>[1] T. Scheurer: Foundations of computing: system development with set theory and logic, Addison-Wesley, 1994.  [2] K. Edwards: Real-time structured methods: systems analysis, Wiley, 1993.  [3] A. Burns, G. Davies: Concurrent programming, Addison-Wesley, 1993.  [4] C.A.R. Hoare: Communicating sequential processes, Prentice-Hall, 1985.  [5] D.R. Martinez, R.A. Bond, and M.M. Vai, High Performance Embedded Computing Handbook: A Systems Perspective, CRC, 2008. – izbrana poglavja  [6] P. Marwedel, Embedded System Design, Springer, 2003.  [7] R. Zurawski, Embedded Systems Handbook, CRC, 2005. – izbrana poglavja  [8] J. Wikander and B. Svensson, Real-Time Systems in Mechatronic Applications, Springer, 1998.  [9] D.C. Karnopp, D.L. Margolis, and R.C. Rosenberg, System Dynamics: Modeling and Simulation of Mechatronic Systems, Wiley, 2006.  [10] F. Caccavale and L. Villani, Fault Diagnosis and Fault Tolerance for Mechatronic Systems, Springer, 2002.  [11] D. Auslander, J. Ridgely, and J. Ringgenberg, Control Software for Mechanical Systems: Object-Oriented Design in a Real-Time World, Prentice Hall PTR, 2002.  [12] R.H. Bishop, The Mechatronics Handbook, Second ed., CRC, 2007. – izbrana poglavja.  [13] C.W.D. Silva, Mechatronic Systems: Devices, Design, Control, Operation and Monitoring, CRC, 2007. – izbrana poglavja  [14] H. Cho: Optomechatronics: Fusion of Optical and Mechatronic Engineering, CRC Press, 2005. – izbrana poglavja  [15] H. Ukita, Micromechanical Photonics, Springer, 2006.  [16] H. Mitchell, Multi-Sensor Data Fusion: An Introduction, Springer, 2007.  [17] J.W. Gardner, V. Varadan, and O.O. Awadelkarim, Microsensors, MEMS and Smart Devices, Wiley, 2001. – izbrana poglavja</p>
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### Cilji in kompetence:

<p><b>Cilji:</b>  Študentu podati metodološko osnovo, nabor specialnih znanj in zahtevnih eksperimentalnih tehnik, potrebnih za samostojno raziskovalno delo na področju mehatronskih sistemov višje stopnje kompleksnosti.</p> <p><b>Kompetence:</b></p> <ul style="list-style-type: none"> <li>• sposobnost razumevanja in analize zahtevnih znanstvenih publikacij z ožjega področja študentovega doktorskega študija in s širšega področja kompleksnih mehatronskih sistemov (KMS),</li> <li>• sposobnost uporabe rezultatov iz teh publikacij pri reševanju lastnih raziskovalnih nalog v okviru doktorskega študija;</li> <li>• sposobnost prepoznavanja smeri razvoja na tem področju in usmerjanje lastnega raziskovalnega dela na tej osnovi;</li> <li>• sposobnost uporabe sodobnih metodologij za načrtovanje, razvoj in verifikacijo KMS,</li> <li>• sposobnost snovanja, razvoja, izvedbe in integracije programske opreme za krmiljenje KMS,</li> <li>• sposobnost uporabe najnovejših rešitev na področju strojne in programske opreme za snovanje in razvoj novih rešitev na področju KMS,</li> </ul>	<p><b>Objectives and competences:</b></p> <p><b>Goals:</b>  The principal goal is to give the student the methodology basis, specialist knowledge and advanced experimental techniques required for conducting individual research in the field of complex mechatronic systems.</p> <p><b>Competences:</b>  The student acquires the following core competences:</p> <ul style="list-style-type: none"> <li>• the ability to understand and analyze elaborate scientific/research publications from the narrower field of the student's PhD thesis as well as from the wider field of complex mechatronic systems,</li> <li>• the ability to apply the published results to solve research task within the framework of the student's PhD thesis,</li> <li>• the ability to recognize research and development trends in this field and use this as a basis for directing student's own research work,</li> <li>• the ability to employ advanced methodologies for the design, implementation and verification of complex mechatronics systems (CMS),</li> <li>• the ability to conceive, design, implement and integrate software solutions for the control of CMS,</li> <li>• the ability to use existing state-of-the-art hardware</li> </ul>
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<ul style="list-style-type: none"> <li>osvojena znanja in veščine, potrebna za načrtovanje in izvedbo zahtevnih nalog v okviru eksperimentalnega razvoja na področju KMS.</li> </ul>	<p>and software solutions for conception of novel CMS solutions,</p> <ul style="list-style-type: none"> <li>the know-how required for conducting demanding tasks of experimental development in the field of CMS.</li> </ul>
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<p><b>Predvideni študijski rezultati:</b></p> <ul style="list-style-type: none"> <li>sposobnost razumevanja in analize zahtevnih znanstvenih publikacij z ožjega področja študentovega doktorskega študija in s širšega področja kompleksnih mehatronskih sistemov (KMS),</li> <li>sposobnost uporabe rezultatov iz teh publikacij pri reševanju lastnih raziskovalnih nalog v okviru doktorskega študija;</li> <li>sposobnost prepoznavanja smeri razvoja na tem področju in usmerjanje lastnega raziskovalnega dela na tej osnovi;</li> <li>sposobnost uporabe sodobnih metodologij za načrtovanje, razvoj in verifikacijo KMS,</li> <li>sposobnost snovanja, razvoja, izvedbe in integracije programske opreme za krmiljenje KMS,</li> <li>sposobnost uporabe najnovejših rešitev na področju strojne in programske opreme za snovanje in razvoj novih rešitev na področju KMS,</li> <li>osvojena znanja in veščine, potrebna za načrtovanje in izvedbo zahtevnih nalog v okviru eksperimentalnega razvoja na področju KMS.</li> </ul>	<p><b>Intended learning outcomes:</b></p> <p>The student acquires the following core competences:</p> <ul style="list-style-type: none"> <li>the ability to understand and analyze elaborate scientific/research publications from the narrower field of the student's PhD thesis as well as from the wider field of complex mechatronic systems,</li> <li>the ability to apply the published results to solve research task within the framework of the student's PhD thesis,</li> <li>the ability to recognize research and development trends in this field and use this as a basis for directing student's own research work,</li> <li>the ability to employ advanced methodologies for the design, implementation and verification of complex mechatronics systems (CMS),</li> <li>the ability to conceive, design, implement and integrate software solutions for the control of CMS,</li> <li>the ability to use existing state-of-the-art hardware and software solutions for conception of novel CMS solutions,</li> <li>the know-how required for conducting demanding tasks of experimental development in the field of CMS.</li> </ul>
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<p><b>Metode poučevanja in učenja:</b></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><b>Learning and teaching methods:</b></p> <p>Lectures, laboratory practice &amp; 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 (ustno izpraševanje, projekt):</p> <ul style="list-style-type: none"> <li>projekt (seminarska naloga) (60%)</li> <li>ustno izpraševanje (40%)</li> </ul>		<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 (oral examination, project)</p> <ul style="list-style-type: none"> <li>project (seminar assignment) (60%)</li> <li>oral examination (40%)</li> </ul>

<p><b>Reference nosilca/Lecturer's references:</b></p> <p><b>prof. dr. Janez DIACI</b>  PAVLOVČIČ, Urban, DIACI, Janez, MOŽINA, Janez, JEZERŠEK, Matija. Wound perimeter, area, and volume measurement based on laser 3D and color acquisition. BioMedical engineering online, ISSN 1475-925X, Apr. 2015, vol. 14, f. 1-15.  PRIBOŠEK, Jaka, DIACI, Janez. Electromagnetic microforging apparatus for low-cost fabrication of molds for microlens arrays. Journal of micromechanics and microengineering, ISSN 0960-1317. [Print ed.], 2015, vol. 25, nr. 6, str. 1-10  ZUPANČIČ, Matevž, NOVAK, Dušan, DIACI, Janez, GOLOBIČ, Iztok. An evaluation of industrial ultrafiltration systems for surface water using fouling indices as a performance indicator. Desalination, ISSN 0011-9164. [Print ed.], Jul. 2014, vol. 344, str. 321-328  KUŠČER, Lovro, DIACI, Janez. Assessment of the kinematic parameters of distant noncooperative objects. Advances in mechanical engineering, ISSN 1687-8132. [Printed ed.], 2013, str. 1-7</p>
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BOSIGER, Georgije, PERHAVEC, Tadej, MARINČEK, Marko, DIACI, Janez. Method for optodynamic source localization during Er:YAG laser ablation. *Journal of biomedical optics*, ISSN 1083-3668, Oct. 2013, vol. 18, iss. 10, str. 100505-1-100505-3.