

KONSTRUKCIJSKE TEHNIKE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Konstrukcijske tehnike
Course title:	Engineering Design Techniques
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Konstruiranje (smer)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0566871
Koda učne enote na članici/UL Member course code:	6024-M

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		30			65	5

Nosilec predmeta/Lecturer:	doc. dr. Ivan Demšar, izr. prof. dr. Leon Kos, izr. prof. dr. Nikola Vukašinić
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Izvajalci predavanj:
Izvajalci seminarjev:
Izvajalci vaj:
Izvajalci kliničnih vaj:
Izvajalci drugih oblik:
Izvajalci praktičnega
usposabljanja:

Vrsta predmeta/Course type:	Obvezni strokovni predmet na smeri Konstruiranje, ki je izbirni strokovni predmet na ostalih smereh./Compulsory specialised course in the study of Design Engineering, which is an elective specialised course in other fields of study.
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Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

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

Prerequisites:

Izpolnjevanje pogojev za vpis v Magistrski študijski program II. stopnje Strojništvo - Razvojno raziskovalni program.

Meeting the enrollment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.

Vsebina:

1. Predavanje – Uvod v konstrukcijske tehnike
 - Življenjski cikel proizvoda in S krivulja
 - Vloga konstrukcijskih tehnik pri razvoju proizvodov
 - Različni modeli konstrukcijskega procesa
 - Konstrukcijski zahtevnik v serijski in individualni proizvodnji
2. Predavanje – Konstruiranje za serijsko in individualno proizvodnjo
 - Tehnična dokumentacija pri orodjih (brizganje plastike, štancanje)
 - Zahtevnik za orodje
 - Konstruiranje na novo
 - Patenti kot vir idej za konstruiranje, iskanje med patenti
3. Predavanje – TRIZ metoda
 - Vloga TRIZ metode
 - Idealnost, protislovje, sistemski pristop
 - Primeri rešenih protislovij
 - 40 inovativnih principov
 - Kontradikcijska matrika
4. Predavanje – Vloga standardov in regulative pri razvoju proizvodov
 - Evropska zakonodaja: direktive, uredbe, nacionalna zakonodaja
 - Harmonizirani standardi – vloga pri razvoju proizvodov
 - Zakon o tehničnih proizvodih, varnost proizvodov, nevarnosti in ocena tveganja
5. Predavanje – Dokazovanje ustreznosti proizvodov
 - Certifikat na izdelku, oznaka CE, postopek za pridobitev oznake CE
 - Struktura in vsebina tehnične mape
 - Dokazovanje skladnosti z zakonodajo in regulativo
6. Predavanje – Eko dizajn I
 - Eko-dizajn proizvodov
 - Zakonodaja in regulativa kot poslovna priložnost
 - Analiza vpliva proizvoda na okolje skozi celoten življenjski cikel
7. Predavanje – Eko dizajn II
 - Principi konstruiranja za eko-dizajn
 - Konstruiranje za enostavno ločevanje materialov, označevanje materialov
 - Krožno gospodarstvo in zasnova proizvodov
8. Predavanje – Tehnike konstruiranja v avtomobilski industriji I

Content (Syllabus outline):

1. Lecture - Introduction to design techniques
 - Product life cycle and S-curve
 - The role of design techniques in product development process
 - Different models of engineering design process
 - Design specification in serial and one-of-a-kind production
2. Lecture - Designing for serial and one-of-a-kind production
 - Technical documentation for tools (injection molding, stamping)
 - Specification for tools
 - New design
 - Patents as a source of ideas for engineering design, patents search
3. Lecture - TRIZ method
 - The role of the TRIZ method
 - Ideality, contradiction, systemic approach
 - Examples of resolved contradictions
 - 40 innovative principles
 - Contradiction matrix
4. Lecture - The role of standards and regulation in product development
 - European legislation: directives, regulations, national legislation
 - Harmonized standards - role in product development
 - The Law for technical products, product safety, hazards and risk assessment
5. Lecture - Conformity with product specific EU requirements
 - Product certification, CE marking, procedure for CE marking
 - Structure and content of a technical file
 - Conformity with legislation and regulations
6. Lecture - Eco Design I
 - Eco-design of products
 - Legislation and regulation as a business opportunity
 - Environmental impact analysis throughout product life cycle
7. Lecture - Eco Design II
 - Design principles for eco-design
 - Design for easy splitting of materials, materials labeling
 - Circular economy and product conceptual design
8. Lecture - Design techniques in the automotive industry I
 - Product development process and quality principles
 - The development process in the automotive industry
 - Quality pillars in the product development process (APQP, SPC)
9. Lecture - Design techniques in the automotive industry II
 - Quality pillars in the product development process

- Proces razvoja izdelkov in principi kakovosti - Proces razvoja v avtomobilski industriji - Stebri kakovosti v procesu razvoja proizvodov (APQP, SPC) 9. Predavanje – Tehnike konstruiranja v avtomobilski industriji II - Stebri kakovosti v procesu razvoja proizvodov (MSA, FMEA, plan nadzora) - Konstruiranje za robustnost (Poka Yoke) - Tolerančna veriga 10. Predavanje – Napredni modeli za razvoj proizvodov - Sočasni razvoj, sočasni razvoj skupine rešitev (ang. set based CE) - Razvoj izdelkov po metodi six sigma - Uporaba principov vitkosti pri razvoju proizvodov - Agilne metode v procesu razvoja 11. Predavanje – Stroški in konstruiranje - Struktura stroškov pri konstruiranju - Konstruiranje za znano lastno ceno - Fiksni in variabilni stroški v individualni in serijski proizvodnji - Struktura stroškov skozi faze razvoja in faze uporabe proizvoda - Principi za nižanje stroškov proizvodov 12. Predavanje – Napredno modeliranje proizvodov - Napredne metode za virtualno modeliranje proizvodov - Modeliranje podatkov (ULM), procesov in informacijskih tokov - Upravljanje znanja in razvoj proizvodov 13. Predavanje – Informacijska podpora konstrukcijskega procesa - Tehnični informacijski sistemi (PLM) in njihova funkcionalnost - Obvladovanje tehničnih sprememb, modeliranje informacijskega toka - Upravljanje dokumentov in potrjevanje razvojnih faz 14. Predavanje – Konfiguriranje proizvodov - Konfiguracija izdelkov, variantne kosovnice - Tipizacija gradikov in obvladovanje informacij - Družina proizvodov, platforma, modularna gradnja 15. Predavanje – Verifikacija, validacija in uvajanje konstrukcije v proizvodnjo - Verifikacija in validacija proizvodov - Virtualni prototipi in komunikacija z naročnikom	(MSA, FMEA, control plan) - Designing for robustness (Poka Yoke) - Tolerance chain 10. Lecture - Advanced product development models - Concurrent engineering (CE), set based CE - Design for Six sigma and six sigma methodology - Application of lean principles in product development - Agile methods in the development process 11. Lecture - Costs and product design - Cost structure at product design - Engineering design for the target cost - Fixed and variable costs in one-of-a-kind and serial production - Cost structure through the development and product usage phases - Product cost reduction principles 12. Lecture - Advanced Product Modeling - Advanced methods for virtual product modeling - Modeling of data (ULM), processes and information flows - Knowledge management and product development 13. Lecture - Information support of the engineering design process - Product lifecycle management (PLM) systems and their functionality - Technical change management, information flow modelling - Document management and validation of development phases 14. Lecture - Products configuration - Product configuration, variant bill of materials - Internal standardisation and product information management - Product family, platform concept, modular design 15. Lecture - Verification, validation and introduction of product design into production - Verification and validation of products - Virtual prototypes and communication with customer - verification - Physical prototypes and validation - Safe launch production procedures
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- verifikacija - Fizični prototipi in validacija - Postopki uvajanja v proizvodnjo	
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Temeljna literatura in viri/Readings:

1. K.T. Ulrich and S.D. Eppinger, Product Design and Development, 7th edition, Irwin McGraw-Hill, 2020 2. E. B. Magrab, S.K. Gupta, F.P. McCluskey, P. A. Sandborn, Integrated Product and Process Design and Development, The Product Realization Process, CRC Press, Taylor & Francis Group [COBISS.SI-ID 11296795] 3. G. Pahl, W. Beitz, J. Feldhusen, K.H. Grote, (2007), Engineering design, A Systematic Approach, Third Edition, Springer [COBISS.SI-ID 1391899] 4. M. M. Andreasen, Integrated Product Development, Technical University of Denmark, 2000 [COBISS.SI-ID 642843] 5. Jože Hlebanja, Metodika konstruiranja, Fakulteta za strojništvo, UL, Ljubljana 2003 [COBISS.SI-ID 123009024] 6. K. Ehrlenspiel, A. Kiewert, U. Lindemann, M. S. Hundal, Cost-Efficient Design, 5th Edition, Springer, 2007 [COBISS.SI-ID 10068763]
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Cilji in kompetence:

Cilji in kompetence:	Objectives and competences:
Cilji: 1. Spoznati različne pristope/modele pri razvoju izdelkov na različnih nivojih konstruiranja 2. Spoznati katere metode in orodja uporabljati v posameznih fazah razvoja izdelkov 3. Spoznati značilnosti posameznih metod in kako jih uporabljati 4. Upoštevati v procesu razvoja izdelkov značilne pristope: zakonodaja, okolje, stroški, robustnost, inovativnost, informacijska podpora Kompetence: 1. S2-MAG: Sposobnost kritičnega, analitičnega in sintetičnega mišljenja. Razvijanje novega znanja in razumevanja na področju razvoja proizvodov in konstruiranja. 2. S6-MAG: Sposobnost uporabe informacijsko-komunikacijske tehnologije v procesu razvoja proizvodov. 3. P1-MAG: Sposobnost za nadgrajevanje in uporabo temeljnih strojniških znanj in njihovo implementacijo. 4. P6-MAG: Sposobnost samostojnega izvajanja zahtevnih raziskovalnih, razvojnih del ter sposobnost kreativnega reševanja nalog.	Objectives: 1. To learn about different approaches / models in product development at different levels of design 2. To learn what methods and tools to use in different phases of product development 3. Become familiar with characteristics of different design method and how to use them 4. Consider the following approaches in the product development process: legislation, environment, costs, robustness, innovation, IT support Competencies: 1. S2-MAG: Ability to think critically, analytically and synthetically. Developing new knowledge and understanding in the field of product development and engineering design. 2. S6-MAG: Ability to use information and communication technologies in the product development process. 3. P1-MAG: Ability to upgrade and apply basic mechanical engineering skills and their implementation. 4. P6-MAG: Ability to perform demanding research, development tasks and the ability for independent creative tasks solving.

Predvideni študijski rezultati:

Predvideni študijski rezultati:	Intended learning outcomes:
Znanja:	Knowledge:

Z2: Študent pridobi poglobljeno teoretično, metodološko in analitično znanje o metodah konstrukcijskih tehnik z elementi raziskovanja, ki je osnova za celovit pristop pri razvoju izdelkov na različnih nivojih konstruiranja. Spretnosti: S2.1 Obvladovanje zelo zahtevnih kompleksnih delovnih procesov in metodoloških orodij na področju konstruiranja: - Samostojno reševanje tehničnih problemov v strojništvu. - Usposobljen za delo v skupini in interdisciplinarno povezovanje. S2.3 Načrtovanje in vodenje delovnega procesa na podlagi ustvarjalnega reševanja problemov, povezanih s področjem konstruiranja: - Sposobnost za uporabo sodobnih metod in postopkov in prenašanje spoznanj v prakso	Z2: The student acquires in-depth theoretical, methodological and analytical knowledge of methods of engineering design techniques with elements of research, which is the basis for a comprehensive approach to the development of products at different levels of design. Skills: S2.1 Proficiency in complex work processes and methodological tools in the field of engineering design: - Independent solving of technical problems in mechanical engineering. - Capable of teamwork and interdisciplinary cooperation. S2.3 Planning and managing a workflow based on creative problem solving related to the field of engineering design: - Ability to apply modern methods and procedures and ability to transfer of theoretical knowledge into practice.
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Metode poučevanja in učenja:

P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov. P6 Interaktivna predavanja P4 Laboratorijske vaje z namenski didaktičnimi pripomočki: - računalniške delovne postaje - namenska programska oprema za vodenje razvoja izdelkov - namenska programska oprema za 3D modeliranje in simulacije. P8 Izdelava in predstavitev aplikativnih seminarских nalog P9 Skupinsko delo (strukturirana diskusija, viharjenje možganov, projektno delo, specifične metode za skupinsko delo) P15: Uporaba multi-medijskih vsebin kot priprava na predavanja in vaje	Learning and teaching methods: P1 Lectures by solving selected - typical - theoretical and practical examples. P6 Interactive Lectures P4: Laboratory exercises with dedicated didactic aids: - computer workstations - dedicated software for managing product development - dedicated software for 3D modeling and simulations. P3 Practical classes where theoretical knowledge from lectures is supported by computational examples. P8 Preparing and presentation of applied project tasks P9 Teamwork (structured discussion, brainstorming, project work, specific methods for teamwork) P15: Usage of multi-media for preparing for lectures and tutorials
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Načini ocenjevanja:

Delež/Weight

Assessment:

Teoretične vsebine (predavanja).	50,00 %	Theoretical content (lectures).
Projektno delo (vaje).	50,00 %	Project work (exercises).

Ocenjevalna lestvica:	Grading system:
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

Leon Kos:

1. **KOS, Leon**, VASILESKA, Ivona, TSKHAKAYA, David. On the theory of nonlinear landau damping. Symmetry. 2025, vol. 17, iss. 6, [art. no.] 809, str. 1-11, ilustr. ISSN 2073-8994. <https://www.mdpi.com/2073-8994/17/6/809>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/sym17060809. [COBISS.SI-ID [238548995](#)].
2. **KOS, Leon**, TSKHAKAYA, D. D. Theory of ion-matrix-sheath dynamics. AIP advances. 2018, vol. 8, f. 015202-1-015202-13, ilustr. ISSN 2158-3226. DOI: 10.1063/1.5017654. [COBISS.SI-ID [15819547](#)].
3. **KOS, Leon**, JELIĆ, Nikola, GYERGYEK, Tomaž, KUHN, S., TSKHAKAYA, David. Modeling and simulations of plasma and sheath edges in warm-ion collision-free discharges. AIP advances. Oct. 2018, vol. 8, no 10, str. 1-23, ilustr. ISSN 2158-3226. <https://aip.scitation.org/doi/pdf/10.1063/1.5044664?class=pdf>, DOI: 10.1063/1.5044664. [COBISS.SI-ID [12219988](#)].
4. **KOS, Leon**, PITTS, Richard, SIMIČ, Gregor, BRANK, Matic, ANAND, H., ARTER, W. SMITER : a field-line tracing environment for ITER. Fusion engineering and design. [Print ed.]. Sep. 2019, vol. 146, pt. b, str. 1796-1800, ilustr. ISSN 0920-3796. <https://www.sciencedirect.com/science/article/pii/S092037961930359X?via%3Dihub>, DOI: 10.1016/j.fusengdes.2019.03.037. [COBISS.SI-ID [16530203](#)].
5. BRANK, Matic, PITTS, Richard, SIMIČ, Gregor, LAMALLE, P., KOCAN, M., KÖCHL, F., GRIBOV, Y., POLLI, V., **KOS, Leon**. Assessment of plasma power deposition on the ITER ICRH antennas. Nuclear materials and energy. Jun. 2021, vol. 27, str. 1-9, ilustr. ISSN 2352-1791. <https://www.sciencedirect.com/science/article/pii/S2352179121000971>, DOI: 10.1016/j.nme.2021.101021. [COBISS.SI-ID [78883331](#)].

Nikola Vukašinić:

1. DEMŠAR, Ivan, ČERNE, Borut, TAVČAR, Jože, **VUKAŠINOVIĆ, Nikola**, ZORKO, Damijan. Agile development of polymer power transmission systems for e-mobility : a novel methodology based on an e-bike drive case study. *Polymers*. 2023, vol. 15, iss. 1, str. 1-24, ilustr. ISSN 2073-4360. <https://www.mdpi.com/2073-4360/15/1/68>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/polym15010068. [COBISS.SI-ID [135469315](#)].
2. ČAKŠ, Žiga, ČORLUKA, Željko, DUHOVNIK, Jože, KOKELJ, Gašper, KRAJNC, Matija, LEJLA, Vida, OSELI, Alen, SOMOGYVÁRI, Mónika, VERDEGUER LOPEZ, Javier, **VUKAŠINOVIĆ, Nikola**. Handkühengerät mit zwei Abtrieben = Hand-held kitchen appliance with two drives : Europäische Patentschrift EP2394546 (B1), 2018-08-08. München: Europäisches Patentamt, 2018. 17 f., ilustr. [COBISS.SI-ID [12125723](#)].
3. ČOK, Vanja, VLAH, Daria, **VUKAŠINOVIĆ, Nikola**. Storyboards as an engineering tool for extraction of functional requirements. V: *Design2022*. [Cambridge]: Cambridge University Press, 2022. Vol. 2, str. 2273-2282, ilustr. Proceedings of the Design Society, vol. 2. ISSN 2732-527X. <https://www.cambridge.org/core/journals/proceedings-of-the-design-society/article/storyboards-as-an-engineering-tool-for-extraction-of-functional-requirements/29697F459A77C6CE9567054451602308>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1017/pds.2022.230. [COBISS.SI-ID [109613571](#)].
4. URBAS, Uroš, ARIANSYAH, Dedy, ERKOYUNCU, John Ahmet, **VUKAŠINOVIĆ, Nikola**. Augmented reality aided inspection of gears. *Tehnički vjesnik : znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku*. Jun. 2021, vol. 28, no. 3, str. 1032-1037, ilustr. ISSN 1330-3651. <https://hrcak.srce.hr/258238>, DOI: 10.17559/TV-20200728151912. [COBISS.SI-ID [66828803](#)].

5. URBAS, Uroš, ZORKO, Damijan, **VUKAŠINOVIĆ, Nikola**. Machine learning based nominal root stress calculation model for gears with a progressive curved path of contact. *Mechanism and machine theory*. Nov. 2021, vol. 165, str. 1-14, ilustr. ISSN 0094-114X.
<https://www.sciencedirect.com/science/article/pii/S0094114X21001889>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1016/j.mechmachtheory.2021.104430](https://doi.org/10.1016/j.mechmachtheory.2021.104430). [COBISS.SI-ID [69206531](#)].

Ivan Demšar:

1. ZORKO, Damijan, **DEMŠAR, Ivan**, TAVČAR, Jože. An investigation on the potential of bio-based polymers for use in polymer gear transmissions. *Polymer testing*. [Print ed.]. Jan. 2021, vol. 93, str. 1-13, ilustr. ISSN 0142-9418. <https://www.sciencedirect.com/science/article/pii/S0142941820322236>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1016/j.polymertesting.2020.106994](https://doi.org/10.1016/j.polymertesting.2020.106994). [COBISS.SI-ID [43121667](#)].
2. **DEMŠAR, Ivan**, DUHOVNIK, Jože, LEŠNIK, Blaž, SUPEJ, Matej. Multi-axis prosthetic knee resembles alpine skiing movements of an intact leg. *Journal of Sports Science and Medicine : free electronic journal*. [Online ed.]. Dec. 2015, vol. 14, iss. 4, str. 841-848, ilustr. ISSN 1303-2968. <http://jssm.org/research.php?id=jssm-14-841.xml>, <http://www.jssm.org/gecc.php?id=jssm-14-841.xml>. [COBISS.SI-ID [14346779](#)].
3. ZORKO, Damijan, ČERNE, Borut, TAVČAR, Jože, **DEMŠAR, Ivan**. Towards agile product development - an empirical study on an e-bike drive. V: *ICED 21*. The 23rd International Conference in Engineering Design, 16-20 August 2021, Gothenburg, Sweden. [S. l.: s. n.], 2021. Vol. 1, str. 3209-3218, ilustr. Proceedings of the Design Society, vol. 1. ISSN 2220-4342. <https://www.cambridge.org/core/journals/proceedings-of-the-design-society/article/towards-agile-product-development-an-empirical-study-on-an-ebike-drive/A49FB08C4AC911BCC5E602900FD0DE2D>. [COBISS.SI-ID [74067459](#)].
4. BERNIK, Rajko, **DEMŠAR, Ivan**. *Verižna motorna žuga : patent SI 25888 A, 2021-03-31*. Ljubljana: Urad RS za intelektualno lastnino, 2021. [14] f., ilustr. <https://worldwide.espacenet.com/patent/search/family/075265314/publication/SI25888A?q=SI25888A&queryLang=en%3Ade%3Afr>. [COBISS.SI-ID [63751939](#)] patentna družina: P-201900182, 2019-09-25.
5. ZORKO, Damijan, ČERNE, Borut, **DEMŠAR, Ivan**, TAVČAR, Jože. *Razvoj kompaktnega centralnega pogona za električno kolo : poročilo*. Ljubljana: Fakulteta za strojništvo, Laboratorij za konstruiranje, april 2017. 1 zv. loč. pag., ilustr. [COBISS.SI-ID [15475995](#)].