

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
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Konstruiranje (smer)	1. letnik	1. semester

Univerzitetna koda predmeta/University course code: 0566871

Koda učne enote na članici/UL Member course code: 6024-M

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30		30			65	5

Nosilec predmeta/Lecturer: Damijan Zorko, Leon Kos, Nikola Vukašinović

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.

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.
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Vsebina: **Content (Syllabus outline):**

1. Predavanje – Uvod v konstrukcijske tehnike - Življenjski cikel proizvoda in S krivulja - Vloga konstrukcijskih tehnik pri razvoju proizvodov	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
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<ul style="list-style-type: none"> - Različni modeli konstrukcijskega procesa - Konstrukcijski zahtevnik v serijski in individualni proizvodnji <p>2. Predavanje – Konstruiranje za serijsko in individualno proizvodnjo</p> <ul style="list-style-type: none"> - Tehnična dokumentacija pri orodjih (brizganje plastike, štancanje) - Zahtevnik za orodje - Konstruiranje na novo - Patenti kot vir idej za konstruiranje, iskanje med patenti <p>3. Predavanje – TRIZ metoda</p> <ul style="list-style-type: none"> - Vloga TRIZ metode - Idealnost, protislovje, sistemski pristop - Primeri rešenih protislovij - 40 inovativnih principov - Kontradikcijska matrika <p>4. Predavanje – Vloga standardov in regulative pri razvoju proizvodov</p> <ul style="list-style-type: none"> - Evropska zakonodaja: direktive, uredbe, nacionalna zakonodaja - Harmonizirani standardi – vloga pri razvoju proizvodov - Zakon o tehničnih proizvodih, varnost proizvodov, nevarnosti in ocena tveganja <p>5. Predavanje – Dokazovanje ustreznosti proizvodov</p> <ul style="list-style-type: none"> - Certifikat na izdelku, oznaka CE, postopek za pridobitev oznake CE - Struktura in vsebina tehnične mape - Dokazovanje skladnosti z zakonodajo in regulativo <p>6. Predavanje – Eko dizajn I</p> <ul style="list-style-type: none"> - Eko-dizajn proizvodov - Zakonodaja in regulativa kot poslovna priložnost - Analiza vpliva proizvoda na okolje skozi celoten življenjski cikel <p>7. Predavanje – Eko dizajn II</p> <ul style="list-style-type: none"> - Principi konstruiranja za eko-dizajn - Konstruiranje za enostavno ločevanje materialov, označevanje materialov - Krožno gospodarstvo in zasnova proizvodov <p>8. Predavanje – Tehnike konstruiranja v avtomobilski industriji I</p> <ul style="list-style-type: none"> - Proces razvoja izdelkov in principi kakovosti - Proces razvoja v avtomobilski industriji - Stebri kakovosti v procesu razvoja proizvodov (APQP, SPC) <p>9. Predavanje – Tehnike konstruiranja v avtomobilski industriji II</p> <ul style="list-style-type: none"> - Stebri kakovosti v procesu razvoja proizvodov (MSA, FMEA, plan nadzora) - Konstruiranje za robustnost (Poka Yoke) 	<ul style="list-style-type: none"> - Design specification in serial and one-of-a-kind production <p>2. Lecture - Designing for serial and one-of-a-kind production</p> <ul style="list-style-type: none"> - Technical documentation for tools (injection molding, stamping) - Specification for tools - New design - Patents as a source of ideas for engineering design, patents search <p>3. Lecture - TRIZ method</p> <ul style="list-style-type: none"> - The role of the TRIZ method - Ideality, contradiction, systemic approach - Examples of resolved contradictions - 40 innovative principles - Contradiction matrix <p>4. Lecture - The role of standards and regulation in product development</p> <ul style="list-style-type: none"> - European legislation: directives, regulations, national legislation - Harmonized standards - role in product development - The Law for technical products, product safety, hazards and risk assessment <p>5. Lecture - Conformity with product specific EU requirements</p> <ul style="list-style-type: none"> - Product certification, CE marking, procedure for CE marking - Structure and content of a technical file - Conformity with legislation and regulations <p>6. Lecture - Eco Design I</p> <ul style="list-style-type: none"> - Eco-design of products - Legislation and regulation as a business opportunity - Environmental impact analysis throughout product life cycle <p>7. Lecture - Eco Design II</p> <ul style="list-style-type: none"> - Design principles for eco-design - Design for easy splitting of materials, materials labeling - Circular economy and product conceptual design <p>8. Lecture - Design techniques in the automotive industry I</p> <ul style="list-style-type: none"> - Product development process and quality principles - The development process in the automotive industry - Quality pillars in the product development process (APQP, SPC) <p>9. Lecture - Design techniques in the automotive industry II</p> <ul style="list-style-type: none"> - Quality pillars in the product development process (MSA, FMEA, control plan) - Designing for robustness (Poka Yoke) - Tolerance chain <p>10. Lecture - Advanced product development models</p> <ul style="list-style-type: none"> - Concurrent engineering (CE), set based CE - Design for Six sigma and six sigma methodology
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<ul style="list-style-type: none"> - Tolerančna veriga <p>10. Predavanje – Napredni modeli za razvoj proizvodov</p> <ul style="list-style-type: none"> - 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 <p>11. Predavanje – Stroški in konstruiranje</p> <ul style="list-style-type: none"> - 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 <p>12. Predavanje – Napredno modeliranje proizvodov</p> <ul style="list-style-type: none"> - Napredne metode za virtualno modeliranje proizvodov - Modeliranje podatkov (ULM), procesov in informacijskih tokov - Upravljanje znanja in razvoj proizvodov <p>13. Predavanje – Informacijska podpora konstrukcijskega procesa</p> <ul style="list-style-type: none"> - Tehnični informacijski sistemi (PLM) in njihova funkcionalnost - Obvladovanje tehničnih sprememb, modeliranje informacijskega toka - Upravljanje dokumentov in potrjevanje razvojnih faz <p>14. Predavanje – Konfiguriranje proizvodov</p> <ul style="list-style-type: none"> - Konfiguracija izdelkov, variantne kosovnice - Tipizacija gradikov in obvladovanje informacij - Družina proizvodov, platforma, modularna gradnja <p>15. Predavanje – Verifikacija, validacija in uvajanje konstrukcije v proizvodnjo</p> <ul style="list-style-type: none"> - Verifikacija in validacija proizvodov - Virtualni prototipi in komunikacija z naročnikom - verifikacija - Fizični prototipi in validacija - Postopki uvajanja v proizvodnjo 	<ul style="list-style-type: none"> - Application of lean principles in product development - Agile methods in the development process <p>11. Lecture - Costs and product design</p> <ul style="list-style-type: none"> - 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 <p>12. Lecture - Advanced Product Modeling</p> <ul style="list-style-type: none"> - Advanced methods for virtual product modeling - Modeling of data (ULM), processes and information flows - Knowledge management and product development <p>13. Lecture - Information support of the engineering design process</p> <ul style="list-style-type: none"> - Product lifecycle management (PLM) systems and their functionality - Technical change management, information flow modelling - Document management and validation of development phases <p>14. Lecture - Products configuration</p> <ul style="list-style-type: none"> - Product configuration, variant bill of materials - Internal standardisation and product information management - Product family, platform concept, modular design <p>15. Lecture - Verification, validation and introduction of product design into production</p> <ul style="list-style-type: none"> - Verification and validation of products - Virtual prototypes and communication with customer - verification - Physical prototypes and validation - Safe launch production procedures
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Temeljna literatura in viri/Readings:

1. K.T. Ulrich and S.D. Eppinger, Product Design and Development, 6th edition, Irwin McGraw-Hill, 2015Vir 2
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
3. J. Stjepandić, N. Wognum, J.C. W. Verhagen, Concurrent Engineering in the 21st Century, Foundations, Developments and Challenges, Springer 2015

4. G. Pahl, W. Beitz, J. Feldhusen, K.H. Grote, (2007), Engineering design, A Systematic Approach, Third Edition, Springer
5. M. M. Andreasen, Integrated Product Development, Technical University of Denmark, 2000
6. A. Boeijen, J. Daalhuizen, J. Zijlstra, R. Schoor, Delft Design Guide, Design Strategies and Methods, TU Delft, 2013
7. A. Maurya, Delaj vitko (ang. Running lean), Pasadena d.o.o., 2014
8. Jože Hlebanja, Metodika konstruiranja, Fakulteta za strojništvo, UL, Ljubljana 2003
9. K. Ehrlenspiel, A. Kiewert, U. Lindemann, M. S. Hundal, Cost-Efficient Design, 5th Edition, Springer, 2007

Cilji in kompetence:

Objectives and competences:

<p>Cilji:</p> <ol style="list-style-type: none"> 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 <p>Kompetence:</p> <ol style="list-style-type: none"> 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. 	<p>Objectives:</p> <ol style="list-style-type: none"> 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 <p>Competencies:</p> <ol style="list-style-type: none"> 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.
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Predvideni študijski rezultati:

Intended learning outcomes:

<p>Znanja:</p> <p>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.</p> <p>Spretnosti:</p> <p>S2.1 Obvladovanje zelo zahtevnih kompleksnih delovnih procesov in metodoloških orodij na področju konstruiranja:</p>	<p>Knowledge:</p> <p>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.</p> <p>Skills:</p> <p>S2.1 Proficiency in complex work processes and methodological tools in the field of engineering</p>
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<ul style="list-style-type: none"> Samostojno reševanje tehničnih problemov v strojništvu. Usposobljen za delo v skupini in interdisciplinarno povezovanje. <p>S2.3 Načrtovanje in vodenje delovnega procesa na podlagi ustvarjalnega reševanja problemov, povezanih s področjem konstruiranja:</p> <ul style="list-style-type: none"> Sposobnost za uporabo sodobnih metod in postopkov in prenašanje spoznanj v prakso 	<p>design:</p> <ul style="list-style-type: none"> Independent solving of technical problems in mechanical engineering. Capable of teamwork and interdisciplinary cooperation. <p>S2.3 Planning and managing a workflow based on creative problem solving related to the field of engineering design:</p> <ul style="list-style-type: none"> Ability to apply modern methods and procedures and ability to transfer of theoretical knowledge into practice.
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Metode poučevanja in učenja:

Learning and teaching methods:

<p>P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.</p> <p>P6 Interaktivna predavanja</p> <p>P4 Laboratorijske vaje z namenski didaktičnimi pripomočki:</p> <ul style="list-style-type: none"> računalniške delovne postaje namenska programska oprema za vodenje razvoja izdelkov namenska programska oprema za 3D modeliranje in simulacije. <p>P8 Izdelava in predstavitev aplikativnih seminarskih nalog</p> <p>P9 Skupinsko delo (strukturirana diskusija, viharjenje možganov, projektno delo, specifične metode za skupinsko delo)</p> <p>P15: Uporaba multi-medijskih vsebin kot priprava na predavanja in vaje</p>	<p>P1 Lectures by solving selected - typical - theoretical and practical examples.</p> <p>P6 Interactive Lectures</p> <p>P4: Laboratory exercises with dedicated didactic aids:</p> <ul style="list-style-type: none"> computer workstations dedicated software for managing product development dedicated software for 3D modeling and simulations. <p>P3 Practical classes where theoretical knowledge from lectures is supported by computational examples.</p> <p>P8 Preparing and presentation of applied project tasks</p> <p>P9 Teamwork (structured discussion, brainstorming, project work, specific methods for teamwork)</p> <p>P15: Usage of multi-media for preparing for lectures and tutorials</p>
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Načini ocenjevanja:

Delež/Weight

Assessment:

Teoretične vsebine (predavanja).	50,00 %	Theoretical content (lectures).
Samostojno delo na laboratorijskih vajah.	30,00 %	Independent work in laboratory exercises.
Projektna naloga.	20,00 %	Project work.

Reference nosilca/Lecturer's references:

Leon Kos

- KOS, Leon, KULOVEC, Simon, ZALETELJ, Viktor, DUHOVNIK, Jože. Structure generation for free-form architectural design. Advanced engineering, ISSN [1846-5900](#), 2009, vol. 3, no. 2, str. 187-194, ilustr. [COBISS.SI-ID 11096091]

2. KOS, Leon, TSKHAKAYA, D. D., JELIĆ, Nikola. Unified Bohm criterion. Physics of plasmas, ISSN 1070-664X, 2015, vol. 22, str. 1-5, ilustr. <http://scitation.aip.org/content/aip/journal/pop/22/9/10.1063/1.4930207>, doi: [10.1063/1.4930207](https://doi.org/10.1063/1.4930207). [COBISS.SI-ID 14168603]
3. KOS, Leon, TSKHAKAYA, D. D. Theory of ion-matrix-sheath dynamics. AIP advances, ISSN 2158-3226, 2018, vol. 8, f. 015202-1-015202-13, ilustr., doi: [10.1063/1.5017654](https://doi.org/10.1063/1.5017654). [COBISS.SI-ID 15819547]
4. 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, ISSN 2158-3226, Oct. 2018, vol. 8, no 10, str. 1-23, ilustr. <https://aip.scitation.org/doi/pdf/10.1063/1.5044664?class=pdf>, doi: [10.1063/1.5044664](https://doi.org/10.1063/1.5044664). [COBISS.SI-ID 12219988]
5. KOS, Leon, PITTS, R. A., SIMIČ, G., BRANK, Matic, ANAND, H., ARTER, W. SMITER : a field-line tracing environment for ITER. Fusion engineering and design, ISSN 0920-3796. [Print ed.], Mar. 2019, str. 1-5, ilustr. <https://www.sciencedirect.com/science/article/pii/S092037961930359X?via%3Dihub>, doi: [10.1016/j.fusengdes.2019.03.037](https://doi.org/10.1016/j.fusengdes.2019.03.037). [COBISS.SI-ID 16530203]

Nikola Vukašinović

1. KRIŽAJ, David, VUKAŠINOVIĆ, Nikola. Analysis of implementation of MBD and STEP AP242 standard into modern CAD tools. V: VALENTINČIČ, Joško (ur.), LEVY, Paul R. (ur.), SABOTIN, Izidor (ur.). The MIT International Conference 2018, 12th - 15th September, 2018 Izola, Slovenia. Târgu Jiu: [s. n.], 2019. Vol. 17, no. 1, ilustr. Research and Science Today Supplement, no. 1. ISSN 2344-0007. <https://www.rstjournal.com/?mdocs-file=2515>. [COBISS.SI-ID 16768795]
2. VUKAŠINOVIĆ, Nikola, PAVKOVIĆ, Neven. Use of virtual mobility to facilitate modern project-based NPD education. International journal of engineering education, ISSN 0949-149X, 2017, vol. 33, no. 6(B), str. 2008-2019, ilustr. [COBISS.SI-ID 15770139]
3. VUKAŠINOVIĆ, Nikola, BRAČUN, Drago, MOŽINA, Janez, DUHOVNIK, Jože. A new method for defining the measurement uncertainty model of CNC laser-triangulation scanner. International journal of advanced manufacturing technology. 2012, no. 9/12, str. 1097-1104. ISSN 0268-3768. DOI: 10.1007/s00170-011-3467-3. [COBISS.SI-ID 11915803]
4. 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]
5. ANIĆ, Dino, ANTONIĆ, Krunoslav, DUHOVNIK, Jože, MARLOT, Jernej, PAVKOVIĆ, Neven, PENCA, Jure, POVŠE, Gregor, SOFALVI, Janos, SZABO, Jozsef, TADEJ, Tea, VUKAŠINOVIĆ, Nikola. Handkühengerät mit Schutzabdeckung : EP2394544 (B1), 2014-05-21. München: Europäisches Patentamt, 2014. 11 f., ilustr. [COBISS.SI-ID 12127259]

Damijan Zorko

1. ZORKO, Damijan, KULOVEC, Simon, DUHOVNIK, Jože, TAVČAR, Jože. Durability and design parameters of a Steel/PEEK gear pair. Mechanism and machine theory, ISSN 0094-114X, Oct. 2019, vol. 140, str. 825-846, ilustr. <https://www.sciencedirect.com/science/article/pii/S0094114X19308341>, doi: [10.1016/j.mechmachtheory.2019.07.001](https://doi.org/10.1016/j.mechmachtheory.2019.07.001). [COBISS.SI-ID 16698139], [JCR, SNIP, WoS do 19. 11. 2021: št. citatov (TC): 20, čistih citatov (CI): 10, čistih citatov na avtorja (CIAu): 2.50, Scopus do 20. 1. 2022: št. citatov (TC): 23, čistih citatov (CI): 14, čistih citatov na avtorja (CIAu): 3.50] 2/1/22, 1:41 PM Raziskovalna skupina 0782-019 izumbib.izum.si/bibliografije/R20220201133311-0782-019.html 11/73 kategorija: 1A1 (Z, A', A1/2); uvrstitev: SCI, Scopus, MBP; tip dela je verificiral OSICN točke: 26.84, št. avtorjev: ¼
2. ZORKO, Damijan, KULOVEC, Simon, TAVČAR, Jože, DUHOVNIK, Jože. Different teeth profile shapes of polymer gears and comparison of their performance. Journal of advanced mechanical design, systems and manufacturing, ISSN 1881-3054, Dec. 2017, vol. 11, no. 6, f. 1-10, ilustr. https://www.jstage.jst.go.jp/article/jamdsm/11/6/11_2017jamdsm0083/_article/-char/en, doi: [10.1299/jamdsm.2017jamdsm0083](https://doi.org/10.1299/jamdsm.2017jamdsm0083). [COBISS.SI-ID 15829275], [JCR, SNIP, WoS do 20. 10. 2021: št. citatov (TC): 19, čistih citatov (CI): 10, čistih citatov na avtorja (CIAu): 2.50, Scopus do 23. 11. 2021: št. citatov (TC): 20, čistih citatov (CI): 7, čistih citatov na avtorja (CIAu): 1.75] kategorija: 1A4 (Z); uvrstitev: SCI, Scopus; tip dela je verificiral OSICN točke: 12.42, št. avtorjev: ¼
3. ZORKO, Damijan, ČERNE, Borut, TAVČAR, Jože, DEMŠAR, Ivan. Towards agile product development - an empirical study on an ebike drive. V: ICED 21, The 23rd International Conference in Engineering Design, 16-

20 August 2021, Gothenburg, Sweden, (Proceedings of the Design Society, ISSN 2220-4342, vol. 1). [S. l.: s. n.]. 2021, vol. 1, str. 3209-3218, ilustr. <https://www.cambridge.org/core/journals/proceedings-of-the-design-society/article/towards-agile-product-development-an-empirical-study-on-an-ebikedrive/A49FB08C4AC911BCC5E602900FD0DE2D>. [COBISS.SI-ID [74067459](#)] kategorija: 1C (Z); uvrstitev: MBP; tip dela je verificiral OSICT točke: 22.5, št. avtorjev: ¼

4. TAVČAR, Jože, **ZORKO, Damijan**, DUHOVNIK, Jože. Designing a coupling joint for connecting tube profiles. V: *Mechanika 2016 : proceedings of the 21st International Scientific Conference*, 12, 13 May 2016, Kaunas, 21st International Scientific Conference, 12, 13 May 2016, Kaunas, (Mechanika (Kaunas University of Technology), ISSN 1822-2951). Kaunas: University of Technology. 2016, str. 272-279, ilustr. [COBISS.SI-ID [14639387](#)], [WoS do 23. 7. 2016: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0, Scopus do 8. 4. 2017: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0] kategorija: 4C (Z); tip dela je verificiral OSICN točke: 8.33, št. avtorjev: 1/3
5. ČERNE, Borut, **ZORKO, Damijan**, DUHOVNIK, Jože. Semi-analytical method for the prediction of the flank temperatures of polymer gears during running. V: *Europe invites the world, International Conference on Gears, International Conference on Gear Production, International Conference on High Performance Plastic Gears*, Technische Universität München, Garching, September 2/1/22, 1:41 PM Raziskovalna skupina 0782-019 izumbib.izum.si/bibliografije/R20220201133311-0782-019.html 35/73 13th to 15th, 2017, (VDI-Berichte, ISSN 0083-5560, 2294.2). Düsseldorf: VDI. 2017, str. 1611-1623, ilustr. [COBISS.SI-ID [15664155](#)] kategorija: SU (S); tip dela je verificiral OSICT točke: 3.33, št. avtorjev: 2/3