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 (od študijskega leta 2024/2025 dalje)	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:	Leon Kos, Nikola Vukašinović

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.

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:	Content (Syllabus outline):
1. Predavanje – Uvod v konstrukcijske tehnike - Življenjski cikel proizvoda in S krivulja - Vloga konstrukcijskih tehnik pri razvoju proizvodov - Različni modeli konstrukciskega 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	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

- Kontradikcijska matrika	- European legislation: directives, regulations, national legislation
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	- Harmonized standards - role in product development - The Law for technical products, product safety, hazards and risk assessment
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	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. Predavanje – Eko dizajn I - Eko-dizajn proizvodov - Zakonodaja in regulativa kot poslovna priložnost - Analiza vpliva proizvoda na okolje skozi celoten življenjski cikel	6. Lecture - Eco Design I - Eco-design of products - Legislation and regulation as a business opportunity - Environmental impact analysis throughout product life cycle
7. Predavanje – Eko dizajn II - Principi konstruiranja za eko-dizajn - Konstruiranje za enostavno ločevanje materialov, označevanje materialov - Krožno gospodarstvo in zasnova proizvodov	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. Predavanje – Tehnike konstruiranja v avtomobilski industriji I - Proces razvoja izdelkov in principi kakovosti - Proces razvoja v avtomobilski industriji - Stebri kakovosti v procesu razvoja proizvodov (APQP, SPC)	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. Predavanje – Tehnike konstruiranja v avtomobilski industriji II - Stebri kakovosti v procesu razvoja proizvodov (MSA, FMEA, plan nadzora) - Konstruiranje za robustnost (Poka Yoke) - Tolerančna veriga	9. Lecture - Design techniques in the automotive industry II - Quality pillars in the product development process (MSA, FMEA, control plan) - Designing for robustness (Poka Yoke) - Tolerance chain
10. Predavanje – Napredni modeli za razvoj proizvodov - Sočasni razvoj, sočasni razvoj	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

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 - verifikacija
- Fizični prototipi in validacija
- Postopki uvajanja v proizvodnjo

process
11.   Lecture - Costs and product design
-    Cost structure at product design
-    Enginering 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

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]

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

sposobnost kreativnega reševanja nalog.	independent creative tasks solving.

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.	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.
Spretnosti:	Skills:
S2.1 Obvladovanje zelo zahtevnih kompleksnih delovnih procesov in metodoloških orodij na področju konstruiranja:	S2.1 Proficiency in complex work processes and methodological tools in the field of engineering design:
• 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:	• 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:
• Sposobnost za uporabo sodobih metod in postopkov in prenašanje spoznanj v prakso	• Ability to apply modern methods and procedures and ability to transfer of theoretical knowledge into practice.

Metode poučevanja in učenja:	**Learning and teaching methods:**
P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.	P1 Lectures by solving selected - typical - theoretical and practical examples.
P6 Interaktivna predavanja	P6 Interactive Lectures
P4 Laboratorijske vaje z namenskimi didaktičnimi pripomočki:	P4: Laboratory exercises with dedicated didactic aids:
• računalniške delovne postaje • namenska programska oprema za vodenje razvoja izdelkov • namenska programska oporema za	• computer workstations • dedicated software for managing product development • dedicated software for 3D modeling and simulations.

3D modeliranje in simulacije. P8 Izdelava in predstavitev aplikativnih seminarskih nalog	P3 Practical classes where theoretical knowledge from lectures is supported by computational examples.
P9 Skupinsko delo (strukturirana diskusija, viharjenje možganov, projektno delo, specifične metode za skupinsko delo)	P8 Preparing and presentation of applied project tasks
	P9 Teamwork (structured discussion, brainstorming, project work, specific methods for teamwork)
P15: Uporaba multi-medijskih vsebin kot priprava na predavanja in vaje	P15: Usage of multi-media for preparing for lectures and tutorials

Načini ocenjevanja:	Delež/ Weight	Assessment:
Teoretične vsebine (predavanja).	50,00 %	Theoretical content (lectures).
Projektno delo (vaje).	50,00 %	Project work (excercises).

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**, 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/22/9/10.1063/4930207, doi: 10.1063/4930207. [COBISS.SI-ID 14168603]
2. **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. [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, 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. [COBISS.SI-ID 12219988]
4. **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. [COBISS.SI-ID 16530203]
5. BRANK, Matic, PITTS, Richard, SIMIČ, Gregor, LAMALLE, P., KOCAN, M., KÖCHL, F., GRIBOV, Y., POLLI, V., and **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](10.1016/j.nme.2021.101021). [COBISS.SI-ID [78883331](78883331)]

Nikola Vukašinović:

1. **VUKAŠINOVIĆ, Nikola**, BRAČUN, Drago, MOŽINA, Janez, DUHOVNIK, Jože. A new method for defining the measurementuncertainty 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](11915803)]

2. ČAKŠ, Žiga, ĆORLUKA, Željko, DUHOVNIK, Jože, KOKELJ, Gašper, KRAJNC, Matija, LEJLA, Vida, OSELI, Alen, SOMOGYVÁRI, Mónika, VERDEGUER LOPEZ, Javier, **VUKAŠINOVIĆ, Nikola**. Handküchengerät 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](12125723)]

3. ANIĆ, Dino, ANTONIĆ, Krunoslav, DUHOVNIK, Jože, MARLOT, Jernej, PAVKOVIĆ, Neven, PENCA, Jure, POVŠE, Gregor, SOFALVI, Janos, SZABO, Joszef, TADEJ, Tea, **VUKAŠINOVIĆ, Nikola**. Handküchengerät mit Schutzabdeckung : EP2394544 (B1), 2014-05-21. München: Europäisches Patentamt, 2014. 11 f., ilustr. [COBISS.SI-ID [12127259](12127259)]

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](10.17559/TV-20200728151912). [COBISS.SI-ID [66828803](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, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=138691, DOI: 10.1016/j.mechmachtheory.2021.104430. [COBISS.SI-ID [69206531](69206531)]