

METODIKA KONSTRUIRANJA - RRP

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Metodika konstruiranja - RRP
Course title:	Engineering Design Methodology - RRP
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - razvojno raziskovalni program, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0562761
Koda učne enote na članici/UL Member course code:	2022-U

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			40	4

Nosilec predmeta/Lecturer:	doc. dr. Vanja Čok, 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 splošni predmet /Compulsory general course
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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 Univerzitetni študijski program I. stopnje Strojništvo - Razvojno raziskovalni program.	Meeting the enrollment conditions for the Academic study programme of Mechanical Engineering - Research and Development program.

Vsebina:	Content (Syllabus outline):
Predavanje: Uvod v metodiko konstruiranja - Konstruiranje v celem življenjskem ciklu izdelka - Nivoji in viri konstruiranja - Iskanje priložnosti za razvoj novega izdelka - Naravni in tehnični proces, ter razumevanje procesov	. Lecture: Introduction to methodology of engineering design - Engineering design throughout the product life cycle - Levels and sources of design - Finding opportunities to develop a new product

- Primer izvedenega konstrukcijskega procesa 2. Predavanje: Konstrukcijske zahteve - "Design brief" - Potrebe uporabnikov - Metode za ugotavljanje potreb - Inženirske specifikacije - Ciljne in končne specifikacije - QFD matrika; preslikava zahtev kupca v tehnične zahteve - Vpliv standardov, regulative in socialno-konstrukcijskega okolja na razvoj izdelka 3. Predavanje: Koraki konstruiranja - Faze konstrukcijskega procesa po VDI 2222 - Konstrukcijski proces po avtomobilskem standard (zahtev, mejniki) - Konstruiranje za večjo zanesljivost 4. Predavanje: Sočasni razvoj - Značilnosti sočasnega razvoja - Prednosti in slabosti sočasnega izvajanja aktivnosti - Elementi sočasnega razvoja (metode, IT, vodenje projekta, dobavitelji in odjemalci) - Sočasen razvoj več variant (ang. set based CE) 5. Predavanje: Tehnični sistem in funkcijska struktura - Konstruiranje kot faza razvoja izdelkov - Tehnični proces - Tehnični sistem - Funkcijska struktura; vloga abstraktne predstavitve problema - Funkcijska dekompozicija - Naravni efekt - Delovni princip, struktura elementarnih nosilcev funkcij in struktura component 6. Predavanje: Iskanje rešitev delnih funkcij - Fizikalni zakoni kot vir idej za delovne principe - Toga in fleksibilna funkcijska struktura - Povečanje iskalnega prostora za generiranje konceptov - Manipulacija efektov, struktur in komponent - Veriženje fizikalnih zakonov - Viri konstruiranja (topologija, material, fizikalni zakoni, geometrija) 7. Predavanje: Generiranje rešitev - Snovanje - Klasične metode za iskanje rešitev - Intuitivne metode za iskanje rešitev - Diskurzivne metode za iskanje rešitev - Morfološka matrika 8. Predavanje: Generiranje konceptov - Konvencionalni pripomočki za iskanje rešitev - Variacija konstrukcijskih značilnosti - Sinteza variant / rešitev 9. Predavanje – Metode za spodbujanje kreativnosti - Nevihta možganov (brainstorming) - galerijska metoda - metoda 6 klobukov - bionika, - Design thinking 10. Predavanje: Vrednotenje in izbira najboljših	- Natural and technical process, and understanding of processes - An example of a conducted engineering design process 2. Lecture: Engineering design requirements - Design brief - User needs - Methods for identifying needs - Engineering specifications - Target and final specifications - QFD matrix; mapping customer requirements into technical requirements - Impact of standards, regulation and socio-design environment on product development 3. Lecture: Engineering design Steps - Phases of the engineering design process according to VDI 2222 - Automotive engineering design process (requirements, milestones) - Engineering design for greater reliability 4. Lecture: Concurrent engineering - Characteristics of concurrent engineering - Advantages and disadvantages of carrying out activities concurrently - Elements of concurrent engineering (methods, IT, project management, suppliers and clients) - Concurrent engineering of multiple variants (set based CE) 5. Lecture: Technical system and functional structure - Engineering design as a product development phase - Technical process - Technical system - Functional structure; the role of an abstract representation of a problem - Functional decomposition - Natural effect - Working principle, structure of elementary function carriers and structure of component 6. Lecture: Finding solutions to partial functions - Physical laws as a source of ideas for working principles - Rigid and flexible function structure - Increase the search space for generating concepts - Manipulation of effects, structures and components - Chaining of physical laws - Engineering design sources (topology, material, physical laws, geometry) 7. Lecture: Generating of solutions - Conceptual Design - Classic methods for searching solutions - Intuitive methods for searching solutions - Discursive methods for searching solutions - Morphological matrix 8. Lecture: Generating concepts - Conventional tools for searching solutions - Variation in structural features - Synthesis of variants / solutions 9. Lecture - Methods for stimulating creativity
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konceptov - Vrednotenje po tehniških kriterijih - Vrednotenje po ekonomskih kriterijih - Model za ocenjevanje rešitev po tehničnih in ekonomskih kriterijih - Model ocenjevanja kriterijev s funkcijo - VDI-2225 - Metoda Analytic Hierarchic Process (AHP) - Matrika odločanja - Ocena izvedljivosti 11. Predavanje: Izvedba konstrukcije in detaljiranje - Materializacija delovnega principa - Principi enoličnosti pri oblikovanju konstrukcije - Principi enostavnosti pri konstruiranju - Varnost 12. Predavanje: Izvedba konstrukcije in detaljiranje - Princip podpornega delovanja, princip stabilnosti in labilnosti - Principi varnosti pri konstruiranju - Pravila pri oblikovanju konstrukcije (izravnava sil, deformabilnost, delne funkcije) 13. Predavanje: Izvedba konstrukcije in detaljiranje - Smernice pri oblikovnem konstruiranju - Konstruiranje in izdelovalne tehnologije - Modularna struktura proizvodov 14. Predavanje: Ergonomija - Človekova navzočnost v tehničnem sistemu - Uporabniku prilagojeni tehnični sistemi - Biomehanske, kognitivne in fiziološke sposobnosti človeka 15. Predavanje: Prototipiranje - Vloga virtualnih in fizičnih prototipov v procesu razvoja izdelkov - Delni prototipi, Fizični in analitični prototipi - Načrtovanje prototipov - 3D printanje in prototipiranje	- Brainstorming - Gallery method - Method of 6 hats - Bionics, - Design thinking 10. Lecture: Evaluation and selection of the best concepts - Evaluation by technical criteria - Evaluation by economic criteria - Model for evaluating solutions by technical and economic criteria - Criteria evaluation model with function - VDI-2225 - Analytical Hierarchic Process (AHP) Method - Decision matrix - Feasibility assessment 11. Lecture: Design and detailing - Materialization of the working principle - Principles of uniformity in structural design - Principles of simplicity of engineering design - Safety 12. Lecture: Embodiment design and detailing - The principle of supportive action, the principle of stability and lability - Principles of product design safety - Structural design rules (force balancing, deformability, partial functions) 13. Lecture: Embodiment design and detailing - Engineering design guidelines - Engineering design and manufacturing technologies - Modular product structure 14. Lecture: Ergonomics - Human presence in the technical system - Customized technical systems - Human biomechanical, cognitive and physiological abilities 15. Lecture: Prototyping - The role of virtual and physical prototypes in the product development process - Partial prototypes, physical and analytical prototypes - Prototype design - 3D printing and prototyping
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Temeljna literatura in viri/Readings:

1. Hlebanja, J., Metodika konstruiranja, Univerza v Ljubljani, Fakulteta za strojništvo, 2003, [COBISS.SI-ID [123009024](#)]
2. Ullman, D.G., The Mechanical Design Process, 6th Edition, 2018, [COBISS.SI-ID [11277339](#)]
3. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H. Engineering Design: A Sytematic Approach, 3rd edition, 2007 [COBISS.SI-ID [1391899](#)]
4. Ulrich, K.T., Eppinger, S.D., Product Design and Development, različne izdaje, 7th ed (2020) [COBISS.SI-ID [174327811](#)]
5. M. M. Andreasen, Integrated Product Development, Technical University of Denmark, 2000 [COBISS.SI-ID [642843](#)]

Cilji in kompetence:

- Cilji:
1. Spoznati pomen izdelkov

Objectives and competences:

- Objectives:
1. Understand the importance of products

2. Spoznati razvojni proces 3. Spoznati proces konstruiranja in deležnike v procesu 4. Spoznati vlogo ergonomije oblikovanja v procesu konstruiranja 5. Spoznati uporabniške potrebe in inženirske specifikacije 6. Spoznati osnovne kreativne metode in tehnike konstruiranja 7. Spoznati smernice utelešenja konceptov 8. Spoznati vlogo prototipiranja v procesu konstruiranja Kompetence: 1. S1-RRP, S2-RRP, P1-RRP: Sposobnost uporabe korakov razvojnega in konstrukcijskega procesa in sinteza različnih pogledov na generiranje izdelka. 2. S3-RRP, S7-RRP, P2-RRP: Sposobnost poiskati osnovne uporabniške potrebe in sintetizirati inženirske specifikacije. 3. S5-RRP, S6-RRP, S8-RRP, P4-RRP: Sposobnost oceniti in izbrati primerne koncepte glede na inženirske specifikacije. 4. S9-RRP, P5-RRP: Sposobnost uporabe smernic za utelešenje konceptov ter izbire ustreznega načina prototipiranja in izvedba analize prototipov.	2. Know the development process 3. Know the engineering design process and stakeholders in the process 4. To understand the role of design ergonomics in the engineering design process 5. Understand user needs and engineering specifications 6. Learn basic creative design methods and techniques 7. Learn the guidelines for embodiment of concepts 8. Understand the role of prototyping in the engineering design process Competencies: 1. S1-RRP, S2-RRP, P1-RRP: Ability to apply the steps of the development and engineering design process and synthesize different views on product generation. 2. S3-RRP, S7-RRP, P2-RRP: Ability to find basic user needs and synthesize engineering specifications. 3. S5-RRP, S6-RRP, S8-RRP, P4-RRP: Ability to evaluate and select suitable concepts according to engineering specifications. 4. S9-RRP, P5-RRP: Ability to use guidelines to embody concepts and to choose the appropriate prototyping method and perform prototype analysis.
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Predvideni študijski rezultati:

Znanja: Z1: Poglobljeno strokovno teoretično in praktično znanje sistematičnega razvoja izdelkov, razvojnega in konstrukcijskega procesa podprto s širšo teoretično in metodološko osnovo. • poznavanje vplivov na razvojni in konstrukcijski proces. • strokovno teoretično in praktično poznavanje metod in tehnik iskanja priložnosti za nov izdelek. • strokovno teoretično in praktično poznavanje sinteze konceptov, ocenjevanja in izbire konceptov, utelešenja, prototipiranja in analize prototipov izdelka. Spretnosti: S1.1 Izvajanje kompleksnih operativno-strokovnih opravil, ki vključujejo tudi uporabo metodoloških orodij: • diagnosticiranje in reševanje problemov uporabnikov S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah: • uporaba preskušanih konstrukcijskih metod sinteze in analize ter tehnik za razvoj in konstrukcijo novih izdelkov

Intended learning outcomes:

Knowledge: Z1: In-depth professional theoretical and practical knowledge of systematic product development, development and engineering design process supported by a broader theoretical and methodological basis. - Knowledge of impacts on the development and engineering design process. - Professional theoretical and practical knowledge of methods and techniques for finding opportunities for a new product. - Professional theoretical and practical knowledge of concept synthesis, evaluation and concept selection, embodiment, prototyping and prototype analysis of the product. Skills: S1.1 Performing complex operational and professional tasks, including the use of methodological tools: - Diagnosing and solving of user problems S1.2 Mastering complex work processes with the independent use of knowledge in new work situations: - The application of the proven design methods of synthesis and analysis and techniques for the development and design of new products
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Metode poučevanja in učenja:

Learning and teaching methods:

P1: Avditorna predavanja z reševanjem izbranih industrijskih primerov P2: Obravnava snovi po urejeni in vnaprej razloženi sistematiki P4 Laboratorijske vaje z namenski didaktični pripomočki: • računalniške delovne postaje • namenska programska oprema za vodenje razvoja izdelkov • namenska programska oprema za 3D modeliranje in simulacije P5: Uporaba študijskega gradiva v obliki e-verzije predstavitve predavanja P7: Študij literature in razprava P9: Skupinsko delo (razprave za-proti, viharjenje možganov in projektno delo) P15: Uporaba video vsebin kot priprava na predavanja in vaje	P1: Lectures with case studies on selected industrial cases P2: Topics according to an orderly and pre-explained systematics P4: Laboratory exercises with dedicated didactic aids: • computer workstations • dedicated software for managing product development • dedicated software for 3D modeling and simulations. P5: Use of study materials in the form of an e-version of the lecture presentation P7: Literature study and discussion P9: Teamwork (discussions pro and contra, brainstorming and project work) P15: Use video content to prepare for lectures and tutorials
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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.

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:

Nikola Vukašinić:

1. **VUKAŠINOVIĆ, Nikola**, PAVKOVIĆ, Neven. Use of virtual mobility to facilitate modern project-based NPD education. *International journal of engineering education*. 2017, vol. 33, no. 6(b), str. 2008-2019, ilustr. ISSN 0949-149X. [COBISS.SI-ID [15770139](#)].
2. ZORKO, Damijan, WEI, Peitang, **VUKAŠINOVIĆ, Nikola**. The effect of gear-manufacturing quality on the mechanical and thermal responses of a polymer-gear pair. *Journal of computational design and engineering*. Feb. 2024, vol. 11, iss. 1, str. 195-211, ilustr. ISSN 2288-5048. <https://academic.oup.com/jcde/article/11/1/195/7589742>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1093/jcde/qwae010](#). [COBISS.SI-ID [186260739](#)].
3. VLAH, Daria, ŽAVBI, Roman, **VUKAŠINOVIĆ, Nikola**. Evaluation of topology optimization and generative design tools as support for conceptual design. V: *Proceedings of the 16th International Design Conference : DESIGN 2020*. Cambridge: Cambridge University Press, 2020. Vol. 1, str. 451-460, ilustr. Proceedings of the Design Society, Vol. 1. ISSN 2633-7762. <https://www.cambridge.org/core/journals/proceedings-of-the-design-society-design-conference/article/evaluation-of-topology-optimization-and-generative-design-tools-as-support-for-conceptual-design/E7FC2E5C9A561FE267D9BE1074F0D162>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1017/dsd.2020.165](#). [COBISS.SI-ID [20977411](#)].
4. FAIN, Nuša, **VUKAŠINOVIĆ, Nikola**. Entrepreneurial mindset development in business and engineering education : an experiment. V: *Proceedings of the 16th International Design Conference : DESIGN 2020*. Cambridge: Cambridge University Press, 2020. Vol. 1, str. 1707-1714, ilustr. Proceedings of the Design Society, Vol. 1. ISSN 2633-7762. <https://www.cambridge.org/core/journals/proceedings-of-the-design-society-design-conference/article/entrepreneurial-mindset-development-in-business-and-engineering-education-an-experiment/B658E7756DC27EDEAAD73F7B0191BBDB>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1017/dsd.2020.71](#). [COBISS.SI-ID [20977667](#)].
5. URBAS, Uroš, VLAH, Daria, **VUKAŠINOVIĆ, Nikola**. Machine learning method for predicting the influence of scanning parameters on random measurement error. *Measurement science & technology*. [Print ed.]. 2021, vol. 32, no. 6, str. 1-9, ilustr. ISSN 0957-0233.

<https://iopscience.iop.org/article/10.1088/1361-6501/abd57a>, DOI: [10.1088/1361-6501/abd57a](https://doi.org/10.1088/1361-6501/abd57a).
[COBISS.SI-ID [49131523](#)].

Vanja Čok:

1. **ČOK, Vanja**, FAIN, Nuša, VUKAŠINOVIĆ, Nikola, ŽAVBI, Roman. Multicultural issues of product development education in virtual teams. International journal of engineering education. 2015, vol. 31, nr. 3, str. 863-873, ilustr. ISSN 0949-149X
2. **ČOK, Vanja**, VLAH, Daria, POVH, Janez. Methodology for mapping form design elements with user preferences using Kansei engineering and VDI. Journal of engineering design. [Print ed.]. 2022, vol. 33, iss. 2, str. 144-170, ilustr. ISSN 0954-4828.
<https://www.tandfonline.com/doi/full/10.1080/09544828.2021.2012133>, DOI: 10.1080/09544828.2021.2012133
3. **ČOK, Vanja**, DREŠAR, Primož, PETRIČ, Klemen, ČRV, Matija. Optimizacija oblike ohišja prototipa mobilne baterijske pršilke (COR Liquishot) : 2. faza : poročilo. Ljubljana: Fakulteta za strojništvo, 2020. 27 f., ilustr. [COBISS.SI-ID [29161475](#)]
4. **ČOK, Vanja**. Razvoj in postavitev polnilnice za električna letala za podjetje Pipistrel : Po Kreativni poti do praktičnega znanja 2016/17 : razvojne faze projekta. Ljubljana: Fakulteta za strojništvo, 2017. 36 f., graf. prikazi. [COBISS.SI-ID [15590427](#)]
5. **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>, DOI: 10.1017/pds.2022.230
6. LU, Weihua, YE, Chenyan, FANG, Yingying, **ČOK, Vanja**, PETIOT, Jean-François. A systematic review of Kansei engineering in vehicle design. Digital engineering. Dec. 2024, vol. 3, [art. no.] 100022, str. 1-15, ilustr. ISSN 2950-550X. <https://www.sciencedirect.com/science/article/pii/S2950550X24000220>, DOI: 10.1016/j.dte.2024.100022. [COBISS.SI-ID [215450883](#)]