

RAZISKAVE V STROJNIŠTVU

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Raziskave v strojništvu
Course title:	Research in Mechanical Engineering
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Energetsko strojništvo (smer)	2. letnik	2. semester	obvezni
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Konstruiranje (smer)	2. letnik	2. semester	obvezni
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Mehanika (smer)	2. letnik	2. semester	obvezni
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Mehatronika in laserska tehnika (smer)	2. letnik	2. semester	obvezni
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Procesno strojništvo (smer)	2. letnik	2. semester	obvezni
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Proizvodno strojništvo (smer)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0566826
Koda učne enote na članici/UL Member course code:	6011-M

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
90		90			195	15

Nosilec predmeta/Lecturer:

doc. dr. Vid Agrež, izr. prof. dr. Ciril Arkar, doc. dr. Tomaž Berlec, doc. dr. Drago Bračun, izr. prof. dr. Miha Brojan, prof. dr. Gregor Čepon, doc. dr. Martin Česnik, prof. dr. Matevž Dular, prof. dr. Iztok Golobič, prof. dr. Edvard Govekar, izr. prof. dr. Peter Gregorčič, izr. prof. dr. Miroslav Halilović, prof. dr. Niko Heraković, prof. dr. Marko Hočevar, izr. prof. dr. Boris Jerman, prof. dr. Matija Jezeršek, prof. dr. Mitjan Kalin, prof. dr. Tomaž Katrašnik, doc. dr. Tomaž Kek, prof. dr. Andrej Kitanovski, prof. dr. Jernej Klemenc, doc. dr. Katja Klinar, izr. prof. dr. Damjan Klobčar, doc. dr. Dominik Kozjek, izr. prof. dr. Davorin Kramar, doc. dr. Andraž Kravos, izr. prof. dr. Robert Kunc, izr. prof. dr. Jože Kutin, izr. prof. dr. Franc Majdič, doc. dr. Boštjan Mavrič, prof. dr. Sašo Medved, izr. prof. dr. Nikolaj Mole, izr. prof. dr. Mitja Mori, prof. dr. Marko Nagode, izr. prof. dr. Simon Oman, izr. prof. dr. Tomaž Pepelnjak, izr. prof. dr. Aljoša Peperko, prof. dr. Rok Petkovšek, prof. dr. Primož Podržaj, doc. dr. Marko Polajnar, doc. dr. Primož Potočnik, izr. prof. dr. Jurij Prezelj, prof. dr. Franci Pušavec, doc. dr. Darja Rupnik Poklukar, prof. dr. Mihael Sekavčnik, prof. dr. Janko Slavič, doc. dr. Lidija Slemenik Perše, izr. prof. dr. Uroš Stritih, prof. dr. Božidar Šarler, izr. prof. dr. Domen Šeruga, izr. prof. dr. Marko Šimic, prof. dr. Roman Šturm, doc. dr. Jovan Trajkovski, Jaka Tušek, izr. prof. dr. Joško Valentinčič, izr. prof. dr. Rok Vrabič, izr.

prof. dr. Nikola Vukašinić, izr. prof. dr. Matevž Zupančič, prof. ddr.
Janez Žerovnik

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

Jeziki/Languages:

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

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

V sklopu predmeta se student spozna s širšim področjem določenega dela tematike, ki jo bo obdelal v magistrski nalogi. Zato so pogoj za vključitev v delo opravljene študijske obveznosti 1. in 2. semestra MAG študijskega programa.

Prerequisites:

As part of the course, the student gets introduced to the broader field of a certain part of the topic, which he will deal with in the master's thesis. Therefore, the requirement for the course is completed study obligations of the 1st and 2nd semester of the MAG study program.

Vsebina:

Glede na širši vidik obravnavane raziskovalne tematike magistrskega dela student izbere enega nosilca tega predmeta, ki prevzame vlogo mentorja. Predmet se izvaja pri treh izvajalcih, pri čemer sta študentu poleg mentorja dodeljena še dva soizvajalca glede na strokovno področje izbrane teme.

1. Predstavitev ciljev predmeta in posameznih raziskovalnih tematik, ki jih bodo študentje opravljali tekom leta.
2. Pregled znanstvene literature dogovoru z izbranimi nosilci predmeta.
3. Interaktivna predstavitev obdelanih temeljnih vsebin z individualno ali skupinsko diskusijo.
4. Opredelitev individualnega parcialnega problema na obravnavanem področju ob vodenju nosilcev predmeta.
5. Priprava načrta iskanja rešitev za opredeljeni parcialni problem ob vodenju nosilcev predmeta.
6. Pregled in študij teoretičnih osnov izbrane tematike.
7. Analitične metode modeliranja sistemov/procesov izbrane tematike*.
8. Numerične metode modeliranja sistemov/procesov izbrane tematike*.

* Glede na predvidene naloge so podani poudarki na eksperimentalnih, računalniških ali analitičnih raziskovalnih vsebinah.

9. Interaktivna predstavitev povzetka obdelanih specializiranih vsebin z individualno ali skupinsko

Content (Syllabus outline):

According to the broader aspect of the research topic of the master's thesis, the student chooses one of the course lecturers, who assumes the role of supervisor. The course is delivered by three lecturers; in addition to the mentor, the student is assigned two co-mentors based on the specialized field of the selected topic.

1. Presentation of the course objectives and individual research topics that students will undertake throughout the year.
2. Review of the scientific literature in agreement with the chosen lecturers.
3. An interactive presentation of discussed core content through individual or group discussion.
4. Definition of an individual partial problem in the area under consideration guided by lecturers.
5. Preparation of a plan for finding solutions to the defined partial problem guided by lecturers.
6. Review and study of the theoretical basis of the selected topic.
7. Analytical methods for modelling systems / processes of the selected topic *.
8. Numerical methods for modelling systems / processes of the selected topic *.

* According to the selected assignment, emphasis are placed on experimental, computer or analytical research.

9. An interactive presentation of a summary of studied specialized content with individual or group discussion.

diskusijo. 10. Zasnova in razvoj naprave / eksperimentalnega sistema / računskega modela v sklopu izbrane tematike. 11. Razvoj metodologije vrednotenja razvite naprave / eksperimentalnega sistema / računskega modela. 12. Razvoj in izvedba eksperimentalnega dela. 13. Korelacija eksperimentalnih rezultatov s teoretičnimi napovedmi. 14. Interaktivna predstavitev eksperimentalnih, računalniških ali analitičnih orodij ter primerjava z ugotovitvami iz dostopne literature. 15. Pregled izzivov za prihodnost na področju izbrane raziskovalne tematike.	10. Design and development of the device / experimental system / computational model within the chosen topic. 11. Development of evaluation methodology of developed device / experimental system / computational model. 12. Development and implementation of experimental work. 13. Correlation of experimental results with theoretical predictions. 14. Interactive presentation of experimental, computer or analytical tools and comparison with findings from available literature. 15. An overview of the challenges ahead for the chosen research topic.
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Temeljna literatura in viri/Readings:

Določena je smiselno v dogovoru s tremi nosilci predmeta za vsakega študenta posebej glede na izbrano problematiko. Literatura je dosegljiva v knjižnici laboratorija, fakultetni knjižnici ali širše. Praviloma študent študira iz člankov, ki so obravnavali podoben primer, kakor ga ima sam definiranega.

It is determined appropriately in agreement with three lecturers for each student according to the chosen topic. Literature is available at the lab library, faculty library or beyond. As a rule, a student studies from articles dealing with a similar case as he or she has defined.

Cilji in kompetence:

Cilji:

1. Omogočiti študentu seznanitev s temeljno in predmetno specifično literaturo na delu tematike, ki bo obravnavana v magistrski nalogi.
2. Seznanitev z namensko opremo na področju eksperimentiranja in uporabe računalniških orodij. Študent tako spozna posebnosti, ki jih lahko uporabi.
3. Predmet se izvaja v laboratoriju (enem ali več) odvisno od dogovora z mentorjem in nosilci predmeta.

Kompetence:

S1-MAG: Sposobnost za opredelitev, razumevanje temeljnih znanstvenih problemov in ustvarjalno reševanje strokovnih izzivov.

S2-MAG: Širitev sposobnosti kritičnega, analitičnega in sintetičnega mišljenja. Razvijanje novega znanja in razumevanja področja. Razvijanje višjih kognitivnih veščin, povezanih z ustvarjanjem novega znanja.

S8-MAG: Sposobnost iskanja virov, kritične presoje informacij, samostojnega nadgrajevanja pridobljenih znanj in poglobljanja znanja na posameznih specializiranih področjih strojništva

S10-MAG: Sposobnost uporabe sodobnih raziskovalnih metod in postopkov. Zmožnost raziskovanja in prenašanja spoznanj v prakso.

P1-MAG: Sposobnost za nadgrajevanje in uporabo temeljnih strojniških znanj ter njihovo razvojno-tehniško implementacijo.

P4-MAG: Sposobnost fizikalnega, matematičnega in numeričnega modeliranja problemov z razvito sposobnostjo kritične analize rezultatov.

Objectives and competences:

Objectives:

1. To enable the student to get acquainted with the basic and specific literature on the topic that will be discussed in the master's thesis.
2. To familiarize with the specific equipment in the field of experimentation and use of computer tools. Thus the student learns about the special features that he can use.
3. The course is carried out in the laboratory (one or more), depending on the agreement with the mentor and course lecturers.

Competencies:

S1-MAG: The ability to define and understand fundamental scientific problems, and to creatively deal with professional challenges.

S2-MAG: Improved capability of critical, analytical and synthetical thinking. Development of new knowledge and comprehension of the professional field. Development of higher cognitive skills, related to the creation of new knowledge

S8-MAG: The ability to find sources, critically evaluate information, independently upgrade the attained knowledge and deepen the knowledge in the individual specialised fields of mechanical engineering.

S10-MAG: The ability to use modern research methods and procedures. Capacity to research and transfer the findings into practice.

P1-MAG: The ability to upgrade and use the fundamental mechanical engineering knowledge, including the developmental-technical implementation thereof.

P7-MAG: Na osnovi analize in sinteze razvita sposobnost iskanja optimalnejših rešitev.	P4-MAG: The ability for physical, mathematical and numerical modelling of problems, including a developed ability to critically analyse the results. P7-MAG: The ability to find optimal solutions based on analysis and synthesis.
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Predvideni študijski rezultati:	Intended learning outcomes:
Znanja: Z2: Poglobljeno teoretično, metodološko in analitično znanje z elementi raziskovanja, ki je osnova za zelo zahtevno strokovno delo. Spretnosti: S2.1 Obvladovanje zelo zahtevnih, kompleksnih delovnih procesov in metodoloških orodij na specializiranih področjih. S2.2 Načrtovanje in vodenje delovnega procesa na podlagi ustvarjalnega reševanja problemov, povezanih s področjem izobraževanja in usposabljanja. S2.3 Sposobnost izvirnih dognanj/stvaritev in kritične refleksije.	Knowledge: Z2: Thorough theoretical, methodological and analytical knowledge with elements of a research work that form a basis for very demanding professional work Skills: S2.1 Mastering very demanding and complex work processes and methodological tools in specialised professional fields. S2.2 Planning and managing of the working process on the basis of creative solving of problems that are linked to the teaching and training content. S2.3 Ability of unique innovations and critical reflections.

Metode poučevanja in učenja:	Learning and teaching methods:
Klasične oblike poučevanja: P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov. P2 Obravnava snovi po urejeni in vnaprej razloženi sistematiki. P5 Uporaba študijskega gradiva v obliki skript, knjig, zapiskov, strokovnih člankov in predstavitev predavanj. Moderne in prožne oblike poučevanja: P6 Interaktivna predavanja P7 Študij literature in razprava P8 Izdelava in predstavitev aplikativnih seminarских nalog P14 Virtualni eksperimenti	Conventional teaching methods: P1 Auditorial lectures with solving selected field-specific theoretical and applied use cases. P2 Presenting the content according to the explained system. P5 Application of study material in form of scripts, textbooks, notes, professional articles and printed lecture presentations. Contemporary and flexible teaching methods: P6 Interactive lectures. P7 Literature study and discussion. P8 Making and presenting applied seminar exercises. P14 Virtual experiments.

Načini ocenjevanja:	Delež/Weight	Assessment:
Ocena predavitve končnih rezultatov.	50,00 %	Presentation of final results.
Ocena končnega poročila.	50,00 %	Evaluation of final report.

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:
Vid Agrež: AGREŽ, Vid, LOKAR, Žiga, PETKOVŠEK, Rok. Laser induced microbubbles as an alternative driver for liquid pumping. <i>Optics and laser technology</i>. [Print ed.]. Oct. 2024, vol. 177, [article no.] 111235, str. 1-9, ilustr. ISSN 0030-3992. https://www.sciencedirect.com/science/article/pii/S0030399224006935, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.optlastec.2024.111235 - POŽAR, Tomaž, AGREŽ, Vid, PETKOVŠEK, Rok. Laser-induced cavitation bubbles and shock waves in water near a concave surface. <i>Ultrasonics Sonochemistry</i>. May 2021, vol. 73, str. 1-11, ilustr. ISSN 1350-

4177. <https://www.sciencedirect.com/science/article/pii/S1350417720317612>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1016/j.ultsonch.2020.105456](https://doi.org/10.1016/j.ultsonch.2020.105456). [COBISS.SI-ID [45742083](#)].

3. HORVAT, Darja, **AGREŽ, Vid**, POŽAR, Tomaž, ŠTARMAN, Bojan, HALILOVIČ, Miroslav, PETKOVŠEK, Rok. Laser-induced shock-wave-expanded nanobubbles in spherical geometry. *Ultrasonics Sonochemistry*. Sep. 2022, vol. 89, str. 1-12, ilustr. ISSN 1350-4177. <https://www.sciencedirect.com/science/article/pii/S1350417722002565>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.1016/j.ultsonch.2022.106160](https://doi.org/10.1016/j.ultsonch.2022.106160). [COBISS.SI-ID [122021123](#)].

Ciril Arkar:

1. DOMJAN, Suzana, MEDVED, Sašo, ČERNE, Boštjan, **ARKAR, Ciril**. Fast modelling of nZEB metrics of office buildings built with advanced glass and BIPV facade structures. *Energies*. Aug. 2019, vol. 12, iss. 16, f. 1-18, ilustr. ISSN 1996-1073. <https://www.mdpi.com/1996-1073/12/16/3194>, [Repozitorij Univerze v Ljubljani – RUL](#), DOI: [10.3390/en12163194](https://doi.org/10.3390/en12163194). [COBISS.SI-ID [16752155](#)].
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3. DOMJAN, Suzana, **ARKAR, Ciril**, MEDVED, Sašo. Computer-aided supporting tool for LCA evaluation of energy efficiency of the buildings : assessment method and case studies. V: PASSER, Alexander (ur.). SBE19 Graz : transition towards a net zero carbon built environment : conference proceedings. Sustainable built environment D-A-CH conference 2019, Graz 11-14 September 2019, Graz, Austria. [S. l.]: IOP, 2019. Vol. 323, f. 1-9, ilustr. IOP conference series. Earth and environmental science (Online), vol. 323. ISSN 1755-1315. <https://iopscience.iop.org/article/10.1088/1755-1315/323/1/012109>, DOI: [10.1088/1755-1315/323/1/012109](https://doi.org/10.1088/1755-1315/323/1/012109). [COBISS.SI-ID [16793371](#)].

Tomaž Berlec:

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2. ŽUŽEK, Tena, GOSAR, Žiga, KUŠAR, Janez, **BERLEC, Tomaž**. *Adopting agile project management practices in non-software SMEs : a case study of a slovenian medium-sized manufacturing company*. Sustainability. 2020, vol. 12, iss. 21, str. 1-17, ilustr. ISSN 2071-1050. <https://www.mdpi.com/2071-1050/12/21/9245>, DOI: [10.3390/su12219245](https://doi.org/10.3390/su12219245). [COBISS.SI-ID [36195331](#)], [ICR, SNIP, WoS do 6. 12. 2022: št. citatov (TC): 10, čistih citatov (CI): 9, čistih citatov na avtorja (CIAu): 2,25, Scopus do 31. 1. 2023: št. citatov (TC): 13, čistih citatov (CI): 12, čistih citatov na avtorja (CIAu): 3,00].
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4. ŽUŽEK, Tena, RIHAR, Lidija, **BERLEC, Tomaž**, KUŠAR, Janez. *Use of a standard risk model and a risk map for product development project planning and management*. V: ZADNIK STIRN, Lidija (ur.), et al. SOR '19 proceedings. Ljubljana: Slovenian Society Informatika, Section for Operational Research, 2019. Str. 269-274, ilustr. ISBN 978-961-6165-55-6. [COBISS.SI-ID [16810779](#)], [Scopus].
5. KOŽELJ, Nejc, **BERLEC, Tomaž**. *Vpliv krajšanja časa menjave orodja na lastno ceno storitve*. V: BERLEC, Tomaž (ur.), BROJAN, Miha (ur.), DROBNIC, Boštjan (ur.). ŠTeKam : Študentska tehniška konferenca : Fakulteta za strojništvo, Ljubljana, 8. 9. 2022. Ljubljana: Fakulteta za strojništvo, 2022. Str. 71-78, ilustr. ISBN 978-961-6980-90-6. [COBISS.SI-ID [121396483](#)].

Drago Bračun:

1. **BRAČUN, Drago**, SELAK, Luka. Optical probing for CNC machining of large parts made from fiber-reinforced polymer composite materials. *International journal of advanced manufacturing technology*, ISSN 0268-3768, 2019, vol. 100, iss. 5/8, str. 1855-1865, ilustr.

<https://link.springer.com/content/pdf/10.1007%2Fs00170-018-2789-9.pdf>, doi: [10.1007/s00170-018-2789-9](https://doi.org/10.1007/s00170-018-2789-9). [COBISS.SI-ID [16273435](#)]

2. **BRAČUN, Drago**, ŠKULJ, Gašper, KADIŠ, Miran. Spectral selective and difference imaging laser triangulation measurement system for on line measurement of large hot workpieces in precision open die forging. *International journal of advanced manufacturing technology*, ISSN 0268-3768, apr. 2017, vol. 90, iss. 1-4, 917-926 str, ilustr. <http://link.springer.com/article/10.1007%2Fs00170-016-9460-0>, doi: [10.1007/s00170-016-9460-0](https://doi.org/10.1007/s00170-016-9460-0). [COBISS.SI-ID [14855195](#)].
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Miha Brojan:

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2. **BROJAN, Miha**, TERWAGNE, Denis, LAGRANGE, Romain, REIS, Pedro. Wrinkling crystallography on spherical surfaces. *Proceedings of the National Academy of Sciences of the United States of America*, ISSN 0027-8424, Jan. 2015, vol. 112, no. 1, str. 14-19, ilustr., DOI: [10.1073/pnas.1411559112](https://doi.org/10.1073/pnas.1411559112). [COBISS.SI-ID [13852187](#)].
3. TERWAGNE, Denis, **BROJAN, Miha**, REIS, Pedro. Smart morphable surfaces for aerodynamic drag control. *Advanced materials*, ISSN 0935-9648, Oct. 2014, vol. 26, iss. 38, str. 6608-6611, ilustr., DOI: [10.1002/adma.201401403](https://doi.org/10.1002/adma.201401403). [COBISS.SI-ID [13725211](#)]

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