

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strojni elementi 2 - RRP
Course title:	MACHINE ELEMENTS 2 - RRP
Članica nosilka/UL Member:	UL FS

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

Univerzitetna koda predmeta/University course code: 0562756

Koda učne enote na članici/UL Member course code: 2018-U

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30		30			40	4

Nosilec predmeta/Lecturer: Jernej Klemenc, Marko Nagode

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:

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):

Predavanja: Zveze gredi in pesta:

- Zagozde, mozniki in utorne zveze.
- Oblikovanje in vrednotenje zvez gredi in pesta.

2. Predavanja: Zveze gredi in pesta:

- Stožčasti nased.
- Spenjalna zveza.

3. Predavanja: Osi:

- Mirujoče in rotirajoče osi.
- Osnovni principi oblikovanja in vrednotenja osi.

4. Predavanja: Gredi:

- Osnovni principi oblikovanja in vrednotenja gredi.

1. Lecture: Shaft-hub connections:

- Wedges, keys and spline shafts.
- Design and evaluation of shaft-hub connections.

2. Lecture: Shaft-hub connections:

- Cone connection.
- Clamping connection.

3. Lecture: Axles:

- Stationary and rotating axles.
- Basic axle design and evaluation principles.

4. Lecture: Shafts:

- Basic shaft design and evaluation principles.

<p>5. Predavanje: Sklopke:</p> <ul style="list-style-type: none"> - Vrste sklopke. - Izbrane toge, izravnalne in varnostne sklopke. <p>6. Predavanje: Sklopke:</p> <ul style="list-style-type: none"> - Zagonska sklopka. - Sklopke za vklapljanje. <p>7. Predavanje: Uvod v gonila:</p> <ul style="list-style-type: none"> - Vrste gonil. - Prestavno razmerje. - Momenti, moči in izkoristki v gonilu. <p>8. Predavanje: Torna gonila:</p> <ul style="list-style-type: none"> - Fizikalne osnove tornih gonil. - Razmere pri nakotaljevanju in prestavno razmerje. <p>9. Predavanje: Torna gonila:</p> <ul style="list-style-type: none"> - Koeficient sojemanja in zdrs. - Vrednotenje tornih gonil. <p>10. Predavanje: Jermenska gonila:</p> <ul style="list-style-type: none"> - Vrste in zgradba jermenov in jermenic. - Dolžina jermena. - Sila prednapetja. - Eitelweinova enačba. - Sila v jermenu zaradi centrifugalne sile. <p>11. Predavanje: Jermenska gonila:</p> <ul style="list-style-type: none"> - Vpliv obodne sile na sile v jermenu. - Napetosti v jermenu. - Vrednotenje jermenskih gonil. - Prednapenjanje jermena. <p>12. Predavanje: Verižna gonila:</p> <ul style="list-style-type: none"> - Vrste in zgradba verig in verižnih koles. - Poligonski efekt. <p>13. Predavanje: Verižna gonila:</p> <ul style="list-style-type: none"> - Sile v verigi. - Oblikovanje in vrednotenje verižnih gonil. <p>14. Predavanje: Zobniška gonila:</p> <ul style="list-style-type: none"> - Osnovni pojmi. - Osnovni zakon ozobja. <p>15. Predavanje: Zobniška gonila:</p> <ul style="list-style-type: none"> - Konstrukcija protiboka in ubirnice ter dolžina ubirnice. 	<p>5. Lecture: Couplings:</p> <ul style="list-style-type: none"> - Types of couplings. - Selected rigid, position aligning and safety couplings. <p>6. Lecture: Couplings:</p> <ul style="list-style-type: none"> - Starting coupling. - Switching couplings. <p>7. Lecture: Power transmission drives:</p> <ul style="list-style-type: none"> - Types of drives. - Speed ratio. - Torques, powers and efficiencies in the drive. <p>8. Lecture: Friction drives:</p> <ul style="list-style-type: none"> - Physical backgrounds of friction drives. - Rolling contact problem and speed ratio. <p>9. Lecture: Friction drives:</p> <ul style="list-style-type: none"> - Coefficient of friction and slip ratio. - Evaluation of friction drives. <p>10. Lecture: Belt drives:</p> <ul style="list-style-type: none"> - Types and design of belts and pulleys. - Belt length. - Pretension force. - Eitelwein equation. - Forces in belt due to centrifugal force. <p>11. Lecture: Belt drives:</p> <ul style="list-style-type: none"> - Influence of tangential force on forces in belt. - Stresses in belt. - Evaluation of belt drives. - Belt tensioning. <p>12. Lecture: Chain drives:</p> <ul style="list-style-type: none"> - Types of chains and design of chains and sprockets. - Polygon effect. <p>13. Lecture: Chain drives:</p> <ul style="list-style-type: none"> - Forces in chain. - Design and evaluation of chain drives. <p>14. Lecture: Gear drives:</p> <ul style="list-style-type: none"> - Basic definitions. - The law of gearing. <p>15. Lecture: Gear drives:</p> <ul style="list-style-type: none"> - Design of opposite tooth profile and the line of action and determination of the line of action length.
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Temeljna literatura in viri/Readings:

1. Wittel H., Jannasch D., Vossiek J., Spura C. Roloff/Matek Maschinenelemente - 23. Auflage. Springer Vieweg, 2017. Izbrana poglavja
2. Decker K.H. Decker Maschinenelemente - 20 Auflage. Carl Hanser Verlag, 2018. Izbrana poglavja
3. Ren Z., Glodež S. Strojni elementi I. del. Založništvo Fakultete za strojništvo, Maribor, 200 Izbrana poglavja
4. Ren Z., Glodež S. Strojni elementi, Uvod v gonila, torna, jermenska in verižna gonila. Založništvo Fakultete za strojništvo, Maribor, 2005.
5. Flašker J., Glodež S., Ren Z. Zobniška gonila. Založba Pasadena, 2010. Izbrana poglavja.

Cilji in kompetence:

Objectives and competences:

Cilji:	Objectives:
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<ol style="list-style-type: none"> 1. Spoznati fizikalne in matematične osnove izbranih strojnih elementov. 2. Spoznati osnovne principe vrednotenja izbranih strojnih elementov na statično nosilnost, utrujanje in obrabo. 3. Spoznati dobre in slabe prakse oblikovanja izbranih strojnih elementov. 4. Spoznati programska orodja za oblikovanje in vrednotenje strojnih elementov in komponent. 5. Spoznati osnovne principe povezovanja strojnih elementov v komponente in izdelke. <p>Kompetence:</p> <ol style="list-style-type: none"> 1. S2-RRP: Sposobnost kritičnega, analitičnega in sintetičnega razumevanja strojnih elementov. 2. S5-RRP: Sposobnost uporabe informacijsko-komunikacijske tehnologije. 3. S6-RRP: Usposobljenost za uporabo pridobljenih znanj pri samostojnem reševanju manj zahtevnih tehničnih problemov v strojništvu. 4. P4-RRP: Sposobnost osnovnega fizikalnega in matematičnega modeliranja strojnih elementov s sposobnostjo kritične analize rezultatov. 5. P6-RRP: Sposobnost samostojnega izvajanja manj zahtevnih razvojnih in inženirskih del ter sposobnost kreativnega reševanja dobro definiranih nalog na področju strojništva. 	<ol style="list-style-type: none"> 1. Gain fundamental knowledge of selected machine elements pertaining to physics and mathematics. 2. Gain basic evaluation principles of selected machine elements pertaining to the static load-bearing ability, fatigue and wear. 3. Gain knowledge of good and bad design of selected machine elements. 4. Gain knowledge of computer software to design and evaluate machine elements and components. 5. Gain knowledge of fundamental principles to assemble machine elements into components and products. <p>Competences:</p> <ol style="list-style-type: none"> 1. S2-RRP: Development of creative, analytical and synthetic understanding of machine elements. 2. S5-RRP: The ability to use information and communication technology. 3. S6-RRP: The ability to use the acquired knowledge to solve professional engineering problems independently. 4. P4-RRP: The ability of basic physical, and mathematical modelling of machine elements with the ability of critically analysing the results. 5. P6-RRP: A Level 1 graduate is able to perform easier development, engineering and professional organisational tasks as well as to solve individual well-defined engineering tasks.
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Predvideni študijski rezultati:

<p>Znanja:</p> <p>Z1: Poglobljeno strokovno teoretično in praktično znanje na določenem področju, podprto s širšo teoretično in metodološko osnovo.</p> <p>- Poglobljeno strokovno teoretično in praktično znanje s področij zvez gredi in pesta, osi in gredi, sklopov, tornih, jermenskih, verižnih in zobniških gonil.</p> <p>Spretnosti:</p> <p>S1.1 Izvajanje kompleksnih operativno -strokovnih opravil, ki vključujejo tudi uporabo metodoloških orodij.</p> <p>- Izvajanje vrednotenja strojnih elementov skladno s sodobno literaturo in veljavnimi standardi.</p> <p>S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah.</p> <p>- Obvladovanje analitičnih in preprostih numeričnih orodij za oblikovanje in vrednotenje strojnih elementov, komponent in izdelkov.</p>	<p>Knowledge:</p> <p>Z1: In-depth professional theoretical and practical knowledge of a certain field, supported by a broader theoretical and methodological fundament.</p> <p>- In-depth professional theoretical and practical knowledge of shaft-hub connections, axles and shafts, clutches, friction drives, belt drives, chain drives and gear drives.</p> <p>Skills:</p> <p>S1.1 Performance of complex operational-professional tasks which include the use of methodological tools.</p> <p>- Evaluation of machine elements in accordance with contemporary literature and latest standards.</p> <p>S1.2 Mastering of demanding, complex operational processes and autonomous use of knowledge in new professional circumstances.</p> <p>- Mastering analytical and simple numerical tools for design and evaluation of machine elements, components and products.</p>
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Metode poučevanja in učenja:**Learning and teaching methods:**

P1: Avditorna predavanja z reševanjem izbranih teoretičnih in praktično uporabnih primerov.	P1: Auditory lectures including solution procedures for selected theoretical and practical examples.
P3: Avditorne vaje, kjer se teoretično znanje s predavanj podkrepi z računskimi primeri.	P3: Auditory exercises where theoretical knowledge gained at auditory lectures is substantiated by numerical examples.
P4: Laboratorijske vaje, kjer se teoretično znanje s predavanj podkrepi z laboratorijskimi preskusi.	P4: Laboratory exercises where theoretical knowledge gained at auditory lectures is substantiated by laboratory experiments.
P7 + P15: Video predavanja in vaje z diskusijo.	P7 + P15: Video lectures and exercises with discussion.

Načini ocenjevanja:**Delež/Weight****Assessment:**

- Teoretične vsebine (predavanja).	50,00 %	- Theoretical knowledge (lectures).
Samostojno delo na vajah.	20,00 %	- Individual work at exercises.
- Delo na laboratorijskih vajah (vključno s poročili).	20,00 %	- Work at laboratory exercises (including reports).
- Seminar.	10,00 %	- Seminar.

Reference nosilca/Lecturer's references:

Marko Nagode:

1. OKORN, Ivan, **NAGODE, Marko**. Analysis of energy efficiency of a test rig for air springs. Strojniški vestnik, ISSN 0039-2480, Jan. 2015, vol. 61, no. 1, str. 53-62, SI 9, ilustr., doi: 10.5545/sv-jme.2014.2143. [COBISS.SI-ID 13857051]
2. OMAN, Simon, **NAGODE, Marko**. On the influence of the cord angle on air-spring fatigue life. Engineering failure analysis, ISSN 1350-6307. [Print ed.], Jan. 2013, vol. 27, str. 61-73, ilustr., doi: 10.1016/j.engfailanal.20109.002. [COBISS.SI-ID 12477467]
3. BEŠTER, Tomaž, OMAN, Simon, **NAGODE, Marko**. Determining influential factors for an air spring fatigue life. Fatigue & fracture of engineering materials & structures, ISSN 1460-2695, Jan. 2019, vol. 42, iss. 1, f. 284-294, ilustr. <https://onlinelibrary.wiley.com/doi/epdf/10.1111/ffe.12904>, doi: 10.1111/ffe.12904. [COBISS.SI-ID 16196891]
4. **NAGODE, Marko**, GOSAR, Aleš, HACK, Michael, HANSENNE, Eric, ŠERUGA, Domen. A review of thermomechanical fatigue damage calculations with the damage operator approach. V: BECK, Tilmann (ur.). LCF8, Eight International Conference on Low Cycle Fatigue, June 27-29, 2017, Dresden, Germany. Berlin: DVM. 2017, str. 511-516, ilustr. [COBISS.SI-ID 15609371]
5. KLEMENC, Jernej, BEŠTER, Tomaž, **NAGODE, Marko**. Eksperimentalna in napredna numerična analiza dinamično obremenjenih spojev v sklopu projekta TPV4LIGHT : končno poročilo UL FS za prvo poročevalsko obdobje. Ljubljana: Fakulteta za strojništvo, Katedra za strojne elemente in razvojna vrednotenja, 2019. 42 f., ilustr. [COBISS.SI-ID 16809243]

Jernej Klemenc:

1. TOMAŽINČIČ, Dejan, SEDLAČEK, Marko, PODGORNIK, Bojan, **KLEMENC, Jernej**. Influence of different micro-imprints to fatigue life of components. Materials performance and characterization, str. 79-95, doi: 10.1520/mpc20160024. [COBISS.SI-ID 1292714]
2. **KLEMENC, Jernej**, RUPP, Andreas, FAJDIGA, Matija. Dynamics of a clapper-to-bell impact. International Journal of Impact Engineering, Jun. 2012, vol. 44, iss. 6, str. 29-39, doi: 10.1016/j.ijimpeng.2011.1006. [COBISS.SI-ID 12166171]

3. **KLEMENC, Jernej**, WAGNER, Andrej, FAJDIGA, Matija. Modeling the S-N curves of polyamide PA66 using a serial hybrid neural network. Journal of engineering materials and technology : Transactions of the ASME, Jul. 2011, vol. 133, iss. 3, 031005-1-031005-14, doi: 10.1115/1.4004054. [COBISS.SI-ID 11844123]
4. **KLEMENC, Jernej**, BUČAR, Tomaž, FAJDIGA, Matija. Inspection of stepping of an electrically adjustable front seat at an end-of-line quality control unit. V: DUBOKA, Čedomir (ur.). Cooperative European Automotive Engineering, 10th EAEC European Automotive Congress in association with the 20th International Conference "Science and Motor Vehicles 2005", Beograd, Serbia & Montenegro, 30th May - 1 June, 2005. Belgrade: Yugoslav Society of Automotive Engineers, JUMV. 2005, str. AQ06-1 - AQ06-7. [COBISS.SI-ID 8251163]
5. OKORN, Ivan, VIDIC, Gašper, **KLEMENC, Jernej**. Evaluation of gear drive for valve spindle. Ljubljana: Fakulteta za strojništvo, Katedra za strojne elemente, 2015. 33 f. [COBISS.SI-ID 14010139]